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Stranded in the wastelands? Natural capital depletion and bank deposit reallocation

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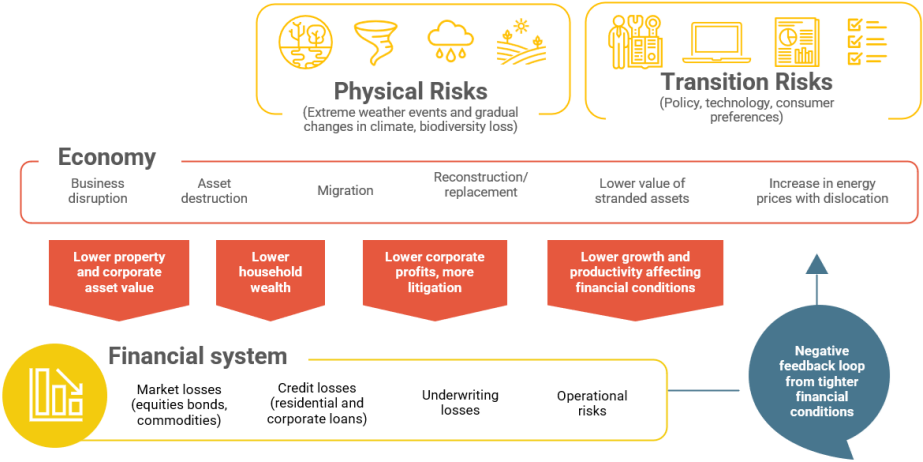
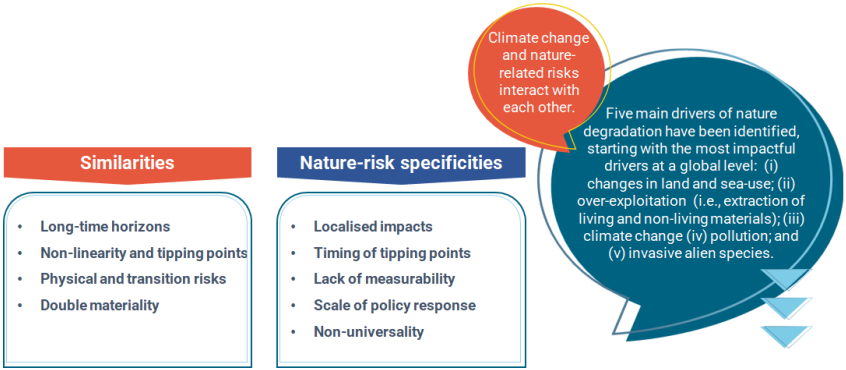
Climate- & nature-related financial risks

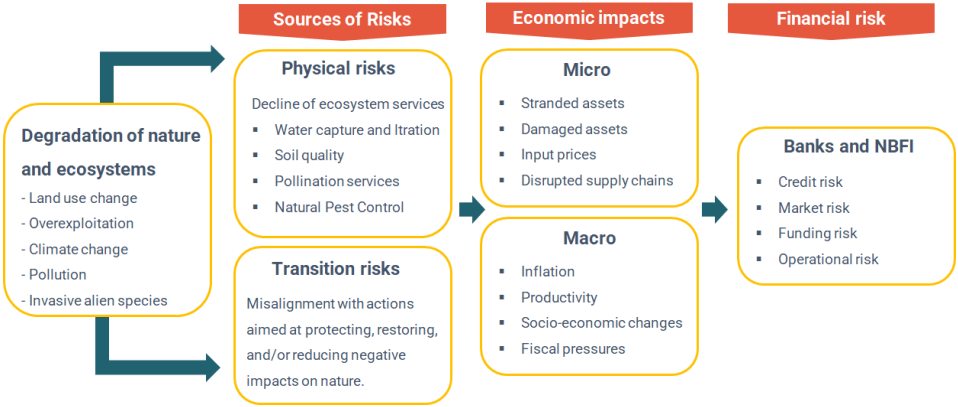


Climate- vs. nature-related risks



- The term 'nature' captures both the biotic (living) and abiotic (non-living) elements on our planet, including biodiversity but also climate.
- Some of these elements, such as natural resources (plants, animals, air, water, soils, minerals etc.), are sometimes also referred to as natural capital.

From environmental degradation to nature risks



- Nature loss is local. Location matters especially when approaching tipping points.
  $\Rightarrow$ cutting down a tree cannot be made equivalent by planting another elsewhere.

- The CFRC is currently working on three workstreams that seek to enhance central banks' technical capacities in areas like macro modeling and stress testing.
- Advances are being published as use cases (open access) in the Latin American Journal of Central Banking (LAJCB).

How can we measure biodiversity losses?

The case of the Jaguarundi (American wild cat).

- The Jaguarundi is an apex predator in the ecosystems where he lives:
  - Intuition: robust predator-prey interactions proxy for a more diverse ecosystem.

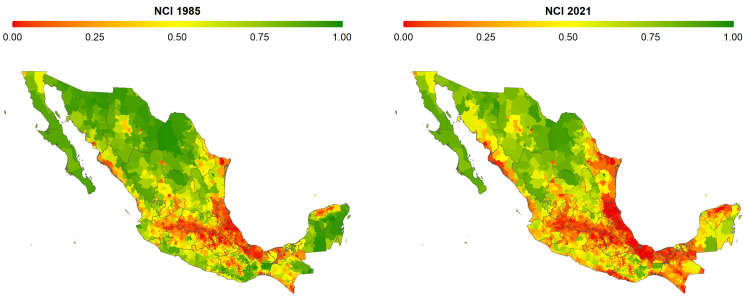
How do financial institutions react when facing widespread natural capital losses?

- Natural capital (NC) losses have been linked to a migration of labor and production from affected regions (see, e.g., Albert et al., 2023, Brottrager et al., 2023).
  - Using unique NC series from Mexico, we unravel a novel mechanism linking NC losses and banks' businesses reallocation.

- Approach & findings:
  - We construct a measure of bank branches' indirect exposure to NC losses in the regions where its parent bank is active.
  - Branches with a larger exposure to NC losses report an increase in deposits' supply.
  - The effect only appears if NC losses occur in regions intensive in agriculture.

Motivation

Natural capital losses: the Mexican experience



Source: Own elaboration with data from CONABIO.

- In Mexico, regions with a high NC endowment as of 1985 lost on average more than 0.2 points in the Natural Capital Index (0-1).

Motivation

Can natural capital losses incentivize a reallocation of banks' assets?

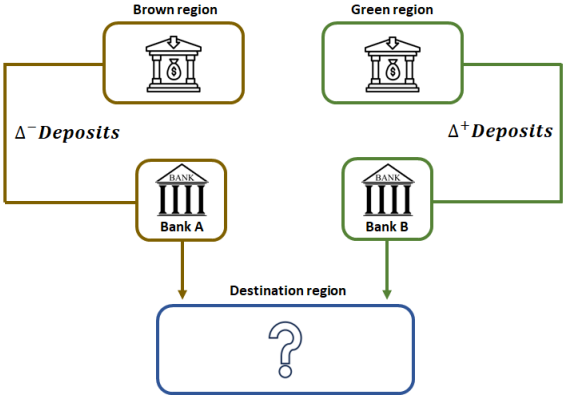
- Factor reallocation (Albert et al., 2023):
  - As the loss of NC endowment exacerbates, NC-dependent industries face productivity losses, leading to a geographical reallocation.
  - Production factors have been found to react to climate change.
- Deposit dependence (Gilje et al., 2016):
  - Absent of deposit market fragmentation, deposit sources could be perfect substitutes.
  - If banks need to invest in a deposit franchise to secure deposit supply, NC losses may trigger a reallocation of banks' businesses.

Research question

- Do natural capital losses induce a reallocation of banks' deposit supply?
  - Compare deposit growth of branches with a different ex-ante exposure to NC losses through related branches.
- Identification strategy sheds light on underlying channels:
  - We explore the impact of NC losses in regions highly dependent on agriculture.
  - We conjecture that this impact may materialize if the affected regions provide sizable shares of a bank's deposits.

Research design

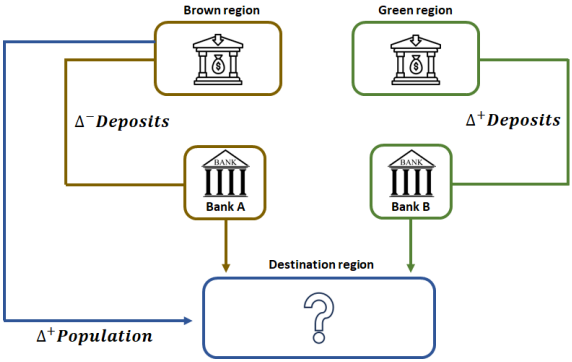
Channeling the effect of NC losses through deposits' dependence



- Bank A depends on deposits raised in a brown region with large NC losses $\Rightarrow$ it triggers a reallocation of deposits to a new destination region.

Research design

Channeling the effect of NC losses through deposits' dependence



- Plausible mechanisms include banks' following a reallocation of production factors that sustain a deposit franchise.

Research design (cont'd)

Identification challenges

- Endogeneity of natural capital losses
  - Banks' activity may be a reason driving NC losses.
  - We focus on an indirect effect on bank deposits outside the regions facing NC losses.
- Omitted variables driving the demand for bank services
  - Changing credit demand conditions could be spuriously correlated with branches' exposure to NC losses.
  - We compare branches with different exposures operating within the same municipality over time.

Empirical Model

Collapsed panel regression from 2014-2021

Model based on a panel at the bank-municipality level:

$$\begin{aligned}\Delta Deposits_{i,j,2014-2021} = &\beta Exposure_{i,j,2014-2021} \\ &+ \gamma \Delta Controls_{i,j,2014-2021} + \mu_j + \gamma_i + \varepsilon_{i,j}\end{aligned} \tag{1}$$

1. $\Delta Deposits_{i,j,2014-2021}$: log change in outstanding deposits, 2014-2021.
2. $Exposure_{i,j,2014-2021}$: Exposure to natural capital losses across regions different than j.
3. μ_j municipality FE and γ_i bank FE.

Empirical Model

Branches indirect exposure to NC losses. Example

We sum the impact of NC losses on all branches different than i, j within i:

$$Exposure_{i,j,2014-2021} = \sum_{m \in M_b, m \neq j} Dep\ share_{i,j} * Ag\ share_j * \Delta NCI_{j,2014-2021} \quad (2)$$

1. $Dep\ share_{i,j}$: Share of branch i, j in bank's i deposits as of 2014.
2. $Ag\ share_j$: Share of agricultural area in municipality's j total area in km2 as of 2014.
3. $\Delta NCI_{j,2014-2021}$: change in the NC index between 2014 and 2021.

Empirical Model

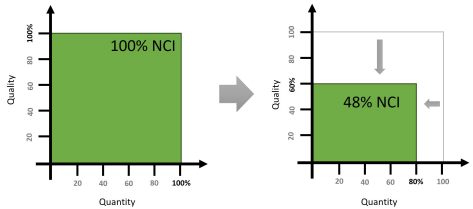
Data sources

- We use data from three main sources:
  - Bank branches: Monthly call reports from 2014 to 2021 collected by the Mexican Banking and Securities Commission, manually merged to banks' consolidated balance sheet.
  - NC Index: Natural Capital Index from 1985 to 2021, published by the Mexican Biodiversity Commission (see Mora, 2019 and Martinez-Jaramillo et al., 2023)
  - Agricultural share: Series constructed using data from the Ministry of Agriculture and Rural Development.

Natural Capital Index

We exploit historical series of field-collected data, dating back to the 1980s. Example

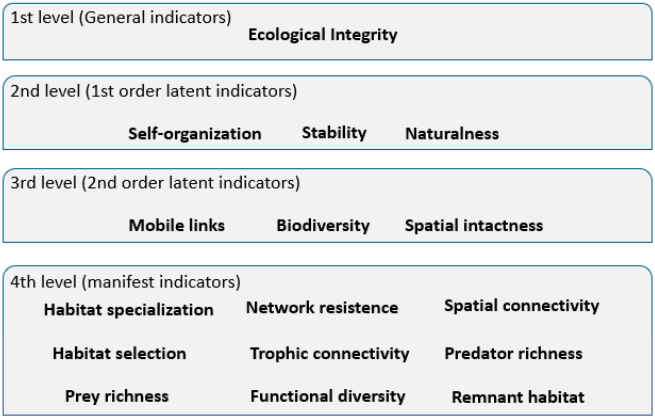
$$NCI = ecosystem\ \ quality \times ecosystem\ \ quantity \tag{3}$$



- The Natural Capital Index (NCI) is a biodiversity indicator based on 2 processes:
  - Ecosystem quantity: measure of intactness of protected areas.
  - Ecosystem quality: intactness of top predator interactions in a given region.

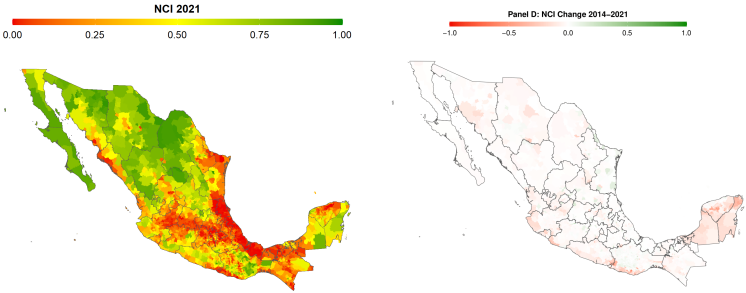
Natural Capital Index

Ecosystem quality is measured following a Ecological Integrity Hierarchical Framework.



Source: from Mora (2019)

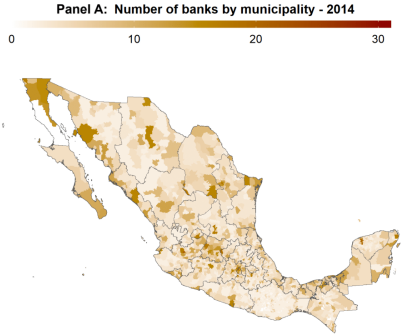
Natural Capital Index - Descriptive stats



Source: Own elaboration.

- Changes in NC between 2014 and 2021:
  - High level of degradation in the central regions and the Gulf coastal plains.
  - High loss of NC in the Yucatan Peninsula and the Pacific coastal plains.

Regional banking sample



Source: Branches' Call Reports, own elaboration.

- Sample consists of 5,171 branches that belong to 25 banks and operating continuously between 2014 and 2021 in 2,231 municipalities across Mexico.

Results

Benchmark results

Table 1: Effect of NC losses on branches' deposits

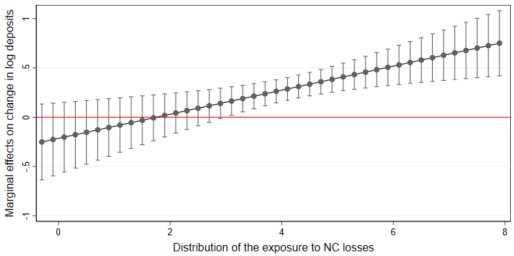
	(1)	(2)	(3)	(4)	(5)
	$\Delta Imports$				
Exposure ΔNCI	0.327***	0.483***	0.460***	0.282**	0.354**
	(0.036)	(0.134)	(0.130)	(0.109)	(0.136)
Observations	5,171	5,171	5,171	3,812	3,808
Adj. R-squared	0.041	0.094	0.114	0.236	0.290
FE	None	None	State	Mun.	Mun. & Bank

Notes: Robust standard errors clustered at the bank level in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

- A larger exposure to natural capital losses outside a branch's region is associated with larger deposit growth rates.
- A one SD higher (pre-determined) exposure to natural capital losses leads to a 32 p.p. larger increase in deposits.

Benchmark results

Quadratic regression & marginal effects



$$\Delta Deposits_{i,j,2014-2021} = \beta_1 Exposure_{i,j,2014-2021} + \beta_2 Exposure^2_{i,j,2014-2021} + \gamma \Delta Controls_{i,j,2014-2021} + \alpha_j + \varepsilon_{i,j}$$

- A one SD higher exposure leads to a larger increase in deposits equivalent to 13% of a SD in the growth rate of deposits.

Taking stock

The effect of NC losses on bank deposit

- Results in line with the notion that banks invest in their deposit franchise in other regions once important deposit sources are lost (Drechsler et al., 2023).
- Next, we explore plausible mechanisms explaining this finding:
  - Banks may expand in regions with a high NC endowment.
  - Regions reporting large agricultural productivity may benefit the most.

Reallocating towards high-endowment regions

Table 2: Effect of NC losses on branches' deposits by regions

Sample:	**full**	**NCI as of 2014**		**ΔAgr. productivity**	
		High	**Low**	**Low**	**Large**
	(1)	(2)	(3)	(4)	(5)
Exposure ΔNCI	0.282**	0.314***	0.239	0.158	0.499***
	(0.109)	(0.088)	(0.149)	(0.098)	(0.120)
Observations	3,812	1,555	2,257	2,568	1,244
Adj. R-squared	0.236	0.244	0.226	0.228	0.264
FE	Mun.	Mun.	Mun.	Mun.	Mun.

Notes: Robust standard errors clustered at the bank level in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

- Effect concentrates in regions with high natural capital endowment and those reporting large increases in agricultural productivity.

Horse race against competing variables

Table 3: Effect of NC losses controlling for alternative exposures

Exposure:	**Baseline** (1)	**Δlog population** (2)	**log mun. area** (3)	**Δlog credit** (4)	**Δlog ATM** (5)
Exposure ΔNCI	0.282***	0.240***	0.274***	0.255**	0.256***
	(0.089)	(0.085)	(0.092)	(0.095)	(0.087)
Alt. Exposure		0.106	-0.056	-0.072	-0.136
		(0.079)	(0.157)	(0.084)	(0.121)
Observations	3,793	3,793	3,793	3,793	3,753
Adj. R-squared	0.243	0.245	0.243	0.243	0.245
FE	Mun.	Mun.	Mun.	Mun.	Mun.

Notes: Robust standard errors clustered at the bank level in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

- Alternative sources of branches' exposure do not affect the main findings ⇒ the change in NCI matters beyond other adjustments in local economies.

Extensions & real effects

- Extensions & robustness
  - Results do not hold if the agricultural share is not included in the exposure metric.
  - Stronger effect for banks with riskier credit portfolios.
- Real economic & aggregate impacts
  - Exposed branches increase credit supply, particularly payday loans.
  - Destination regions face net increases in population, credit-market expansions, and eventually a decrease in natural capital.

Do banks expand credit supply?

Payday loans, directly linked to labor market dynamics, react the strongest to branches' exposure.

Table 4: Effect of NC losses on credit supply

Exposure:	**ΔConsumer loans** (1)	**ΔPayday loans** (2)	**ΔPersonal loans** (3)
Exposure ΔNCI	2.034***	2.303***	-0.986
	(0.648)	(0.499)	(0.630)
Observations	3,268	2,289	3,100
Adj. R-squared	0.491	0.656	0.233

Notes: Robust standard errors clustered at the bank level in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

- Consumer credit expands at a stronger pace — particularly payday loans — when the exposure to NC losses rises.

Final remarks

Unravelling the impact of natural capital losses on deposit reallocation

- We study the impact of natural capital depletion on the reallocation of banks' activities to less environmentally distressed regions.
  - Underscore a channel connecting the reallocation of production factors and banks' businesses once NC is depleted.
  - We bridge the gap between studies on the economic impact of NC losses and those unravelling the dynamics of capital reallocation.
- The results highlight that climate adaptation responses can be conditioned by a natural capital depletion spiral, fueled by banks geographical presence.

Appendix

Contribution

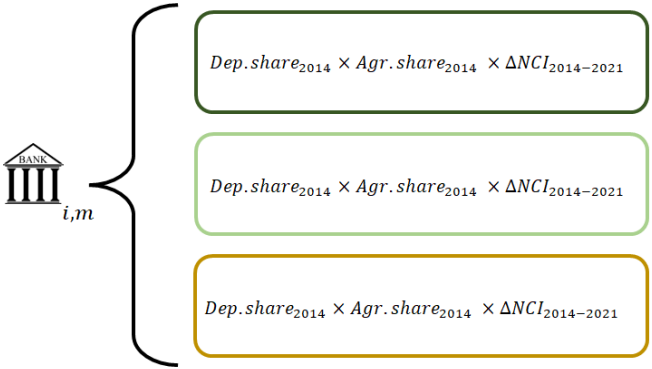
The paper fills a gap in the literature on the interaction between environmental risks and the reallocation of banking services.

- Several studies have documented that climate change, environmental degradation, and related natural disasters have major implications for economic outcomes.
  Cavallo et al. (2023);Dell et al. (2014);Cattaneo and Peri (2021);Albert et al. (2023);Liu et al. (2023);.
  $\Rightarrow$ This paper: shows that NC losses lead banks to reallocate their activities, engaging in the costly investment in new deposit franchises.

- Previous work documents how banks reallocate their liquidity and capital across regions when facing regional-specific liquidity shocks.
  Gilje et al. (2016); Bustos et al. (2016); Littke and Ossandon Busch (2021).
  $\Rightarrow$ This paper: we quantify the sensibility of deposit-dependent banks on NC losses when affected regions are a significant source of bank funding.

Empirical Model

Branches indirect exposure to NC losses. Back



Natural Capital Index

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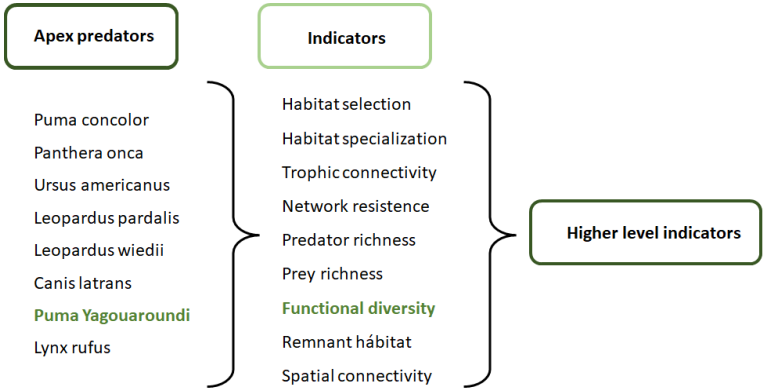

Literature

Literature I

C. Albert, P. Bustos, and J. Ponticelli. The effects of climate change on labor and capital reallocation. *NBER Working Paper No. 28995, National Bureau of Economic Research*, 2023.

M. Brottrager, J. Crespo Cuaresma, D. Kniveton, and S. H. Ali. Natural resources modulate the nexus between environmental shocks and human mobility. *Nature Communications*, 14(1393), 2023.

P. Bustos, B. Caprettini, and J. Ponticelli. Agricultural productivity and structural transformation: Evidence from brazil. *American Economic Review, American Economic Association*, 106(6): 1320–1365, 2016.

C. Cattaneo and G. Peri. The migration response to increasing temperatures. *Journal of Development Economics, Elsevier*, 122(C):127–146, 2021.

E. Cavallo, S. Galiani, I. Noy, and J. Pantano. Catastrophic natural disasters, and economic growth. *The Review of Economics and Statistics, MIT Press*, 95(5):1549–1561, 2023.

M. Dell, B. F. Jones, and B. Olken. What do we learn from the weather? the new climate–economy literature. *Journal of Economic Literature*, 52(3):740–798, 2014.

Literature II

I. Drechsler, A. Savov, P. Schnabl, and O. Wang. Banking on uninsured deposits. *NBER Working Paper No. 31138, National Bureau of Economic Research*, 2023.

E. P. Gilje, E. Loutskina, and P. E. Strahan. Exporting liquidity: Branch banking and financial integration. *Journal of Finance*, 71(3):1159–1184, 2016.

H. C. Littke and M. Ossandon Busch. Banks fearing the drought? liquidity hoarding as a response to idiosyncratic interbank funding dry-ups. *Journal of International Money and Finance, Elsevier*, 119(C), 2021.

M. L. Liu, Y. Shamdasani, and V. Taraz. Climate change and labor reallocation: Evidence from six decades of the indian census. *American Economic Journal: Economic Policy, American Economic Association*, 15(2):395–423, 2023.

S. Martinez-Jaramillo, F. Mora, L. O. Escobar-Farfán, and R. Montañez-Enríquez. Dependencies and impacts of the Mexican banking sector on ecosystem services. *Technical Report, Banco de México*, 2023.

Literature III

F. Mora. The use of ecological integrity indicators within the natural capital index framework: The ecological and economic value of the remnant natural capital of méxico. *Journal for Nature Conservation, Elsevier*, 47:77–92, 2019.