Pricing the Priceless:
The Financing Cost of Biodiversity Conservation

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- **How do investors price (govt-led) biodiversity transition?**
  - short-term transition costs *vs.* long-term sustainability
  - nation-wide investors *vs.* local biodiversity improvements

- **Setting: Green Shield Action (GSA) in China**
  - enforces preservation rules in national nature reserves (NNRs)
  - covers all NNRs <u>for the first time</u> in 2017 & repeated annually
    - 20K+ issues found, 6M+ m^2 constructions razed, 1K+ officials accountable...
  - local govts have <u>little discretion</u> in implementation (GSA & NNRs)
  - local govts are <u>mainly responsible (including funding)</u> for NNRs

- **Empirical strategy:**
  - DID: municipalities with *vs.* without NNRs around the introduction of GSA
    - pre-existing NNRs, balance tests, pre-trend analyses...
 - outcome variables: municipal corporate bond (MCB) spread

- **GSA increased MCB spreads:** by ~24 bps
  - additional interest payments: estimated ~$40 billion (2018-2021)

- **Potential mechanism**
  - ✓ shutting down illegal economic activities within NNRs
  - ✓ expanding local public spending on NNRs
  - × not driven by (potentially) more public financing demand
  - × not driven by (potentially) higher local political risk

- **Heterogeneity:** larger effects in
  - bonds with shorter maturities & local govts in weaker fiscal conditions

- **"Value"** *vs.* **"Values"**
  - **local biodiversity improved**
  - pursuit of financial returns > non-pecuniary preferences on biodiversity

"Externalities" of Biodiversity Conservation

- **Biodiversity matters**
  - Over 50% of global GDP depends on nature (UN, 2022)
  - 25% of species threatened with extinction (Díaz et al., 2019, Science)
  - "Biodiversity loss & ecosystem collapse": 3rd worst long-term risk (WEF, 2024)
  - External validity and externalities? Biodiversity is a GLOBAL/ECOSYSTEM issue!

- **Gaps and actions in biodiversity conservation**
  - CBD-COP15: introduced a framework to reverse biodiversity loss; focus on direct biodiversity metrics and market outcomes (Cardinale, et al., 2012; Costello et al., 2016; Pascual et al., 2023).
  - Global financing gap: investments needed ≈ $700 billion more per year (Deutz et al., 2020)
  - Private sector: challenging (Karolyi & Tobin-de la Puente, 2023; Flammer et al., 2023)
  - Public sector: efforts through wide-ranging policy initiatives, bearing massive costs.

- **Unintended consequences and broader implications of conservation policies**
  - Boost agricultural productivity (Frank et al., 2024).
  - The effects on firms/people indirect, unlike climate.
  - Reduce health risks (Frank & Su-darshan, 2023 AER; Frank, 2021; Keesing & Ostfeld, 2021).
  - Enhance climate/disaster resilience (Isbell et al., 2015 Nature; Taylor & Druckenmiller, 2022 AER).
  - Boost science research (Chen, Cong, Gao, Karolyi, & Wang).
  - Implications for financial markets, especially public financing.

- **Establishment of NNRs pre-determined**
- **The geographical distribution of NNRs**
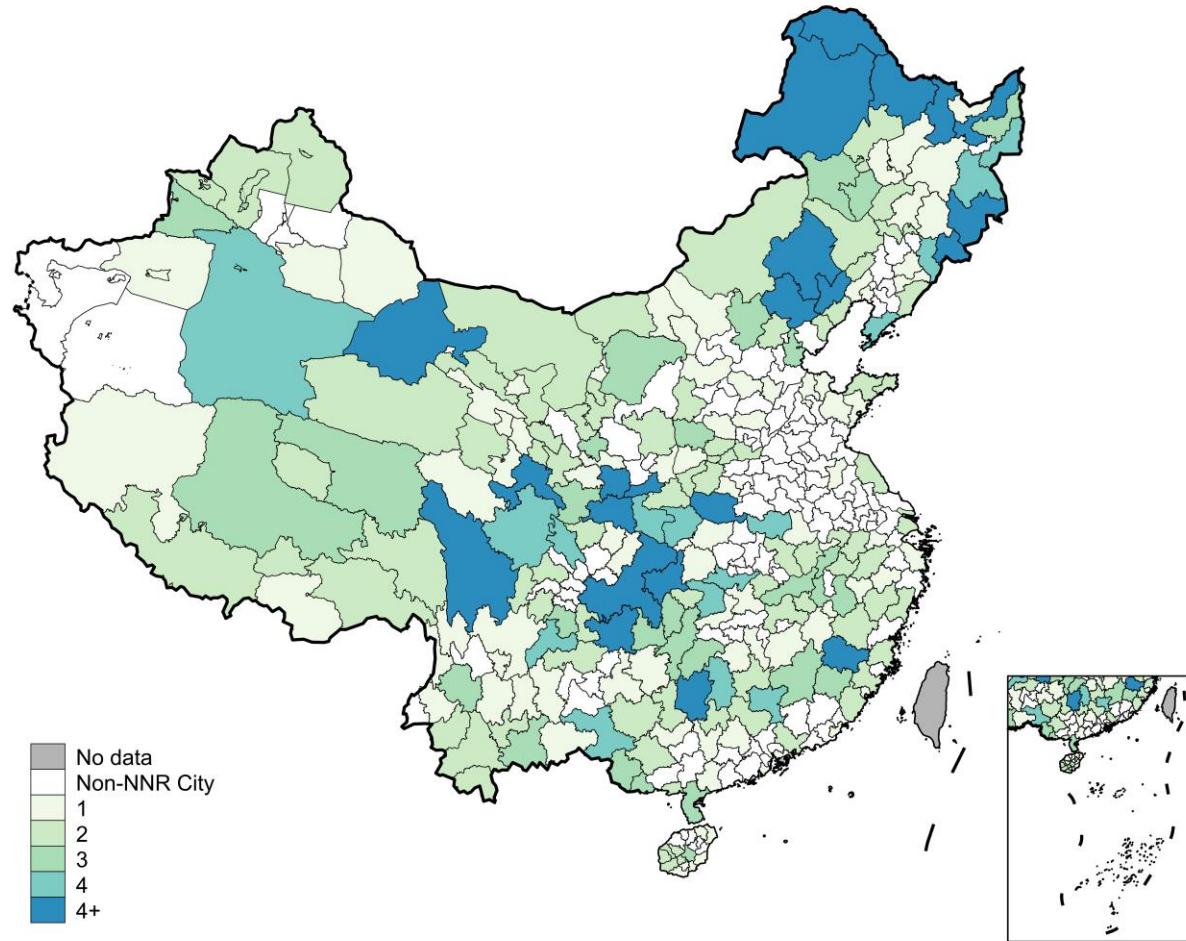
- **NNR**

  - NNR lists: the Ministry of Ecology and Environment

  - a digital map of NNRs

    - borders, dates of inception…

    - merge it with other GIS data

      - city border map

      - satellite/remote sensing datasets: land cover, nighttime lights…

- **MCB**

  - **the only asset with market prices reflecting financing costs of Chinese local govt debt**

  - yield spreads: following Geng & Pan (2024 JF)

   - quarterly level panel, CDB yield reference …

$$Spread_{bict} = \delta_{ic} + \lambda_t + \beta NNR_c \times Post_t + \theta X_c \times Post_t + \gamma Z_{bict} + \varepsilon_{bict} \quad (1)$$

TABLE 2: GSA AND MCB SPREADS: BASELINE ESTIMATES

	Spread			
	(1)	(2)	(3)	(4)
NNR × Post	0.270***	0.250***	0.256***	0.237***
	(0.101)	(0.094)	(0.075)	(0.072)
Year-quarter FE	Yes	Yes	Yes	Yes
Issuer FE	Yes	Yes	Yes	Yes
Bond controls	No	Yes	No	Yes
City pre-shock var. × Post	No	No	Yes	Yes
Adjusted R^2	0.493	0.552	0.503	0.561
Obs	87885	87885	87885	87885

$$Spread_{bict} = \delta_{ic} + \lambda_t + \sum_t \beta_t\, NNR_c \times Time_t\ + \theta X_c \times Post_t + \gamma Z_{bict}\ +\ \varepsilon_{bict} \quad (2)$$
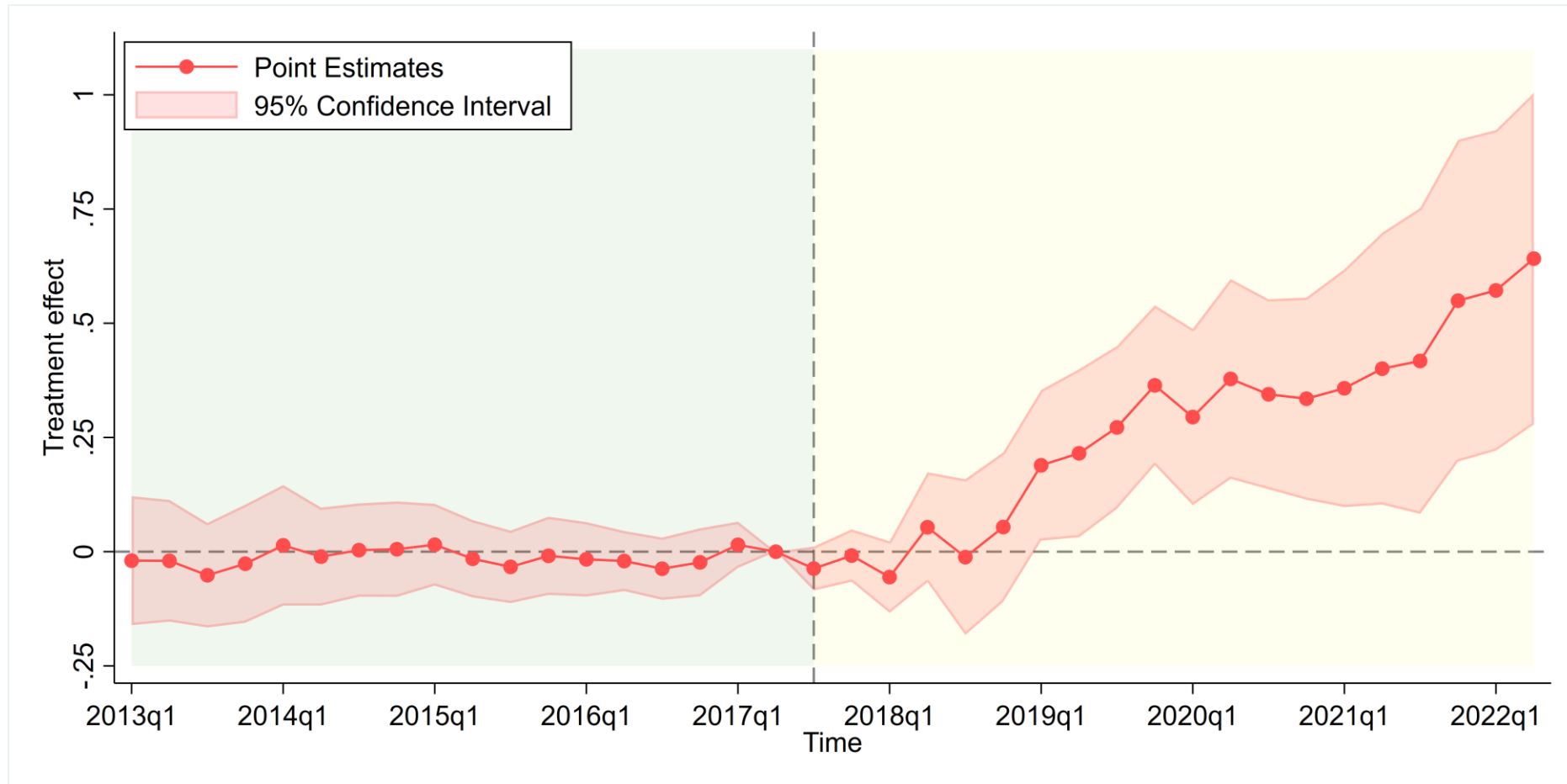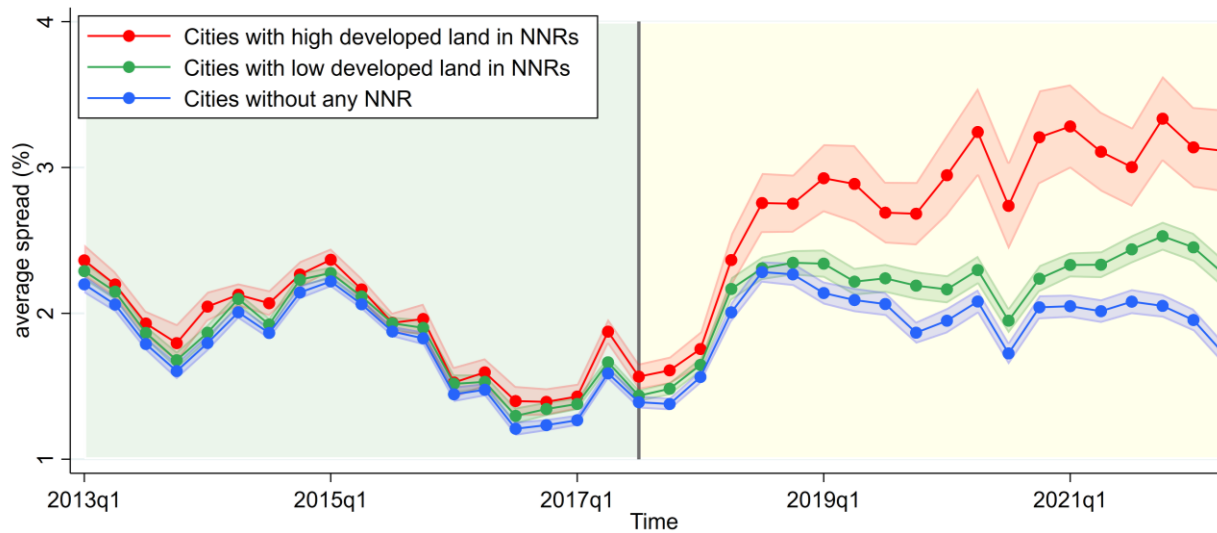
- **Jinyun Mountain NNR in Chongqing**
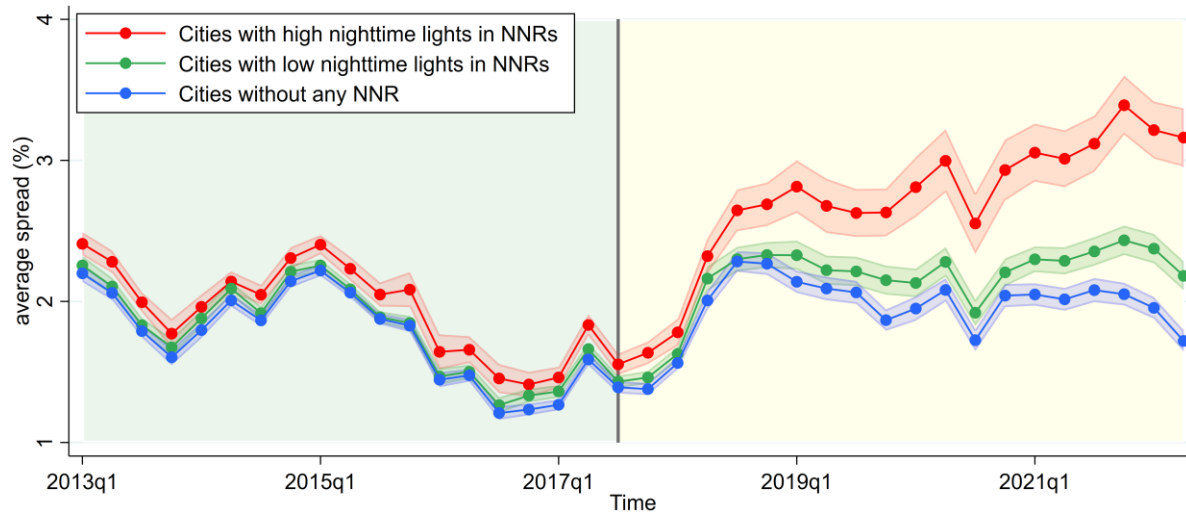

pre-GSA

post-GSA

- Beibei District Govt spent over 440 mill. RMB in relocation effort.

  - fiscal revenue: mere 3 billion RMB for that year (≈15%).

(a) Grouped by Developed Land Area in NNRs

(b) Grouped by Nighttime Lights in NNRs

- Worsen local fiscal condition

TABLE 5: GSA AND LOCAL PUBLIC CREDITWORTHINESS

Panel A: GSA and local fiscal condition

	Fiscal deficit	
	(1)	(2)
NNR × Post	0.253***	0.203**
	(0.097)	(0.079)
Controls	No	Yes
Year FE	Yes	Yes
City FE	Yes	Yes
Adjusted R^2	0.924	0.932
Obs	2725	2725

- Greater effects for cities with higher debt burden.

TABLE 5: GSA AND LOCAL PUBLIC CREDITWORTHINESS

Panel B: GSA and MCB spreads: local debt pressure

	Spread	
	Total debt	Interest-bearing debt
Grouping reference	(1)	(2)
NNR × Post × High debt burden	0.245*	0.286**
	(0.127)	(0.136)
NNR × Post	0.120	0.097
	(0.093)	(0.098)
Other terms of triple differences	Yes	Yes
Controls	Yes	Yes
Year-quarter FE	Yes	Yes
Issuer FE	Yes	Yes
Adjusted R^2	0.562	0.563
Obs	87837	87837

- Greater effects for bonds with shorter maturities:
- Short-term investors do not think about long-term "value"

TABLE 6: GSA AND MCB SPREADS: BOND TERM STRUCTURE

	Spread					
Grouping reference	Long Term >3 years			Long Term >4 years		
Sample	Short Term	Long Term	Full Sample	Short Term	Long Term	Full Sample
	(1)	(2)	(3)	(4)	(5)	(6)
NNR × Post	0.342***	0.178***	0.311***	0.307***	0.151**	0.278***
	(0.097)	(0.066)	(0.091)	(0.076)	(0.077)	(0.078)
NNR × Post × **1**[Long Term]			-0.164**			-0.153**
			(0.075)			(0.072)
Other terms of triple differences			Yes			Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year-quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Issuer FE	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.587	0.655	0.563	0.580	0.673	0.562
Obs	35260	52625	87885	48414	39471	87885

- Investors' non-pecuniary preferences on sustainablity
  - do not favor effective biodiversity improvements
  - inconsistent with the heterogeneity in information disclosure
  - inconsistent with the insignificance among lower-level nature reserves

TABLE A13: GSA AND MCB SPREADS: BIODIVERSITY IMPROVEMENT

	Spread			
	Birds species observed		speicies - ICUN measure	
	(1)	(2)	(3)	(4)
NNR × Post	0.186**	0.193**	0.206**	0.226***
	(0.085)	(0.075)	(0.084)	(0.084)
NNR × Post × High bio improvement	0.113	0.191	0.129	0.044
	(0.112)	(0.185)	(0.111)	(0.098)
Other terms of triple differences	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Year-quarter FE	Yes	Yes	Yes	Yes
Issuer FE	Yes	Yes	Yes	Yes
Adjusted R^2	0.560	0.561	0.561	0.561
Obs	86039	86039	87885	87885

- ➢ Some investors hold non-pecuniary preferences on biodiversity
  - know little about the actual situation of NNRs
  - GSA delivered delayed information on the poor management of NNR
  - ⇒ "values" (impact) investors may blame local authorities for past negligence
    - ■ inconsistent with the dynamic pattern in Figure 4

TABLE A10: GSA AND MCB SPREADS - INFORMATION ASYMMETRY

	Spread	
	(1)	(2)
NNR × Post	0.247**	0.245**
	(0.108)	(0.105)
NNR × Post × High newspaper coverage	-0.014	0.006
	(0.108)	(0.107)
Other terms of triple differences	Yes	Yes
Controls	Yes	Yes
Year-quarter FE	Yes	Yes
Issuer FE	Yes	Yes
Adjusted R^2	0.561	0.561
Obs	87885	75184

FIGURE 7: LOCAL PUBLIC DEBT COST COMPARISON OF TRUE VALUE AND COUNTERFACTUAL ESTIMATES
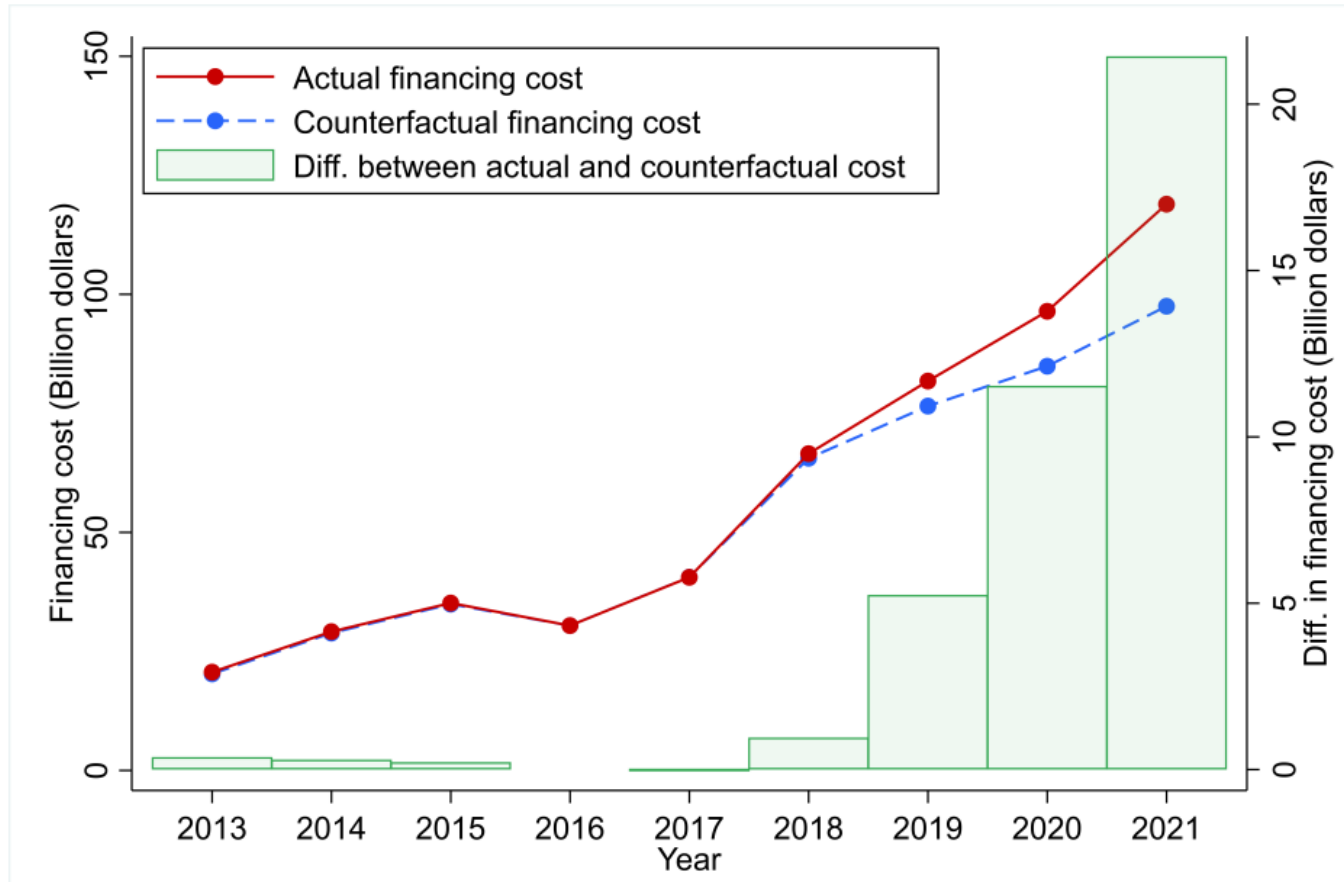
- A **back-of-the-envelope** estimation of additional public financing costs (i.e., interest payment): ~40 billion dollars (2018-2021).

Takeaways

- **Local governments pay; GSA increased MCB spreads:** by ~24 bps
  - Additional interest payments: Estimated ~$40 billion (2018-2021)

- **Potential mechanisms**
  - ✓ shutting down illegal economic activities within NNRs
  - ✓ expanding local public spending on NNRs
  - ✗ not driven by (potentially) more public financing demand
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- **Heterogeneity:** larger effects with shorter maturities & weaker fiscal conditions

- **"Value"** *vs.* **"Values" (when local biodiversity improves)**
  - pursuit of financial returns > non-pecuniary preferences on biodiversity

- **Policy implications**
  - Fiscal condition and biodiversity benefit; allocational "efficient frontier."
  - "Blended" Biodiversity Finance/specialized financing instruments (Flammer, Giroux & Heal, 2023, 2024).
  - Adequate info disclosure and ESG education and cultivation on long-term "value" and "values."