Pricing the Priceless: The Financing Cost of Biodiversity Conservation

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Motivation

- **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": Top 3 worst long-term risk (WEF, 2024,, 2025)

- **Global biodiversity financing gap**
  - Additional investments needed ≈ $700 billion per year (Deutz et al., 2020)
  - Incentivizing private sector remains challenging (Starks, 2023 JF; Karolyi & Tobin-de la Puente, 2023 FM; Flammer et al., 2025 JFE)

- **Government takes the most conservation efforts**
  - financial implications: lack of evidence

This Paper...

- **Research question: How investors price (government-led) biodiversity conservation transition**
  - short-term transition costs *vs.* long-term sustainability
  - nation-wide investors *vs.* local biodiversity improvements
- **Setting: Green Shield Action (GSA) in China**
  - enforced preservation rules in national nature reserves (NNRs)
  - covered all NNRs for the first time in 2017 & repeated annually
    - 20 k+ issues found, 6 million+ m^2 constructions razed, 1k+ officials held accountable in the first round...
  - local governments have little discretion in implementation (GSA & NNRs)
  - local governments are mainly responsible (i.e. transition costs) for NNRs
- **Empirical strategy:**
  - DID: municipalities with *vs.* without NNRs around the introduction of GSA
    - pre-existing NNRs, pre-trend analyses, balance tests, placebo tests with non-NNR reserves...
  - outcome variables: municipal corporate bond (MCB) credit spread

Preview of Main Findings

- **GSA increased MCB spreads:** by ~24 bps (12% of the sample mean)
  - additional financing costs: 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:** more pronounced effects in
  - bonds with shorter maturities & local governments in weaker fiscal conditions
- **"Value"** *vs.* **"Values"**
  - **local biodiversity improved**
  - lack of biodiversity conservation literacy: pursuit of financial returns is greater than the non-pecuniary preferences on biodiversity

The role of National Nature Reserves

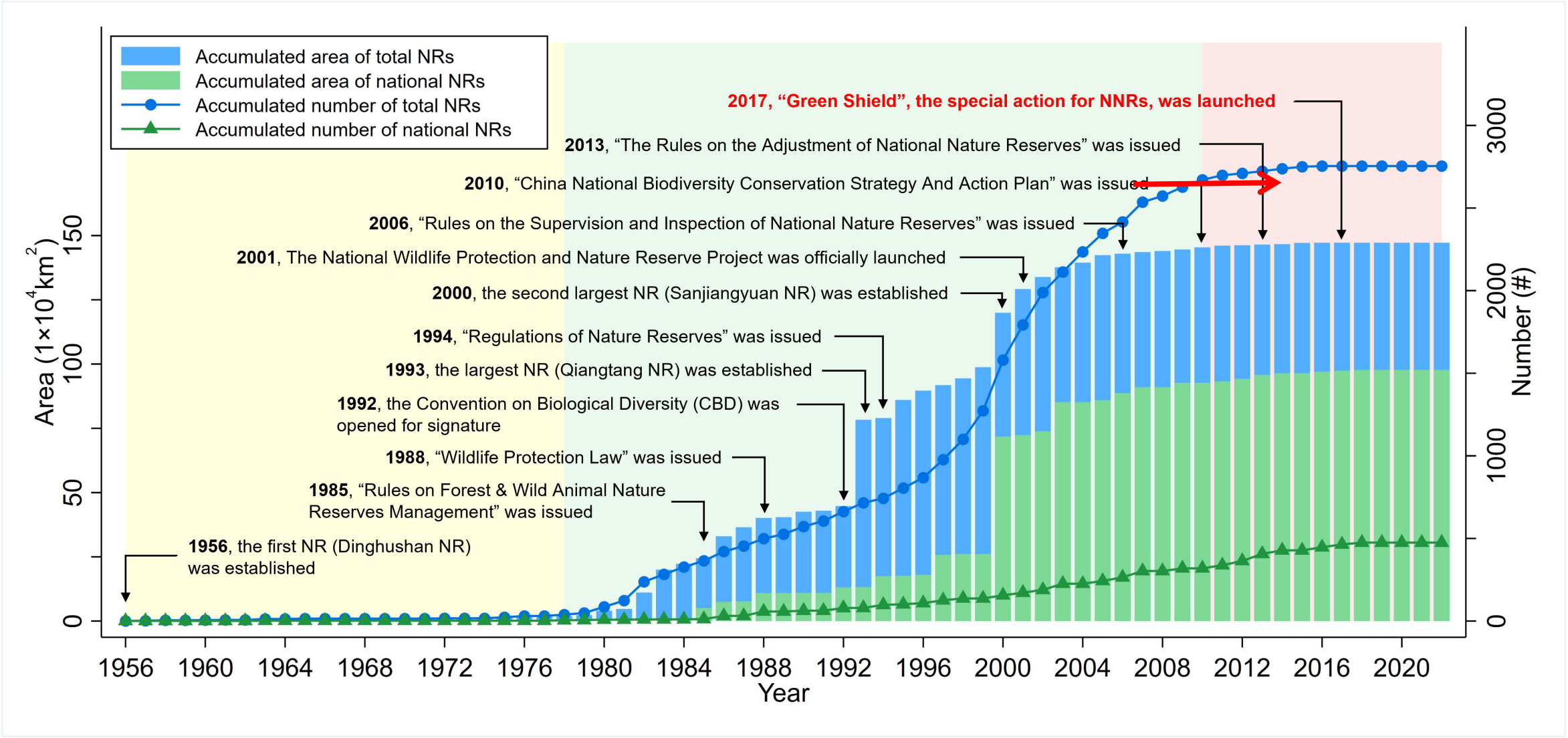
自然保护区是就地保护生物多样性的战略基地，也是现有条件下人类保护自然原真性最有效的手段。正如2003年南非世界自然保护大会《德班协议》指出的那样："我们见证最富有灵感和精神的保护区，有着最为关键的物种和生态系统的生存，在确保食物、空气和水的安全方面发挥至关重要作用，还有最独特的文化和自然遗产。因此，自然保护区最值得受到人类的特别关怀。"

我国是世界上生物多样性最丰富的国家之一，这主要缘于两个因素：

- **NNR:** plausibly exogenous treatment
  - typical natural habitats for rare and endangered wild species *(nature reserves)*
  - a cornerstone in protecting biodiversity and natural capital.
    - only reserves *"holding general significance domestically and internationally, exerting remarkable international scientific influence, or possessing extra-ordinary research value"* can be designated as NNRs
  - established by central govt department
    - *National Nature Reserve Review Committee*
    - the most extensive regulatory oversight & the strictest legal provisions
  - **predetermined** in GSA

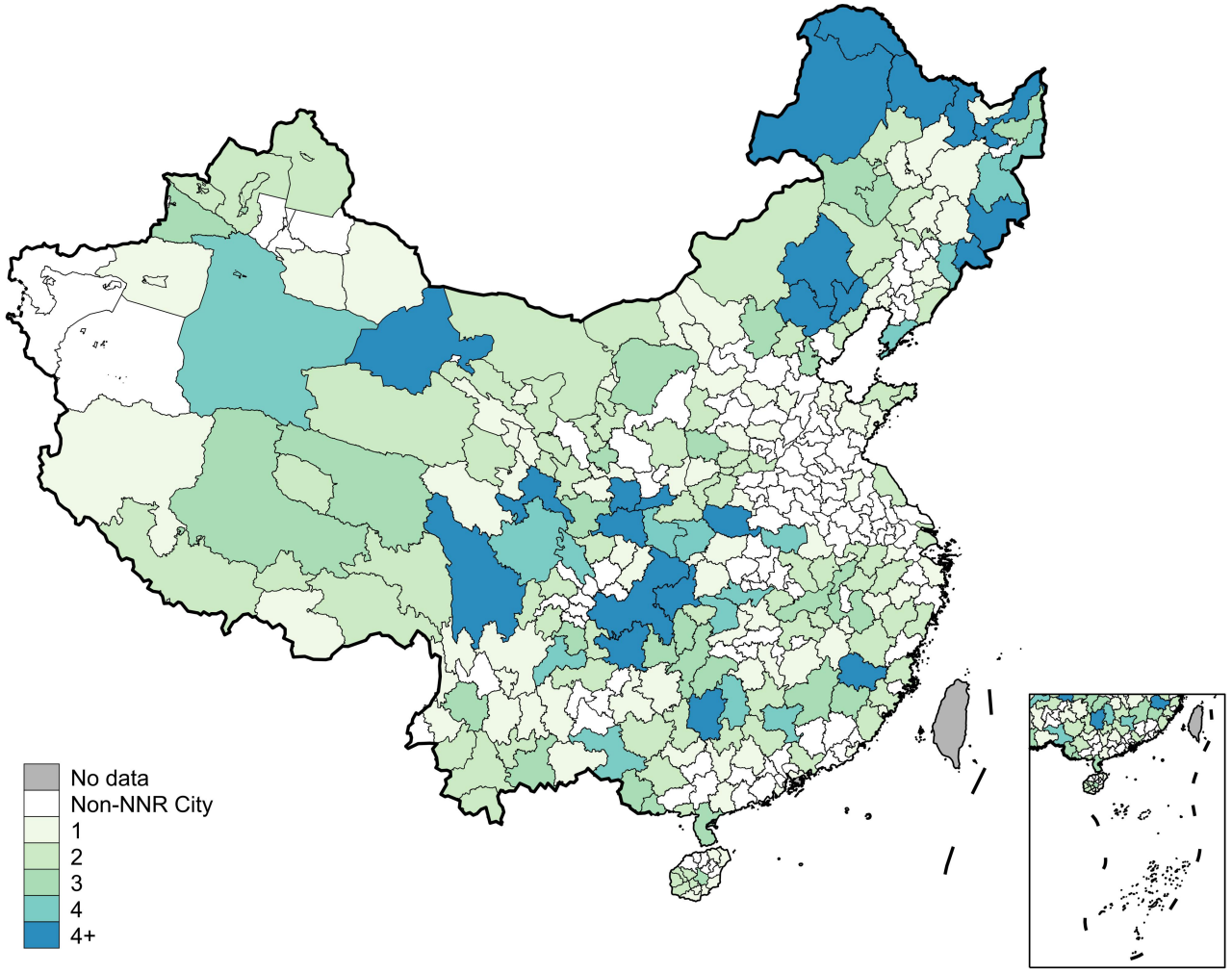
Treatment *vs.* Control Groups

- **The establishment of NNRs: predetermined**



Treatment *vs.* Control Groups

- **The geographical distribution of NNRs**



Treatment *vs.* Control Groups - Balance Test

TABLE A2: PRE-GSA LEVELS AND TRENDS OF LOCALITY CHARACTERISTICS

	NNR=1	NNR=0	Difference
	(1)	(2)	(1)-(2)
GDP (ten billion RMB)	18.236	21.848	-3.612
	(2.012)	(2.287)	[3.169]
Δ GDP (ten billion RMB)	4.053	4.889	-0.836
	(0.622)	(0.638)	[0.952]
GDP per capita (thousand RMB)	42.907	45.715	-2.809
	(2.040)	(2.411)	[3.252]
Δ GDP per capita (thousand RMB)	5.336	7.104	-1.767
	(0.718)	(0.870)	[1.149]
GDP annual growth rate (%)	10.364	10.735	-0.371
	(0.167)	(0.199)	[0.267]
Δ GDP annual growth rate (%)	-3.268	-3.476	0.208
	(0.246)	(0.303)	[0.398]
Tertiary sector GDP (%)	37.972	38.423	-0.451
	(0.728)	(0.792)	[1.132]
Δ Tertiary sector GDP (%)	6.348	6.299	0.049
	(0.349)	(0.437)	[0.566]
Nighttime light intensity	8.581	9.810	-1.230
	(0.525)	(0.659)	[0.854]
Δ Nighttime light intensity	0.671	0.495	0.176**
	(0.046)	(0.044)	[0.069]
Housing price (thousand RMB/ m^2)	4.771	4.917	-0.146
	(0.198)	(0.196)	[0.299]
Δ Housing price (thousand RMB/ m^2)	0.599	0.537	0.062
	(0.109)	(0.108)	[0.162]

	NNR=1	NNR=0	Difference
	(1)	(2)	(1)-(2)
Fixed investment (ten billion RMB)	12.703	14.447	-1.743
	(1.052)	(1.221)	[1.667]
Δ Fixed investment (ten billion RMB)	4.498	4.743	-0.246
	(0.540)	(0.694)	[0.886]
Population (million)	3.943	4.384	-0.440
	(0.256)	(0.254)	[0.388]
Δ Population (million)	0.062	0.111	-0.049
	(0.022)	(0.024)	[0.034]
Population annual growth rate (%)	0.297	0.486	-0.189
	(0.097)	(0.114)	[0.154]
Δ Population annual growth rate (%)	0.015	0.106	-0.091
	(0.142)	(0.204)	[0.243]
Urbanization rate (%)	28.869	29.261	-0.391
	(1.048)	(1.375)	[1.731]
High school and above education rate (%)	20.861	21.722	-0.861
	(0.565)	(0.812)	[0.966]
Local fiscal revenue (million RMB)	18.521	18.572	-0.052
	(3.111)	(2.178)	[4.436]
Δ Local fiscal revenue (million RMB)	5.271	4.356	0.915
	(1.341)	(0.749)	[1.864]
Local fiscal expenditure (million RMB)	32.230	28.558	3.672
	(3.609)	(2.170)	[5.053]
Δ Local fiscal expenditure (million RMB)	12.736	9.906	2.830
	(2.143)	(0.924)	[2.923]

- **National nature reserve (NNR)**
  - NNR lists: the Ministry of Ecology and Environment
  - (hand-collected) digital maps of NNRs
    - record geographical features: borders, dates of inception…
    - merge it with other GIS data
      - city-level administrative border maps
      - satellite/remote sensing datasets: land cover, nighttime lights…
- **Municipal corporate bonds (MCB)**
  - **the only asset with market prices reflecting city-level public financing costs in China**
  - sample construction / spread calculation: following Geng & Pan (2024, JF)
    - Wind Information Co. source
    - quarterly level, China Development Bank (CDB) yield as reference ...

Baseline Results

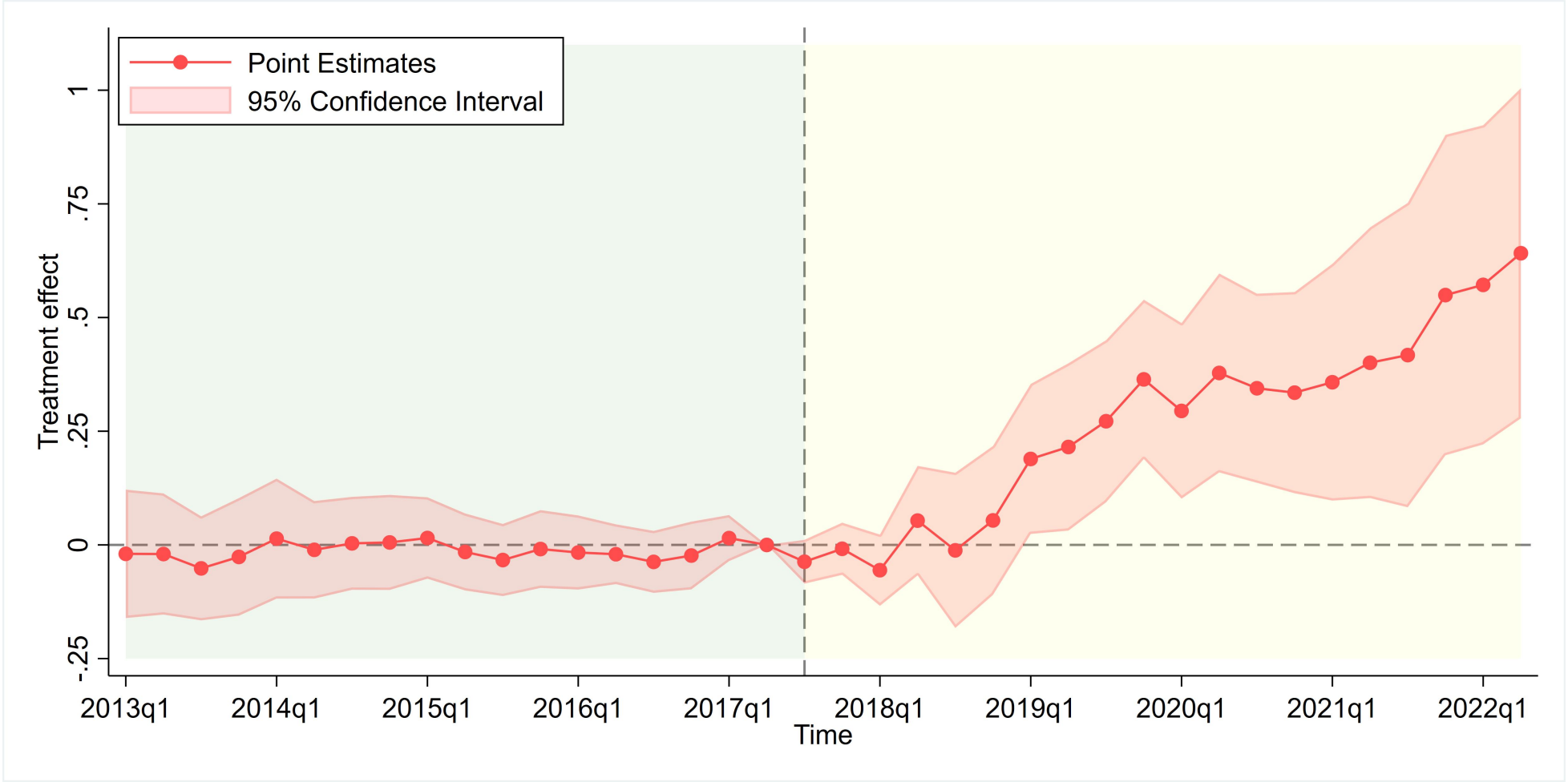
$$Spread_{bict} = \delta_{ic} + \lambda_t + \beta NNR_c \times Post_t + \theta X_c \times Post_t + \gamma Z_{bict} + \varepsilon_{bict} \quad (1)$$

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

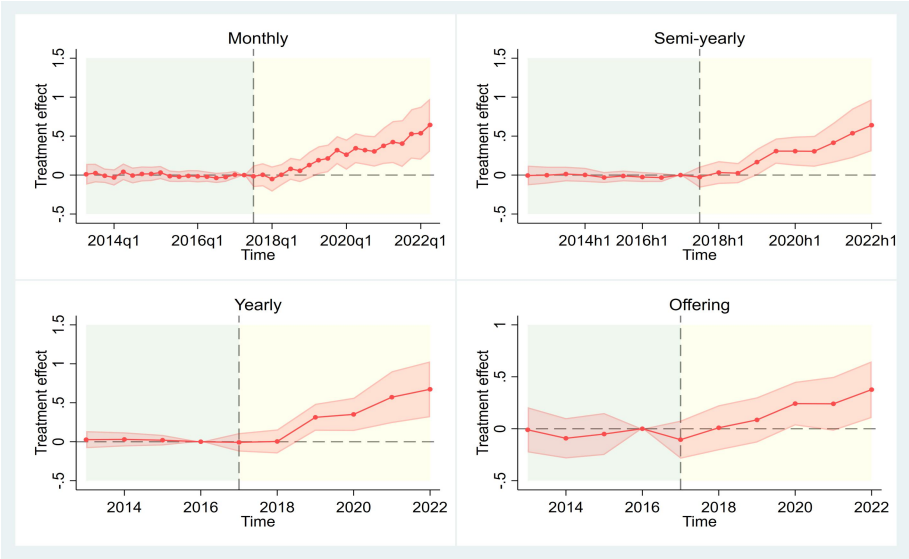
Event Study

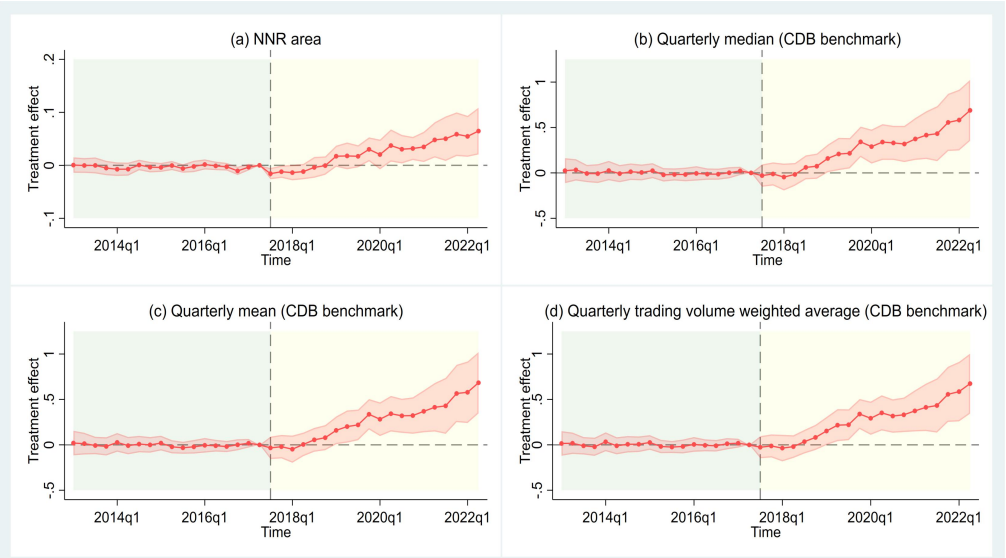
$$Spread_{bict} = \delta_{ic} + \lambda_t + \sum_t \beta_t NNR_c \times Time_t + \theta X_c \times Post_t + \gamma Z_{bict} + \varepsilon_{bict} \quad (2)$$

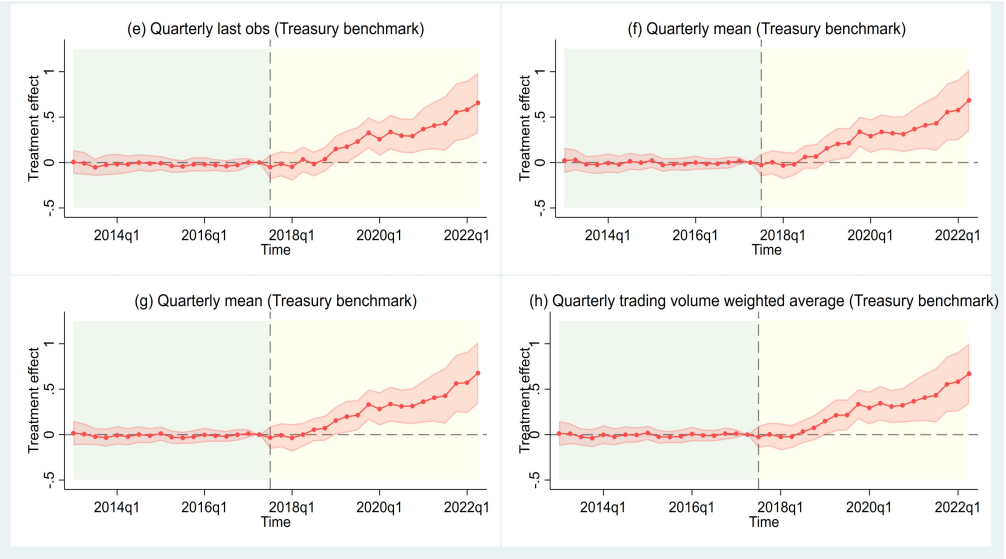


Robustness

- Alternative measures of treatment intensity
  - the area of NNRs in the city
- Alternative measures of bond spread
  - quarterly last obs, quarterly mean, quarterly median, quarterly trading volume weighted average
  - Treasury yield risk-free benchmark
- Alternative freqencies of bond sample
  - monthly, semi-yearly, yearly
  - the primary market (issuance)







Placebo Tests

- Non-significant effects for lower-level nature reserves.

TABLE 3: GSA AND MCB SPREADS: PLACEBO TEST

	Spread			
	(1)	(2)	(3)	(4)
NNR × Post	0.237***	0.234***	0.232***	0.227***
	(0.072)	(0.073)	(0.074)	(0.076)
ProvNR × Post	-0.048			-0.049
	(0.093)			(0.093)
CityNR × Post		-0.018		-0.022
		(0.076)		(0.080)
CountyNR × Post			0.033	0.040
			(0.077)	(0.081)
Controls	Yes	Yes	Yes	Yes
Year-quarter FE	Yes	Yes	Yes	Yes
Issuer FE	Yes	Yes	Yes	Yes
Adjusted R^2	0.561	0.561	0.561	0.561
Obs	87885	87885	87885	87885

Placebo Tests: CSOE bonds

- Non-significant effects for bonds issued by central-govt-owned enterprises

TABLE A9: GSA AND CSOE BOND SPREADS

	Spread			
	Quarterly last obs	Quarterly median	Quarterly mean	Trading volume weighted average
	(1)	(2)	(3)	(4)
NNR × Post	0.029	0.021	0.031	0.026
	(0.096)	(0.098)	(0.099)	(0.098)
Controls	Yes	Yes	Yes	Yes
Year-quarter FE	Yes	Yes	Yes	Yes
Issuer FE	Yes	Yes	Yes	Yes
Adjusted R^2	0.731	0.745	0.739	0.741
Obs	23824	23824	23824	23824

- **Jinyun Mountain NNR in Chongqing**

pre-GSA

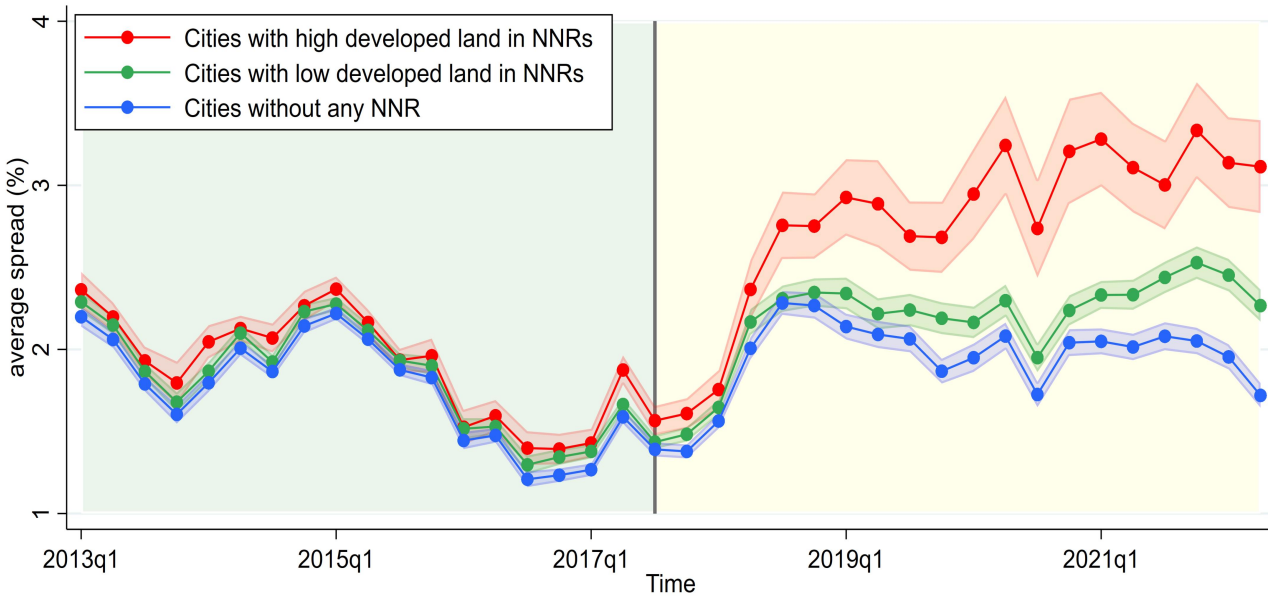
post-GSA

- Beibei District Govt spent over 440 mill. RMB in relocation effort.
  - fiscal revenue: mere 3 billion RMB for that year (≈15%).

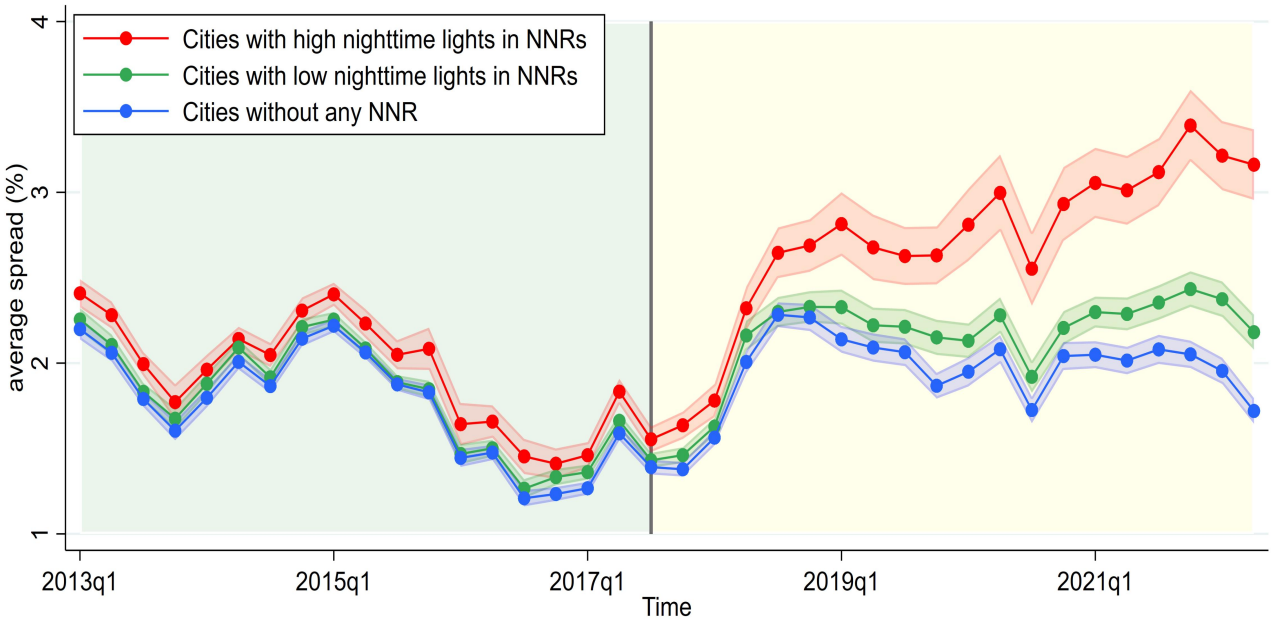
Pre-existing Economic Activities inside NNRs

- Greater effects for cities with more pre-existing economic activities in NNRs

(a) Grouped by Developed Land Area in NNRs



(b) Grouped by Nighttime Lights in NNRs



Pre-existing Economic Activities inside NNRs

- Greater effects for cities with more pre-existing economic activities in NNRs

TABLE 4: GSA AND MCB SPREADS: PRE-EXISTING ECONOMIC ACTIVITIES WITHIN NNRS

Grouping indicator	Spread			
	Developed land area		Nighttime light intensity	
	(1)	(2)	(3)	(4)
NNR × Post × High ex-ante economic activity in NNRs	0.495***	0.307**	0.353**	0.210*
	(0.128)	(0.133)	(0.138)	(0.122)
NNR × Post	0.183*	0.176**	0.181	0.184**
	(0.105)	(0.075)	(0.110)	(0.077)
Other terms of triple differences	Yes	Yes	Yes	Yes
Controls	No	Yes	No	Yes
Year-quarter FE	Yes	Yes	Yes	Yes
Issuer FE	Yes	Yes	Yes	Yes
Adjusted R^2	0.495	0.562	0.494	0.562
Obs	87885	87885	87885	87885

Local Public Creditworthiness

- Worsen local fiscal condition, especially increase the fiscal expenditures

Dependent Variable	(1) Fiscal deficit / Fiscal revenue	(2) Fiscal deficit / Population	(3) Fiscal expenditure / Population	(4) Fiscal revenue / Population
NNR×Post	0.174**	0.502***	0.356*	-0.172
	(0.080)	(0.163)	(0.205)	(0.124)
Controls	Yes	Yes	Yes	Yes
Year FE / City FE	Yes	Yes	Yes	Yes
Observations	2,423	2,423	2,423	2,423
Adjusted R^2	0.953	0.936	0.940	0.957

- 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	
Grouping reference	Total debt	Interest-bearing debt
	(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

Actual Public Spending on Biodiversity

安徽扬子鳄自然保护区夏渡片区东冲片植被恢复项目施工（二次招标）评标结果公示

2018年02月07日 14:51 来源：中国政府采购网 【打印】 【显示公告正文】

公告概要：

公告信息：			
采购项目名称	安徽扬子鳄自然保护区夏渡片区东冲片植被恢复项目施工（二次招标）		
品目			
采购单位	安徽扬子鳄国家级自然保护区管理局		
行政区域	安徽省	公告时间	2018年02月07日 14:51
本项目招标公告日期	2018年01月17日	中标日期	2018年02月06日
评审专家名单	吴刚、方冬根、周阳、郑光和、王建		
总中标金额	￥132.547601 万元（人民币）		
联系人及联系方式：			
项目联系人	马新纪		
项目联系电话	0563-3042599		
采购单位	安徽扬子鳄国家级自然保护区管理局		
采购单位地址	安徽省宣城市宣州区向阳办事处夏渡社区		
采购单位联系方式	13063234026		
代理机构名称	安徽宏基建设项目管理有限公司		
代理机构地址	宣城市状元南路55号		
代理机构联系方式	13856304392		

The name of the NNR

The name of the procurement project

Government department that procures the project

Announcement time

Actual Public Spending on Biodiversity

- ***Narrow GSA contracts*** - those explicitly mentioning NNR names in the contents
- ***Broad GSA contracts*** - those identified as related to biodiversity affairs after text analysis
  - keyword selection using Word2Vec model

Contract Identification	Narrow definition		Broad definition	
	(1)	(2)	(3)	(4)
Dependent Variable	GSA contract num / Population	GSA contract value / Population	GSA contract num / Population	GSA contract value / Population
NNR×Post	0.586***	1.527***	3.300***	8.958***
	(0.102)	(0.337)	(0.836)	(3.387)
Controls	Yes	Yes	Yes	Yes
Year FE / City FE	Yes	Yes	Yes	Yes
Observations	2,423	2,423	2,423	2,423
Adjusted R^2	0.613	0.388	0.675	0.473

Heterogeneity - Bond Term Structure

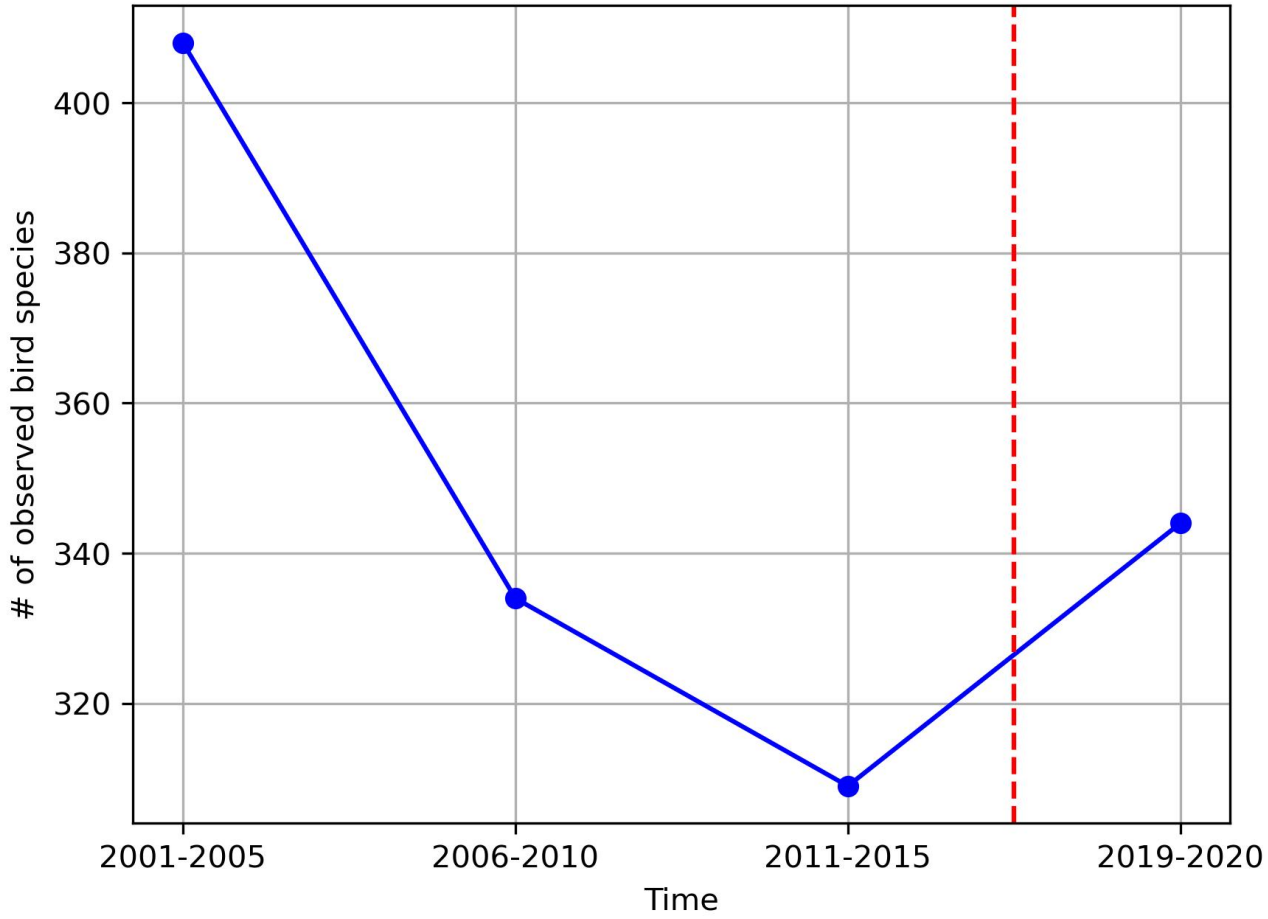
- Greater effects for bonds with shorter maturities

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

Biological Improvement

国家科技基础条件平台
National Science & Technology Infrastructure
国家生态系统观测研究网络
National Ecosystem Research Network of China



- Observations from eleven ecological investigation stations inside NNR municipalities.

Biological Improvement

TABLE A9: GSA AND BIRDWATCHING ACTIVITIES

Dep. Var	# of bird species observed	# of birdwatching reporters	# of birdwatching reports
	(1)	(2)	(3)
NNR × Post	9.240**	0.646	1.370
	(4.625)	(1.040)	(6.240)
Year-quarter FE	Yes	Yes	Yes
City FE	Yes	Yes	Yes
Adjusted R^2	0.606	0.538	0.456
Obs	4582	4582	4582

"Value" *vs.* "Values" – The Pricing Effects

- 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

	Spread			
	Birds species observed		species - IUCN 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

TABLE A15: GSA AND MCB SPREADS: MUTUAL FUND HOLDINGS

	Spread			
	Quarterly last obs	Quarterly median	Quarterly mean	Trading volume weighted average
	(1)	(2)	(3)	(4)
NNR × Post × **1**[Mutual fund holding]	-0.056	-0.062	-0.059	-0.062
	(0.059)	(0.059)	(0.058)	(0.060)
NNR × Post	0.242***	0.241***	0.243***	0.240***
	(0.075)	(0.074)	(0.074)	(0.073)
Controls	Yes	Yes	Yes	Yes
Year-quarter FE	Yes	Yes	Yes	Yes
Issuer FE	Yes	Yes	Yes	Yes
Adjusted R^2	0.562	0.584	0.587	0.586
Obs	87885	87885	87885	87259

Confounding factors & Alternative explanations

× **Increased demand for financing by local governments?**

- non-significant change in public financing amount around GSA.

× **Increased local political risk?**

- non-significant change in political turnover around GSA
- non-significant heterogeneity among officials with different political incentives

× **Confounding effects of Contemporaneous environmental regulation shocks?**

- The estimated effects of GSA remain robust after controlling other policy indicators such as
  - Central Inspection on Environmental Protection (CIEP) / Nationwide Battle to Prevent and Control Pollution (NBPCP)

× **Macro dynamics of the Chinese macro economy (defaults, real estate, bank development...)**

- The estimated effects of GSA hold among AAA-rated bonds
- Non-significant change in CSOE bond spreads around GSA
- Non-significant change in local banking institution development / housing price around GSA

Local banking institution development

Panel A: The pre-GSA difference in local banking institutions and real estate price

	NNR = 1	NNR = 0	Difference
	(1)	(2)	(1) - (2)
ln(Banking branch number)	6.169	6.153	0.016
	(0.051)	(0.068)	[0.084]
Δ ln(Banking branch number)	0.097	0.114	-0.017
	(0.009)	(0.011)	[0.014]
ln(Banking branch capital)	7.959	7.974	-0.015
	(0.100)	(0.134)	[0.164]
Δ ln(Banking branch capital)	0.191	0.223	-0.031
	(0.029)	(0.048)	[0.052]

Panel B: The development of local banking institutions and and housing price around GSA

	(1)	(2)	(3)
	ln(Banking branch number)	ln(Banking branch capital)	ln(Housing price)
NNR × Post	-0.005	0.001	-0.026
	(0.010)	(0.043)	(0.018)
Controls / Year FE / City FE	Yes	Yes	Yes
Observations	2,423	2,423	1,674
Adjusted R^2	0.992	0.958	0.955

TABLE A8: GSA AND LOCAL POLITICAL RISK

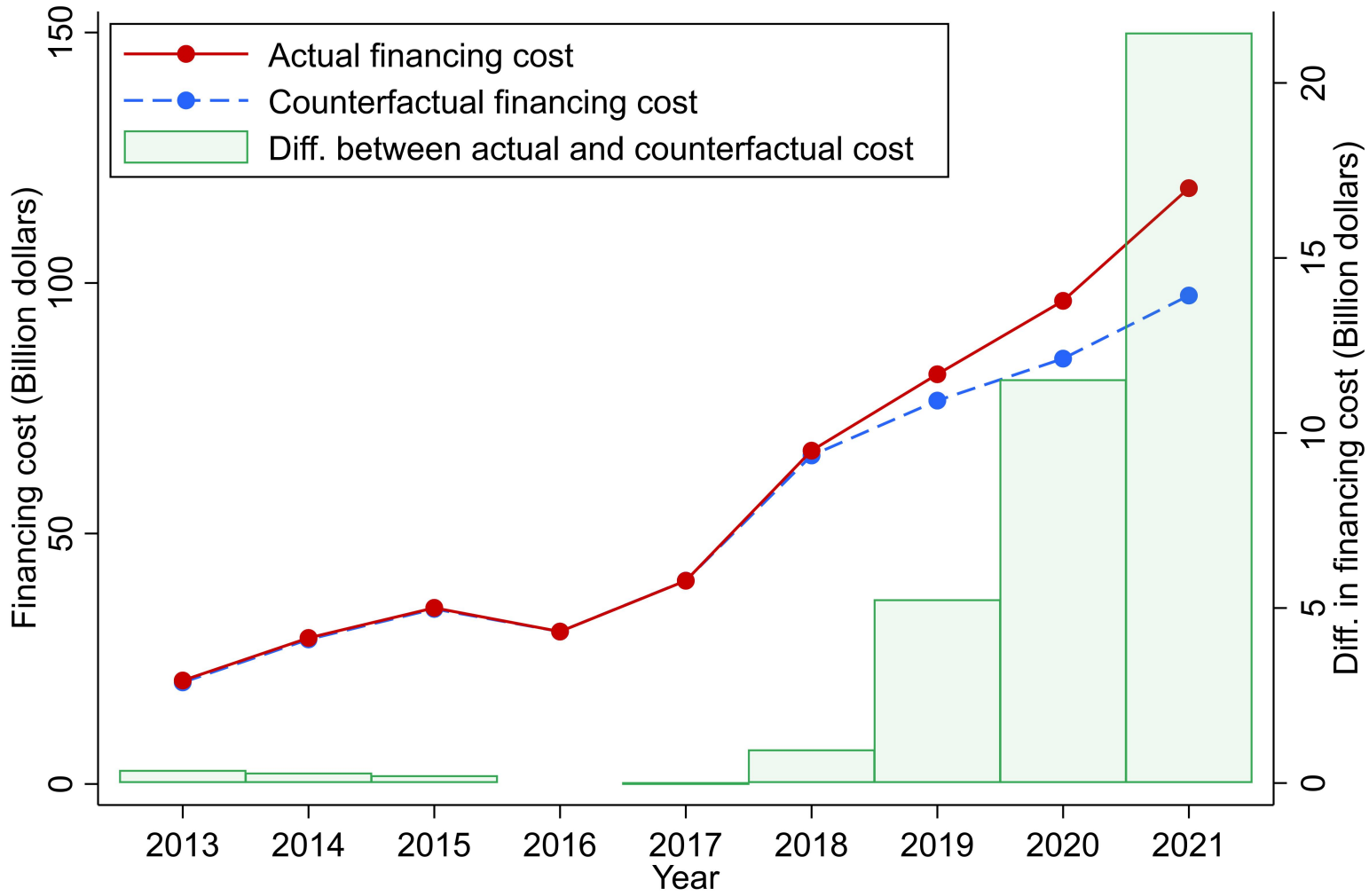
Panel A: GSA and local political turnover

Dep.var	Turnover dummy	
	Municipal CPC secretary	Mayor
	(1)	(2)
NNR × Post	-0.025	0.042
	(0.032)	(0.028)
Controls	Yes	Yes
Year FE	Yes	Yes
City FE	Yes	Yes
Adjusted R^2	0.093	0.115
Obs	2725	2725

Panel B: GSA and MCB spreads: local political risk

Dep.var	Spread	
	Municipal CPC secretary	Mayor
	(1)	(2)
NNR × Post	0.237***	0.236***
	(0.081)	(0.079)
NNR × Post × In the first 2 years of tenure	0.004	0.009
	(0.060)	(0.064)
Other terms of triple diff.	Yes	Yes
Controls	Yes	Yes
Year-quarter FE	Yes	Yes
Issuer FE	Yes	Yes
Adjusted R^2	0.562	0.561
Obs	87885	87885

Additional Financing Costs



- A **back-of-the-envelope** estimation of additional public financing costs (i.e., interest payment): (2018-2021) ~ 40 billion dollars .

Literature

- **Nature capital & biodiversity conservation**
  - The **benefits** of biodiversity conservation
    - "Value of diversity" (Weitzman, 1992,1993,1998 QJE, QJE, ECTA); Heal (2001); Brock & Xepapadeas (2003 AER).
    - reducing health risks (Frank & Sudarshan, 2024 AER; Frank, 2024 Science; Keesing & Ostfeld, 2021 PNAS)
    - mitigating climate change (Isbell et al., 2015 Nature; Rizzi, 2022; Taylor & Druckenmiller, 2022 AER)
  - The **costs** of biodiversity conservation - limited evidence
  - **This paper:** public financing costs (context: a govt-led conservation effort)
- **Biodiversity *&* Financial Markets (emerging)**
  - Recent work: Giglio et al. (2023), Garel et al. (2024, RF; 2025), Gjerde et al. (2025); Coqueret et al. (2024 Ecol E), Xiong (2023)...
    - characterize the biodiversity risks
    - risk premia in equity or derivatives markets
  - **This paper**: how the costs of biodiversity conservation are priced in bond markets in a large emerging economy of significance for global biodiversity transition

Literature

- **Sustainability & climate finance**
  - Climate finance (Choi et al., 2020 RFS; Engle et al., 2020 RFS; Sautner et al., 2023 JF; Seltzer et al., JFE R&R)
  - In contrast, biodiversity issues (Karolyi & Tobin-de la Puente, 2023 FM):
    - more challenges in valuation and property rights .
    - harder to address through market mechanisms like carbon trading
  - Govt (public capital) engagement in conservation: necessary

    ⇒ raise concerns about govt's fiscal sustainability.
  - **This paper**: significant effects on **the cost of public capital**

- **Impact investing**
  - Financial benefits ("value") & non-pecuniary preferences ("values") (Starks, 2023 JF)
    - "values" motivation (Baker et al., 2022; Barber et al., 2021 JFE)
    - "value" motivation (Giglio et al., 2023; Dimson et al., 2015 RFS, 2021; Krueger et al., 2020 RFS; Starks et al., 2023; Hoepner et al., 2024 RF)
  - **This paper:** lack of biodiversity conservation literacy

Policy Implications

- **External validity:**
  - Biodiversity loss is a global issue
  - China: biologically & economically important (e.g., Egli et al., 2018)

- **Implications: "Government moving first" in biodiversity transition**
  - limited budget + fiscal burden: expensive external financing (our finding)
    - optimal targeting
      - heterogeneity in biological benefit *vs.* financial cost
    - specialized financing instruments
    - adequate information disclosure
    - cultivation of ESG investors
    - social consensus of biodiversity conservation

  ⇒ **"Blended" Biodiversity Finance** (Flammer, Giroux & Heal, 2025 JFE; 2024)

Conclusions

- **GSA increased MCB spreads:** by ~24 bps
  - additional public 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:** more pronounced effects in
  - bonds with shorter maturities & local governments in weaker fiscal conditions
- **"Value"** *vs.* **"Values"**
  - **local biodiversity improved**
  - pursuit of financial returns > non-pecuniary preferences on biodiversity

Thanks!

➢ **中华人民共和国自然保护区条例规定：**

- 第二条　本条例所称**自然保护区**，是指对**有代表性的自然生态系统、珍稀濒危野生动植物物种的天然集中分布区、有特殊意义的自然遗迹等保护对象所在的陆地、陆地水体或者海域**，依法划出一定面积予以特殊保护和管理的区域。
- 第十一条 自然保护区分为国家级自然保护区和地方级自然保护区。**在国内外有典型意义、在科学上有重大国际影响或有特殊科学研究价值**的自然保护区，列为**国家级自然保护区**。
- 《中华人民共和国自然保护区条例》规定：**禁止**在自然保护区内进行砍伐、放牧、狩猎、捕捞、采药、开垦、烧荒、开矿、采石、挖沙等活动。

➢ NNRs serve as a cornerstone in protecting biodiversity and natural capital.

附件

“绿盾 2017”国家级自然保护区监督检查专项行动方案

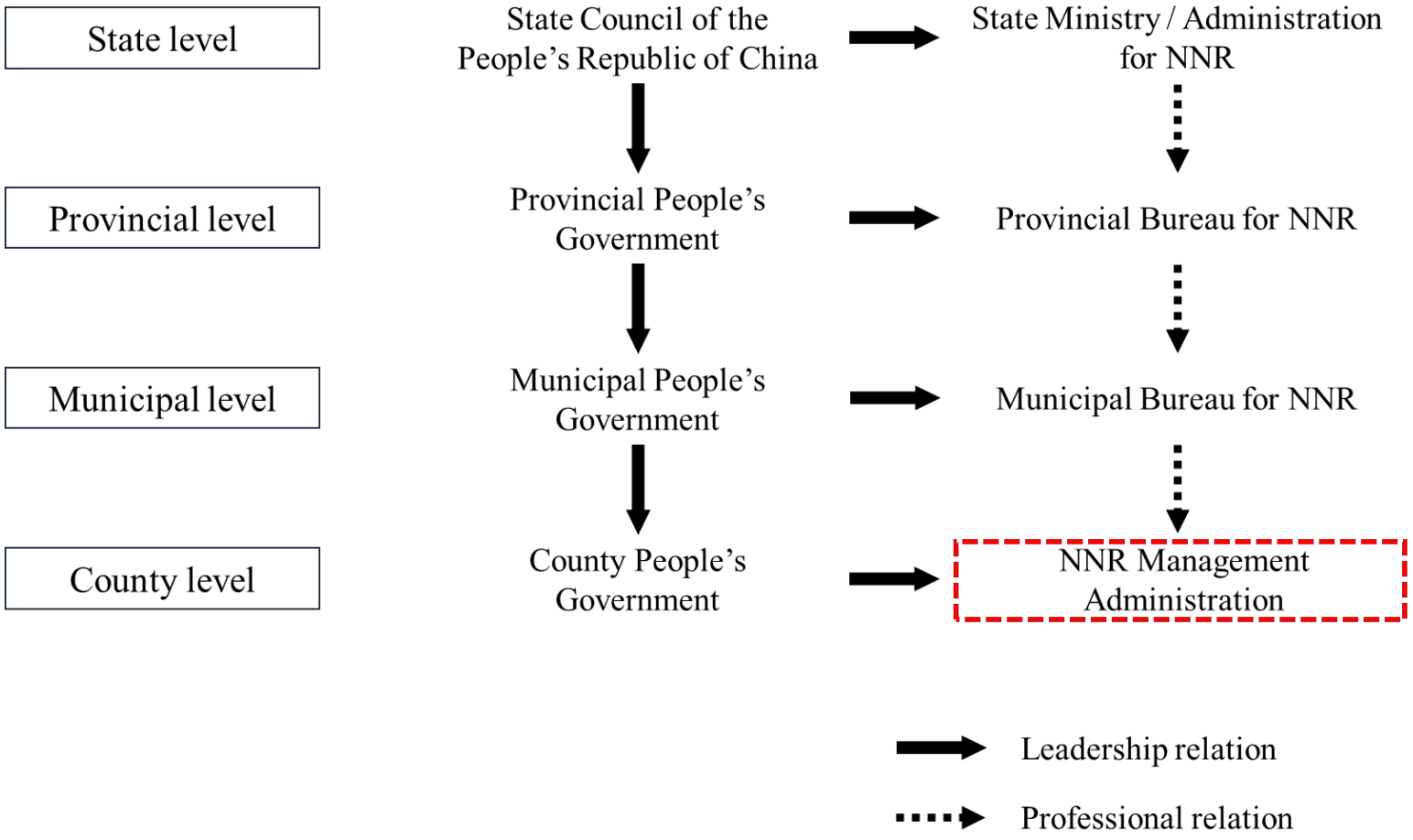
为贯彻落实《中共中央办公厅 国务院办公厅关于甘肃祁连山国家级自然保护区生态环境问题督查处理情况及其教训的通报》（中办发电〔2017〕13 号）（以下简称《两办通报》）精神，切实加强自然保护区监督管理，环境保护部、国土资源部、水利部、农业部、国家林业局、中国科学院、国家海洋局共同在全国组织开展“绿盾 2017”国家级自然保护区监督检查专项行动。

一、指导思想

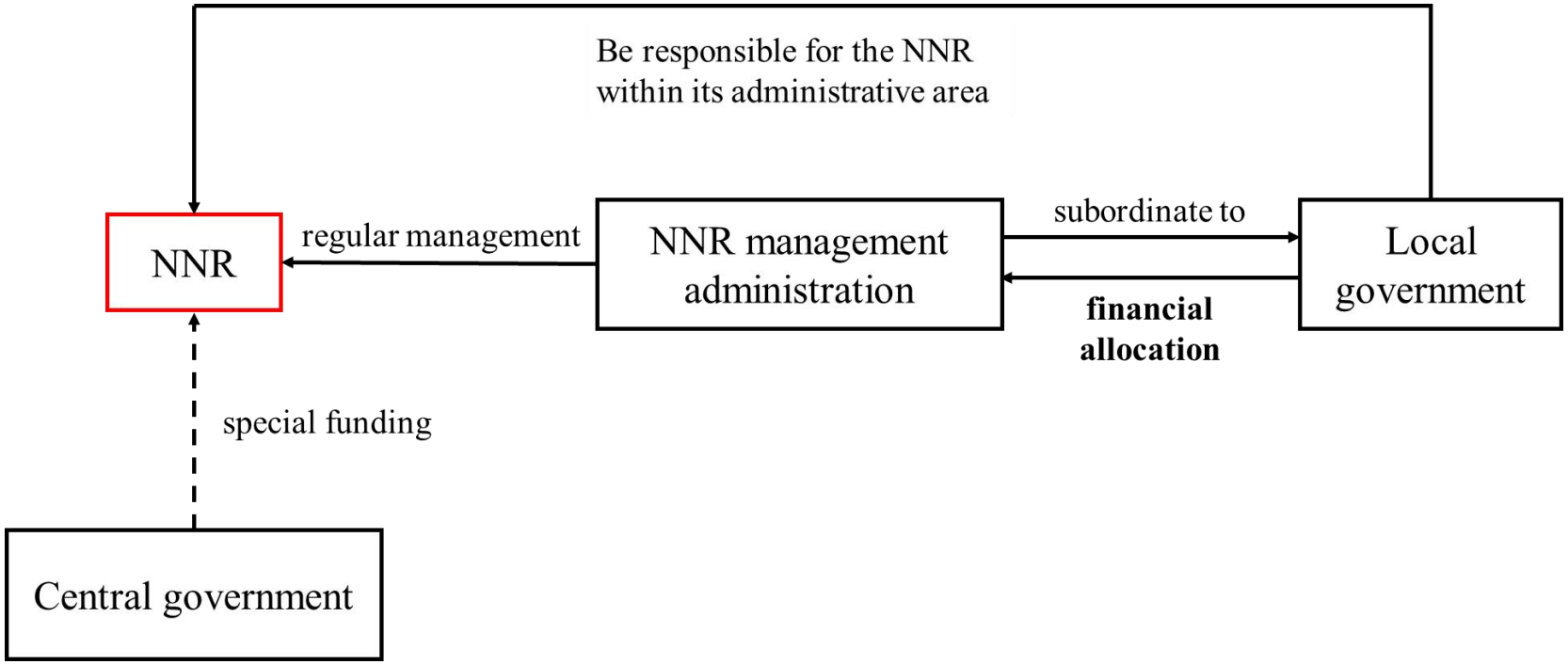
深入贯彻党中央、国务院关于生态文明建设的决策部署，认真落实习近平总书记等中央领导同志重要批示精神，切实提高政治站位，牢固树立“四个意识”，坚决把思想和行动统一到《两办通报》要求上来，深刻吸取甘肃祁连山生态环境问题的教训，严厉打击涉及自然保护区的各类违法违规行为，把加强自然保护区监督管理作为重要政治责任，严格执行，不打折扣，牢固构筑国家生态安全屏障。

Background of NNRs - How NNRs work

FIGURE B4: INSTITUTIONAL STRUCTURE ARRANGEMENTS FOR NNRS



Background of NNRs - How NNRs work



根据《自然保护区条例》第三章第二十三条：管理自然保护区**所需经费**，由自然保护区所在地的县级以上**地方人民政府安排**。国家对国家级自然保护区的管理，给予**适当的**资金补助。

According to Article 23 of Chapter 3 of the "*Regulations on Nature Reserves*": The funds required for the management of nature reserves shall be arranged by the local government at the county level or above where the nature reserve is located. The central government just provides appropriate financial subsidies for the management of national-level nature reserves.

Background of NNRs - How NNRs work

- Media report:
  - The central government only allocates 600 million yuan annually for the existing 474 national nature reserves, averaging only 1.26 million yuan per reserve.

- An example: financial statement of Jinhuacha NNR in 2022

Panel A Jinhuacha National Nature Reserve	
项目 Item	金额 Amount (10 thousand)
一、一般公共预算财政拨款收入 General Public Budgetary Financial Appropriation Income	2,154.35
二、政府性基金预算财政拨款收入 Government Fund Budgetary Financial Appropriation Income	0.00
三、国有资本经营预算财政拨款收入 State-Owned Capital Operation Budgetary Financial Appropriation Income	0.00
四、上级补助收入 Subsidy Income from Higher Authorities	**0.00**
五、事业收入 Operating Income	0.00
六、经营收入 Business Income	0.00
七、附属单位上缴收入 Income Turned Over by Affiliated Departments	0.00
八、其他收入 Other Income	182.89

Background of GSA - Qilian Mountain NNR

- Many local governments in charge of NNRs initiallly failed to fulfill responsibilities
  - An example: the Qilian Mountain National Nature Reserve

pre GSA

post GSA

- The "Qilian Mountain Incident" triggered the nationwide supervision and inspection actions led by national departments since July 2017, namely the Green Shield Action.
  - **achieved complete coverage of all of NNRs for the first time**
    - Over 20,800 issues have been found (in the first round, the same below).
    - Over 5.9 million sq.m of constructed facilities have been pulled down.
    - Over 1,100 officials held accountable.
  - **repeated annually in following years (campaign style → regular regime)**
  - ✓ **exerting pressure on local govts to act in response to reported violations**

Unconditional Pattern of MCB Spreads

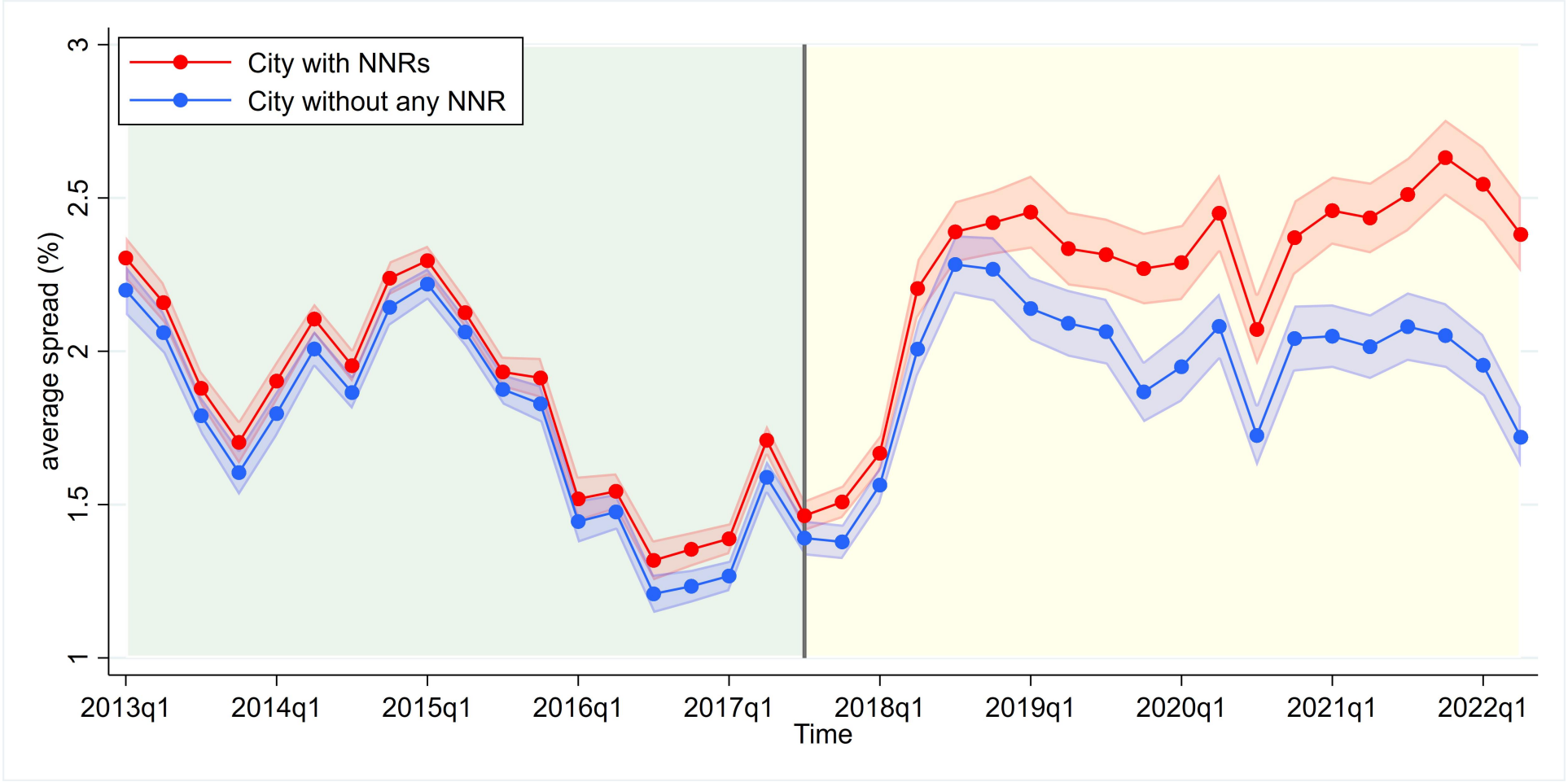


Table A6: GSA and MCB Spreads: Major Confounding Events

Panel A: Central Inspection on Environmental Protection

	Spread					
	(1)	(2)	(3)	(4)	(5)	(6)
NNR × Post	0.237***	0.237***	0.236***	0.233***	0.229***	0.226***
	(0.072)	(0.072)	(0.072)	(0.072)	(0.072)	(0.073)
In the 1st round	0.055**		0.055**			
	(0.025)		(0.025)			
In the 2nd round		-0.017	-0.017			
		(0.049)	(0.049)			
After the 1st round				0.086**		0.082**
				(0.038)		(0.037)
After the 2nd round					0.084	0.082
					(0.066)	(0.066)
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	0.561	0.561	0.561	0.561	0.561	0.561
Obs	87885	87885	87885	87885	87885	87885

Table A6: GSA and MCB Spreads: Major Confounding Events

Panel B: Nationwide Battle to Prevent and Control Pollution

	Spread					
	(1)	(2)	(3)	(4)	(5)	(6)
NNR × Post	0.200***	0.229***	0.220***	0.218***	0.213***	0.186**
	(0.076)	(0.073)	(0.074)	(0.075)	(0.076)	(0.080)
AQI × Post2018Q1	-0.004					-0.004
	(0.003)					(0.003)
Industrial SO2 / GDP2 × Post2018Q1		0.718***			0.698***	0.681***
		(0.115)			(0.158)	(0.154)
industrial sewage / GDP2 × Post2018Q1			-0.049		-0.315*	-0.333**
			(0.171)		(0.167)	(0.166)
Industrial dust / GDP2 × Post2018Q1				0.697***	0.281	0.302
				(0.240)	(0.280)	(0.274)
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	0.553	0.549	0.546	0.546	0.548	0.548
Obs	85741	84739	84628	83482	83482	83482

Table A7: GSA and Public Financing Demand

Dep. Var	MCB issuance dummy	MCB issuance amount	Growth rate of LGFV debt	Growth rate of LGFV interest-bearing debt
	(1)	(2)	(3)	(4)
NNR × Post	-0.040	-1.615	-1.291	-8.404
	(0.030)	(1.291)	(3.710)	(6.338)
Controls	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
City FE	Yes	Yes	Yes	Yes
Adjusted R^2	0.372	0.775	0.181	0.154
Obs	2437	2437	2437	2437

Notes: This table reports the city-year-level regression results of the effects of GSA on the quantity of local public financing. *MCB issuance dummy* is a dummy variable that equals one if a city has a new MCB issuance in that year and zero otherwise. *MCB issuance amount* is a continuous variable that represents the the total amount of new MCB issued by a city in that year (in billion RMB yuan). *Growth rate of LGFV debt* is a continuous variable that represents the growth rate of city-year-level aggregated total debts of LGFVs with outstanding MCBs (in percentage). *Growth rate of LGFV interest-bearing debt* is a continuous variable that represents the growth rate of city-year-level aggregated interest-bearing debts of LGFVs with outstanding MCBs (in percentage). *NNR* is a dummy variable that equals one if there is at least one national nature reserve in the city and zero otherwise. *Post* is a dummy variable that equals one for years in and after 2017 and zero otherwise. Regressions include year and city fixed effects, as well as the city-level control variables (i.e., *city pre-shock var.*×*Post* used in Table 2). Standard errors in parentheses are clustered at the city level. ***, **, and * indicates significance at the 1%, 5%, and 10% level, respectively.

GSA and Political Risk

TABLE A8: GSA AND LOCAL POLITICAL RISK

Panel A: GSA and local political turnover

Dep.var	Turnover dummy	
	Municipal CPC secretary	Mayor
	(1)	(2)
NNR × Post	-0.025	0.042
	(0.032)	(0.028)
Controls	Yes	Yes
Year FE	Yes	Yes
City FE	Yes	Yes
Adjusted R^2	0.093	0.115
Obs	2725	2725

Panel B: GSA and MCB spreads: local political risk

Dep.var	Spread	
	Municipal CPC secretary	Mayor
	(1)	(2)
NNR × Post	0.237***	0.236***
	(0.081)	(0.079)
NNR × Post × In the first 2 years of tenure	0.004	0.009
	(0.060)	(0.064)
Other terms of triple diff.	Yes	Yes
Controls	Yes	Yes
Year-quarter FE	Yes	Yes
Issuer FE	Yes	Yes
Adjusted R^2	0.562	0.561
Obs	87885	87885

"Value" *vs.* "Values" – Investor's learning through GSA

- 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

TABLE A8: GSA AND MCB SPREADS: AAA-RATED BONDS

	Spread			
	(1)	(2)	(3)	(4)
NNR × Post	0.189**	0.163**	0.161**	0.171**
	(0.081)	(0.077)	(0.077)	(0.077)
Controls	Yes	Yes	Yes	Yes
Year-quarter FE	Yes	Yes	Yes	Yes
Issuer FE	Yes	Yes	Yes	Yes
Adjusted R^2	0.664	0.677	0.685	0.687
Obs	17920	17920	17920	17676

Additional Financing Costs

TABLE A12: ADDITIONAL LOCAL PUBLIC DEBT COSTS AND CORRESPONDING ECONOMIC SIGNIFICANCE

Scenario A: China bears the gap in biodiversity financing according to its share of global species (6.4%) Scenario B: China bears the gap in biodiversity financing according to its share of global land area (7%) Scenario C: China bears the gap in biodiversity financing according to its share of global GDP (18.5%)				
Year	2018	2019	2020	2021
Additional financing costs for MBC markets (Billion dollars)	0.96	5.25	11.54	21.44
Global biodiversity financing gap estimated by Deutz *et al.* (2020) (Billion dollars)		711	711	711
China's biodiversity financing gap in Scenario A (Billion dollars)		45.5	45.5	45.5
China's biodiversity financing gap in Scenario B (Billion dollars)		49.77	49.77	49.77
China's biodiversity financing gap in Scenario C (Billion dollars)		131.54	131.54	131.54
The proportion of additional financing costs in China's biodiversity financial gap in Scenario A (%)		11.54	25.36	47.12
The proportion of additional financing costs in China's biodiversity financial gap in Scenario B (%)		10.55	23.19	43.08
The proportion of additional financing costs in China's biodiversity financial gap in Scenario C (%)		3.99	8.77	16.30

Notes: This table presents results of a simple back-of-the-envelope calculation on the aggregate costs of GSA on the LGFVs' debt interest payments and the corresponding economic significance. The exchange rate between the US dollar and the Chinese RMB yuan is set as 1: 7.