The Rise of Green Banks: Implications for Inclusive Green Finance in the U.S.

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Abstract

I examine how U.S. Green Banks (i.e., public or mission-driven lenders that recycle capital for climate related projects) shape the flow of green finance in the U.S. I assemble project-level microdata for 11 public and quasi-public Green Banks across nine states, and present first evidence that higher borrowing costs and coordination frictions lower the likelihood of private co-financing while raising the Green Bank's dollar contribution per project. A simple Stackelberg model, with a welfare maximising Green Bank that co-finances with profit-maximising lenders, highlights leverage caps and coordination frictions as key constraints.

Keywords: Green Banks, Climate Finance, Financial Inclusion, Public-Private Partnerships.

JEL Classification: G21, Q55

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1 Introduction

Green Banks are publicly-backed or quasi-public institutions designed to mobilize private investment for clean energy and climate related projects. Despite their name, Green Banks are not deposit-taking institutions and do not operate as traditional commercial banks. Instead, they function as specialized intermediaries that deploy public funds through loans, credit enhancements, co-investments, and guarantees to address market failures and financing gaps in green sectors. Their core mission is to leverage limited public resources to mobilize larger flows of private capital, especially in contexts where traditional financing has been limited. Over time, Green Banks have also taken on mandates to promote inclusive access to green finance, directing investments toward underserved or disadvantaged communities as part of broader environmental and social policy goals.

This paper examines the rapid institutional expansion of Green Banks in the United States and their role in shaping the flow and structure of green capital. The analysis is motivated by the landmark 2023 allocation of $20 billion by the U.S. Environmental Protection Agency (EPA) through the Greenhouse Gas Reduction Fund (GGRF), representing the largest federal investment to date in these institutions.[1] Despite their growing importance, there remains limited empirical evidence on how Green Banks deploy capital, interact with traditional lenders, and how their activity shapes access to green finance across communities.[2]

A key contribution of this study is the construction of a novel hand-collected dataset documenting the project-level activity, financial instruments, and sectoral focus of U.S. Green Banks. This dataset enables the first systematic empirical analysis of the institutional expansion of Green Banks, the sources and uses of their capital, and their role in mobilizing private investment, particularly in underserved communities.

The paper addresses three central questions: (1) How have Green Banks evolved institutionally across U.S. states? (2) How is climate finance allocated across regions and sectors through

[1]On 11 March 2025 newly appointed EPA Administrator Lee Zeldin issued a press release terminating the $20 billion Greenhouse Gas Reduction Fund (GGRF) awards, alleging "fraud, waste and abuse" (EPA (2025); see also Politico (2025)). Several awardees immediately sued. On 15 April 2025 a preliminary injunction was granted blocking the termination (Post (2025)). The litigation is ongoing and the final outcome remains uncertain.

[2]While working on this draft, I became aware of work by Rizzi et al., 2025, who study the impact of Green Bank presence on venture capital investment in climate-tech startups. Their focus is on startup-level investment dynamics and signaling mechanisms, whereas my paper centers on the institutional evolution and capital deployment strategies of Green Banks, especially in the context of inclusive access to green finance.

Green Banks? and (3) To what extent do Green Banks expand access to green finance for low- and moderate-income or otherwise underserved communities?

In this paper, I distinguish between two notions of leverage that are central to understanding the Green Bank model. *Accounting leverage* refers to the use of debt on a Green Bank's own balance sheet (e.g., tax-exempt bonds, credit lines). *Mobilization leverage* refers to the crowd-in of private dollars per public dollar deployed at the project level. While the former applies only to a subset of Green Banks with borrowing authority, the latter is universal, as all institutions are mandated to mobilize private investment. The key mechanism in this paper is that balance-sheet constraints limit an institution's ability to scale its mobilization function. A Green Bank without borrowing authority must rely exclusively on transfers and program income, constraining the volume of projects it can finance and the amount of private capital it can attract. Institutions that can borrow on their own balance sheet can expand lending capacity, support larger project pipelines, and sustain higher levels of mobilization ratios. The model formalizes this mechanism, and the empirical analysis documents patterns consistent with it.

To the best of my knowledge, this is the first paper to build a comprehensive project-level dataset on U.S. Green Banks and link it to broader questions about institutional evolution and equitable access to capital in the green transition.

Section 2 provides institutional context on the development of Green Banks in the U.S. Section 3 introduces the novel dataset and describes key patterns in project-level activity. Section 6 outlines the empirical strategy and presents the main findings. Section 5 presents a simple model. Section 7 concludes with implications for policy and future research.

Related literature. This paper contributes to three strands of literature. First, it relates to the growing body of work on climate and green finance, particularly efforts to understand how institutional design can address investment frictions in the transition to a low-carbon economy (e.g., Flammer, 2021, Giglio et al., 2021, Krueger et al., 2020, Baker et al., 2022, Baldauf et al., 2020). Second, it builds on research examining the role of development banks and mission-driven financial institutions in financing public goods, innovation, and long-horizon investments (e.g., Lazzarini et al., 2015, Mertens et al., 2021, Griffith-Jones and Ocampo, 2018). Green Banks operate with similar aims but often at a subnational level and through more flexible institutional forms. Third, this work contributes to the literature on financial inclusion and equitable capital allocation, particularly in the context of climate policy (Kaul and Hernandez-Cortes, 2025, Wing et al., 2022, Crago, 2023, Sunter et al., 2019). By examining the geographic and demographic targeting of Green Bank investments, this paper offers new insights into how public financial institutions influence the distributional outcomes of green finance.

2 Institutional Background

Green Banks emerged in the United States in the aftermath of the 2008 financial crisis, with the Connecticut Green Bank established in 2011 as the nation's first. Since then, several states and localities have created similar institutions, often structured as nonprofit entities or quasi-public agencies, with mandates to mobilize private investment for clean energy, climate-change mitigation, and resilience projects. Although they share a common mission, their legal forms, oversight arrangements, and funding models vary widely.

Legal charters. Four basic forms cover almost every case. (i) *Quasi-public corporations* created by their own state law, such as the Connecticut Green Bank and New York Green Bank. They can issue revenue bonds, offer credit guarantees, and recycle program income. (ii) *State finance authorities* that added a green-bank unit to an older infrastructure or development statute (for example, Rhode Island Infrastructure Bank or California IBank). (iii) *City development authorities* that run green-bank programs under local ordinance (for example, Invest Atlanta or Finance New Orleans); and (iv) *Independent 501(c)(3) nonprofits,* for example Michigan Saves and Inclusive Prosperity Capital, which rely on grants and partner lenders because they cannot tax or issue their own bonds.

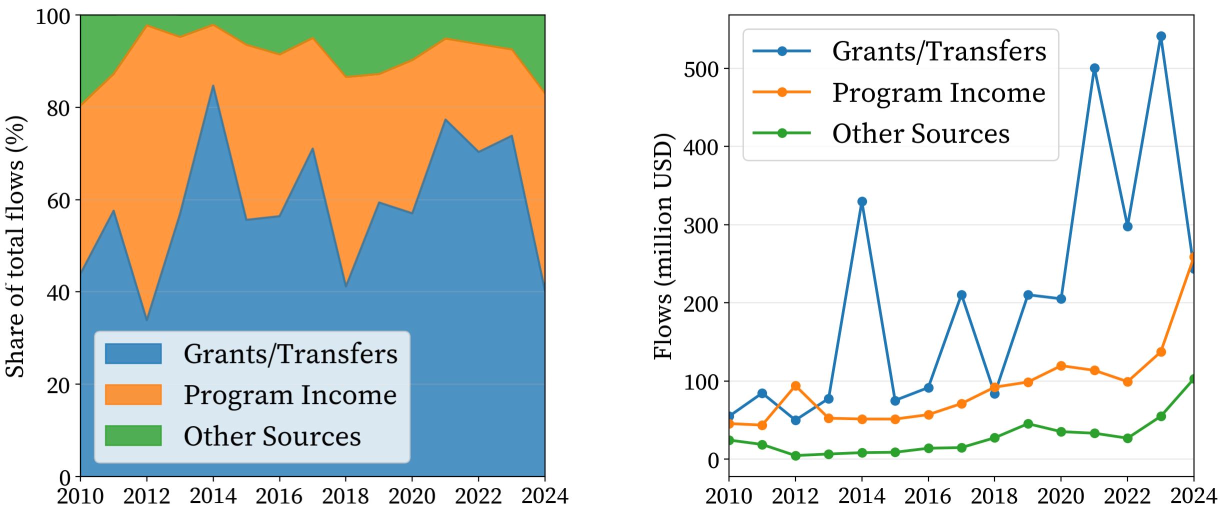
Governance and oversight. A state-chartered Green Bank is treated like any other public authority: board seats for state officials, open meetings, yearly budgets approved in a hearing, and audited financials. Nonprofit Green Banks sit in yet another box. They file Form 990 with the IRS, follow state charity law, and must keep donor money in line with the stated mission, but they are not examined for credit risk the way a traditional bank is. Some nonprofits add voluntary safeguards (advisory boards, published loan policies, and third-party impact reviews) to reassure funders.

Funding structure. Green Banks cannot take deposits, so they rely on two main categories of external revenue. The first is state-based transfers. Some of these are stable and recurring, most notably the systems benefit charges (utility bill surcharges) that have long provided predictable capitalization for institutions like the Connecticut Green Bank. Others take the form of budget appropriations or bond proceeds, which depend on legislative action and are less certain year to year. The second category is grants and external allocations. These include proceeds from programs such as the Regional Greenhouse Gas Initiative (RGGI), federal infusions through initiatives like the State Small Business Credit Initiative (SSBCI) or Department of Energy grants, and occasional philanthropic contributions.

Over time, however, program income has become increasingly important. This includes loan repayments, interest, sales of renewable energy credits, and operating fees. In Rhode Island, repayments from the Efficient Buildings Fund are recycled into new loans, while in New York, NY Green Bank now covers its entire operating budget through program income. Connecticut and Maryland have also expanded their portfolios to the point where internally generated revenue equals or surpasses state transfers. As Figure 1 shows, early Green Banks relied heavily on transfers and grants to fund operations and lending, but program income has matured into a durable revolving base, marking the transition from grant dependence to financial self sufficiency.

Conduit issuance. A subset of state authorities (e.g., Ohio Air Quality Development Authority, Illinois Finance Authority) primarily serve as conduit issuers. In this role, the Green Bank (or related authority) issues tax-exempt bonds on behalf of private borrowers such as renewable developers, manufacturers, or EV fleet operators. The bonds are legally and financially the borrower's liability: the Green Bank has no repayment obligation, and bondholders rely on the project's cash flows. From the issuer's perspective, conduit transactions are off balance sheet. They therefore expand the total volume of mobilized green capital without increasing the Green Bank's accounting leverage. Over the past decade, annual issuance has at times exceeded $3–4 billion in a single state, and outstanding balances for some issuers now reach into the tens of billions. These patterns highlight that, although not part of core on-balance sheet flows, conduit bonds remain a major source of mobilized green capital across several states.

In my database, I track conduit issuance projects alongside on-balance sheet activity. This allows me to capture the full scope of green capital mobilization, while still distinguishing between loans and investments that sit on a Green Bank's balance sheet and those that are purely conduit



(a) Share of revenue **(b) Total revenue (millions USD)**

Figure 1: Composition and volume of Green Bank revenues by source.

Notes: This figure reports the composition and total volume of Green Bank revenues, disaggregated by source. Revenues are classified into three categories: (i) transfers and grants (state appropriations, utility surcharges, carbon-auction proceeds, federal program allocations, and philanthropic inflows); (ii) program income (loan repayments, interest on promissory notes, sales of renewable energy credits, and fee-based revenues); and (iii) other revenues (investment income and miscellaneous items). Data are aggregated across all Green Banks in the baseline sample and cover fiscal years 2010–2024. The definition of Green Banks follows Section 3, which restricts attention to mission-driven lenders that recycle public or philanthropic capital through repayable instruments to crowd in private climate investment.

in nature.

Reporting. State-chartered and quasi-public Green Banks must comply with statutory disclosure rules requiring audited financial statements, annual budgets, and regular performance reports. Nonprofit Green Banks primarily disclose through the IRS's Form 990, but many voluntarily publish annual reports, project-level disclosures, and environmental impact metrics. The recent $20 billion allocation through the U.S. Environmental Protection Agency's Greenhouse Gas Reduction Fund (GGRF) introduces a new layer of standardized federal reporting, especially on greenhouse-gas reductions, private-capital mobilization, and service to disadvantaged communities.

This fragmented regulatory landscape presents both a challenge and an opportunity for data collection. Because there is no centralized reporting framework, the dataset I construct in this paper is based on original hand collection from a range of primary sources, including institutional reports and public financial disclosures. This approach allows for detailed project-level analysis across a wide range of institutional models.

3 Data

Definition of Green Bank. To construct a consistent list of Green Banks, I apply a working definition grounded in both legal structure and operational function. Specifically, I define Green Banks as mission-driven financial institutions, typically quasi-public agencies or nonprofit entities, that deploy public or philanthropic capital through repayable financial instruments such as loans, credit enhancements, and co-investments to mobilize private investment in clean energy and climate resilience. This definition excludes climate-focused institutions that engage solely in education, advocacy, or grantmaking, as these organizations do not function as financial intermediaries or revolve capital.

The primary sources for identifying candidate institutions are the Coalition for Green Capital, a national nonprofit that advocates for and incubates Green Bank models, and the Green Bank 50 coalition, an informal network of roughly 50 green lending institutions that formed in 2024 to share data and coordinate access to new federal programs such as the EPA's GGRF.

Institutions are classified as Green Banks if they meet at least three of the following criteria: (i) their core mission includes mobilizing climate-related private capital; (ii) they use market-based financial tools; (iii) they are structured to allow capital recycling; and (iv) they operate under a public mandate or nonprofit governance model. This filtering strategy ensures the dataset captures institutions that actively shape green capital flows through direct financial activity. Table 1 summarizes the list of Green Banks in my sample.

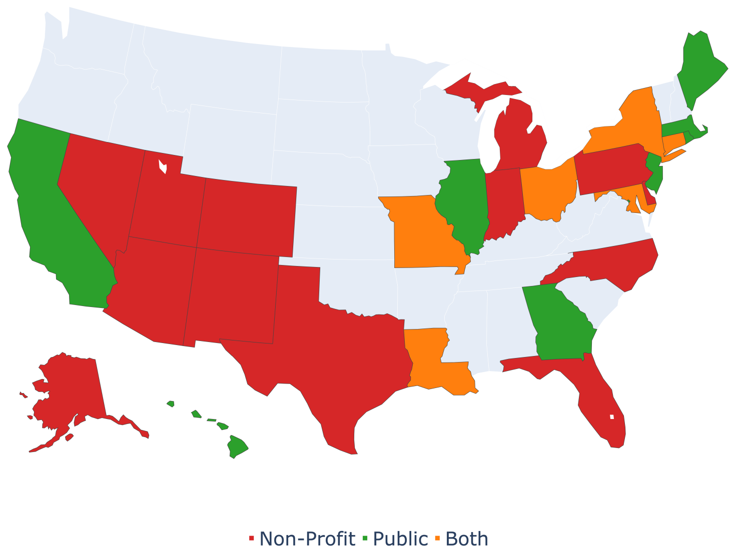
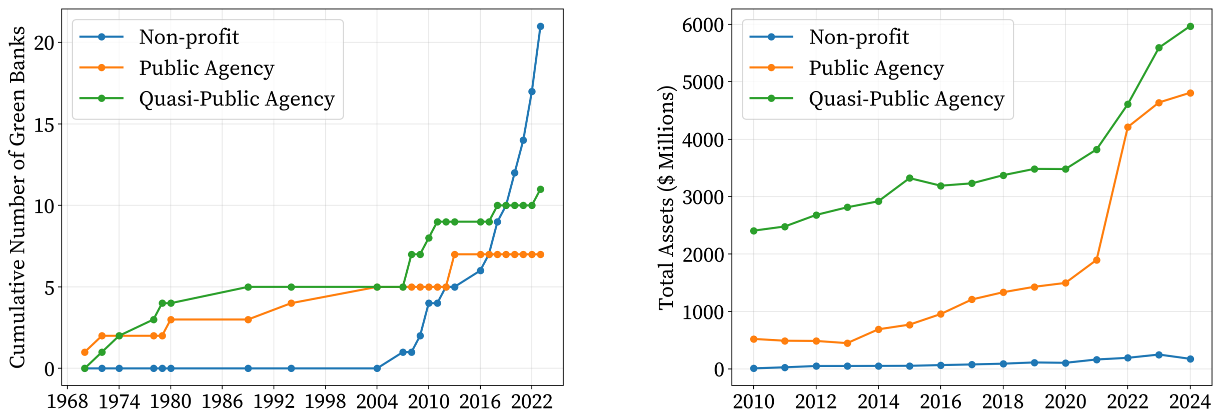


Figure 2: U.S. states that host at least one Green Bank, 2011–2024.

Notes: Shaded jurisdictions meet the Green Bank definition from Section 3 ("mission-driven lenders that recycle public or philanthropic capital through repayable instruments to crowd in private climate investment"). Highlighting is based on the list in Table 1 and reflects the institutional landscape as of July 2025. Both public/quasi-public agencies and nonprofit green banks are included; states hosting more than one qualifying institution (e.g., California, Massachusetts, Ohio) are plotted in orange. Puerto Rico, which also hosts a green bank, lies outside the map frame and is omitted.

Data collection. A central contribution of this paper is the construction of a novel dataset on Green Bank activity in the United States. I assemble it manually from multiple primary sources: audited financial statements, Form 990 filings, EMMA-posted official statements, program dashboards, and publicly accessible project registries. For the roughly one-half of Green Banks that are public or quasi-public authorities, I filed state open-records (FOIA-equivalent) requests. Private nonprofit Green Banks are not subject to FOIA; I therefore relied on direct outreach. Most of the nonprofit institutions replied that they are still in a start-up phase and could only share high-level aggregates. Where detailed files were unavailable, I recorded balance sheet and program totals from their latest public disclosures.



(a) Cumulative number of Green Banks

(b) Total assets (millions USD)

Figure 3: Growth and balance sheet expansion of Green Banks in the U.S.

Notes: This figure summarizes the institutional development and financial growth of Green Banks in the United States. Panel (a) reports the cumulative number of Green Banks founded in the United States, disaggregated by legal structure. Institutions are classified according to their organizational form (e.g., nonprofit entities, public or quasi-public agencies) as reported in Table 1. Year of establishment is taken from official Green Bank filings, press releases, or institutional reports, and the sample reflects the universe of qualifying institutions active between 2010 and 2024. The definition of Green Banks follows Section 3, which restricts attention to mission-driven lenders that recycle public or philanthropic capital through repayable instruments to crowd in private climate investment. Panel (b) shows the evolution of total assets (in millions of USD) held by active Green Banks over the same period, by legal structure. Asset data are compiled from annual reports, audited financial statements, or equivalent disclosures.

Table 1: U.S. Green Banks: Legal Form and Year Founded

Name	State	Year	Type	Sub-type
Connecticut Green Bank	Connecticut	2011	Public Agency	—
New York Green Bank	New York	2013	Public Agency	—
Rhode Island Infrastructure Bank	Rhode Island	1989	Public Agency	—
California Infrastructure and Economic Development Bank (IBank)	California	1994	Public Agency	—
Hawaii Green Infrastructure Authority (HGIA)	Hawaii	2013	Public Agency	—
DC Green Bank	District of Columbia	2018	Public Agency	—
California Alternative Energy and Advanced Transportation Financing Authority (CAEATFA)	California	1980	Public Agency	—
California Pollution Control Financing Authority (CPCFA)	California	1972	Public Agency	—
Atlanta Development Authority *d/b/a* Invest Atlanta	Georgia	1979	Public Agency	—
Illinois Finance Authority / Climate Bank	Illinois	2004	Public Agency	—
Finance New Orleans	Louisiana	1978	Public Agency	—
Efficiency Maine Trust	Maine	2010	Public Agency	—
Maryland Clean Energy Center	Maryland	2008	Public Agency	—
Massachusetts Clean Energy Center	Massachusetts	2008	Public Agency	—
Massachusetts Community Climate Bank	Massachusetts	2023	Public Agency	—
Environmental Improvement and Energy Resources Authority (EIERA)	Missouri	1972	Public Agency	—
New Jersey Economic Development Authority	New Jersey	1974	Public Agency	—
Ohio Air Quality Development Authority	Ohio	1970	Public Agency	—
Michigan Saves	Michigan	2009	Non-profit	Public Charity
Montgomery County Green Bank	Maryland	2016	Non-profit	Public Charity
Energize Delaware	Delaware	2010	Non-profit	Supporting Org.
Solar and Energy Loan Fund of Florida (SELF)	Florida	2010	Non-profit	Public Charity
Nevada Clean Energy Fund	Nevada	2017	Non-profit	Public Charity
Colorado Clean Energy Fund	Colorado	2018	Non-profit	Public Charity
Louisiana Clean Energy Fund	Louisiana	2023	Non-profit	Public Charity
Indiana Energy Independence Fund	Indiana	2023	Non-profit	Public Charity
Missouri Green Banc	Missouri	2022	Non-profit	Private Foundation
New Mexico Climate Investment Center	New Mexico	2023	Non-profit	Public Charity
New York City Energy Efficiency Corporation (NYCEEC)	New York	2010	Non-profit	Public Charity
North Carolina Clean Energy Fund	North Carolina	2020	Non-profit	Public Charity
Columbus Region Green Fund	Ohio	2021	Non-profit	Public Charity
GO Green Energy Fund (Growth Opps)	Ohio	2020	Non-profit	Public Charity
Philadelphia Green Capital Corp.	Pennsylvania	2021	Non-profit	Public Charity
Puerto Rico Green Energy Trust	Puerto Rico	2019	Non-profit	Public Charity
Clean Energy Fund of Texas	Texas	2021	Non-profit	Public Charity
SustainEnergyFinance	Utah	2023	Non-profit	Public Charity
Inclusive Prosperity Capital	National (CT)	2018	Non-profit	Public Charity
Spruce Root	Alaska	2012	Non-profit	Public Charity
Groundswell Capital	Arizona	2022	Non-profit	Supporting Org.

Notes: "Public Agency" covers both state agencies and quasi-public authorities created by statute or local ordinance. "Non-profit" entries follow IRS determinations; "Supporting Org." is a 509(a)(3) structure. Years are the enabling statute date or, for non-profits, the IRS incorporation year. Source: author compilation from statutes, Form 990 filings, and institutional websites.

Financial information. All balance-sheet and income figures come from publicly-available primary documents; no secondary databases are used. I rely on five source types that together cover every Green Bank in the sample:

(i) *State Comprehensive Annual Financial Reports (CAFRs)* and *component-unit audits*. Quasi-public and state-agency green banks appear in the enterprise-fund or component-unit sections of their state CAFR; the PDFs include a full Statement of Net Position, a Statement of Revenues and Expenses, and all debt footnotes.

(ii) *Standalone audited financial reports.* About one-third of the quasi-public banks (e.g. Connecticut Green Bank, DC Green Bank) publish their own GAAP-based audit separate from the CAFR. These reports provide detail on program loans, loan-loss reserves, and restricted net position that is not in the CAFR.

(iii) *IRS Form 990 filings*. Every non-profit bank files Form 990; the balance sheet (Part X) and revenue statement (Part VIII) supply cash, grants receivable, secured debt, and unrestricted net assets. XML versions are pulled from the ProPublica Non-profit Explorer webpage; PDFs are used when XML is missing.

(iv) *MSRB EMMA disclosures*. Whenever a Green Bank issues tax-exempt or "green" bonds, the Official Statement and continuing-disclosure filings on EMMA list coupon rates, amortisation schedules, and outstanding principal. These numbers are cross-checked against the liabilities shown in (i)–(iii).

(v) *Federal-grant and program reports*. For institutions that receive EPA Greenhouse Gas Reduction Fund (GGRF) or other public funds, I confirm draw-downs and unspent balances from the first-quarter 2024 financial reports, posted on USASpending.gov.

If a figure conflicts across documents, I follow a simple hierarchy: standalone audit → CAFR note → Form 990 → EMMA. Missing items (mostly for start-up non-profits that have not yet filed a 990) are requested directly from staff or, where necessary, via state FOIA. A log of every PDF and XML file, together with the code used to parse them, is archived in the Internet Appendix for reproducibility.

In this paper, I define a Green Bank's leverage as the ratio of its debt obligations (e.g., tax-exempt bonds, credit lines, or other borrowing) to total capital (debt plus equity-type funds such as grants, retained earnings, and philanthropic contributions). For banks that operate solely on grants or appropriations, leverage is zero.[3] This definition allows consistent comparison across institutions with different legal forms and funding models.

Project-level information. I collect project-level information for 11 Green Banks across 9 U.S. states between 2011 and 2024.[4] Each observation contains project characteristics such as funding amount, financial instrument (loan, guarantee, credit enhancement), co-financing details, target sector (e.g., residential solar, commercial efficiency), and geographic location (ZIP or census tract level where available). I use three primary sources:

(a) *Annual reports*: every Green Bank that publishes an Annual Impact Report, ACFR, or "Transaction Profile" series is scraped for deal-level tables.

(b) *Board packets and sunshine-law portals*: meeting minutes and project registers released under state open-records statutes (e.g., NY Open Meetings Law, Connecticut FOI) provide the most granular line-item data.

(c) *Direct requests and FOIA/FOIL queries*: for banks without public deal logs, redacted spreadsheets are obtained via negotiated data-sharing agreements or formal FOIA requests to the state energy office [ongoing].

Project classification. To align the empirics with the theoretical model, I focus on transactions where Green Banks commit capital that is at risk and repayable. Pure grants and subsidies are excluded from the baseline sample, since they do not revolve, carry no repayment obligation,

[3] Several Green Banks in the sample (particularly nonprofit start-ups) operate entirely on grants, appropriations, or philanthropic equity and carry no debt. For these institutions, leverage is mechanically zero in all years. In the baseline regressions, I code their leverage ratio as zero, which both preserves the full sample and reflects their institutional reality. Results are robust to (i) excluding non-leveraged banks, and (ii) interacting leverage with a nonprofit indicator. Both approaches yield qualitatively similar coefficients, suggesting that the estimated effect of leverage constraints is not driven solely by banks with borrowing authority.

[4] The sample covers the following institutions: Connecticut Green Bank; New York Green Bank; Rhode Island Infrastructure Bank; California Infrastructure and Economic Development Bank (IBank); California Pollution Control Financing Authority (CPCFA); Illinois Finance Authority (Climate Bank program); Maryland Clean Energy Center; Massachusetts Clean Energy Center; Massachusetts Community Climate Bank; Environmental Improvement and Energy Resources Authority (EIERA, Missouri); and New Jersey Economic Development Authority. **Ongoing FOIA and data-sharing requests cover the Hawaii Green Infrastructure Authority (HGIA), DC Green Bank, the California Alternative Energy and Advanced Transportation Financing Authority (CAEATFA), the Atlanta Development Authority (Invest Atlanta), Finance New Orleans, Efficiency Maine Trust, and the Ohio Air Quality Development Authority.**

and bypass leverage or co-financing frictions. Hybrid structures that combine subsidies with repayable loans are coded only on the repayable component. Contingent risk-sharing instruments such as funded loan loss reserves are retained, as they represent capital deployed and exposed to potential loss.

All transactions are then classified into four mutually exclusive categories: (i) *on-balance lending*, such as direct loans, leases, participations, or mezzanine financing from Green Bank funds; (ii) *credit enhancements*, such as cash reserves, or collateral support that are fully funded and at risk; (iii) *conduit issuance*, when the Green Bank issues tax-exempt bonds on behalf of a private borrower, but credit risk remains with the borrower and the transaction is off-balance sheet; and (iv) *facilitation-only*, which are projects fully financed by private lenders where the Green Bank provides only convening or technical assistance.

In the baseline regressions, I include categories (i) and (ii), which involve Green Bank dollars at risk and are directly subject to balance-sheet constraints. Conduit issuance and facilitation-only projects are excluded from the baseline but analyzed separately in robustness checks.

Other variables considered. I supplement these project-level data with county-level socioeconomic and climate attitude variables. Median income is drawn from the U.S. Census Bureau's Small Area Income and Poverty Estimates (SAIPE) dataset at the county level. Measures of population and GDP are obtained from the U.S. Bureau of Economic Analysis dataset on personal income and economic activity by county. Finally, climate concern is measured using the Yale Program on Climate Change Communication's (YPCCC) county-level survey estimates (Howe et al. (2015)), specifically the share of adults who are somewhat or very worried about global warming (with a national average of 63% in 2024). These sources allow me to examine whether co-financing is systematically related to both project-level financial structure and broader county-level socioeconomic and climate context.

Lastly, I classify projects by sector using the Climate Bonds Initiative (CBI) taxonomy. This taxonomy is an internationally recognized classification system developed by CBI to identify investments consistent with climate mitigation and resilience goals. It provides standardized sector categories (e.g., solar energy, electric transport) and is widely used in green bond certification. Using this taxonomy ensures comparability of project types across institutions and time, and aligns my classification with the broader sustainable finance literature.

4 Summary Statistics

Green Banks show significant variation in project size, leverage ratios, and regional targeting, highlighting the importance of institution-level heterogeneity. Table 2 summarizes the scope and activities of major U.S. Green Banks and related state authorities. The institutions vary widely in scale: while Connecticut Green Bank has financed over 10,000 projects with relatively small average ticket sizes, NY Green Bank and Rhode Island Infrastructure Bank have mobilized over a billion dollars each through larger, fewer transactions. Patterns of co-financing also differ: some institutions, such as the Environmental Improvement and Energy Resources Authority and Maryland Clean Energy Center, report nearly universal private participation, while others, like NY Green Bank, focus on balance-sheet lending with limited co-investment. The sectoral distribution likewise reflects institutional design, with state infrastructure banks (California, Rhode Island, Ohio) concentrating on water and industrial facilities, while clean energy focused banks (Connecticut, DC, Massachusetts) primarily target buildings and solar energy.

Table 2: Summary statistics of selected green banks and related institutions.

Green Bank / Institution	Proj.	FY Min	FY Max	Cap. (M)	Proj. Amt. (M)	Avg. (M)	Med. (M)	Share Cof. (%)	Pub/Priv. Cof. (%)	# Ctys	Top Sector
Atlanta Development Authority (Invest Atlanta)	16	2011	2025	3.87	58.74	3.67	1.73	68.8	58.9	2	Buildings
California Infrastructure & Economic Dev. Bank	97	2000	2024	634.58	1000.52	10.31	5.69	81.4	22.9	34	Water
Connecticut Green Bank	10,321(*)	2013	2025	157.93	742.41	0.07	0.02	100.0	95.1	8	Buildings
DC Green Bank	35	2020	2024	53.13	186.29	5.32	1.80	100.0	18.4	1	Energy
Environmental Improvement & Energy Resources Authority	22	2010	2025	0.00	1022.91	46.50	26.04	100.0	100.0	5	Water
Illinois Finance Authority / Climate Bank	27	2024	2026	28.90	40.80	1.51	0.45	100.0	14.9	16	Energy
Maryland Clean Energy Center	551	2013	2025	0.32	193.34	0.35	0.01	100.0	94.8	19	Buildings
Massachusetts Clean Energy Center	56	2018	2024	9.16	12.11	0.22	0.10	100.0	5.0	6	Energy
Massachusetts Community Climate Bank	49	2025	2026	3.40	3.40	0.07	0.07	100.0	0.0	13	Buildings
NY Green Bank	86	2016	2025	1358.94	1538.44	17.89	10.00	4.7	3.1	20	Energy
New Jersey Economic Dev. Authority	48	2010	2024	35.83	35.83	0.75	0.21	—	0.0	0	Land Use
Ohio Air Quality Dev. Authority	212	2010	2023	36.54	4422.27	20.86	1.17	94.8	94.8	64	Industry
Rhode Island Infrastructure Bank	229	2015	2024	1026.04	1142.65	4.99	0.94	100.0	15.7	5	Water

Notes: The table reports summary statistics for major U.S. Green Banks. “Committed capital” is the total amount directly deployed on balance sheet by the institution (USD millions). “Project amount” includes both committed capital and mobilized co-financing (USD millions). “Avg.” and “Med.” refer to the average and median project size. “Share co-financed” is the percentage of projects with any co-financing reported. “Public/Private co-financed” is the percentage of projects that involve both public and private sources of capital. “# Ctys” indicates the number of distinct counties in which projects have been located. “Top sector” identifies the sector with the largest share of projects. (*) The very large project count primarily reflects its *Smart-E* program, under which thousands of small retail loans for home energy upgrades (and related measures) are originated via partner lenders and recorded as individual projects. Source: author’s database, compiled from institutional reports and bond disclosures.

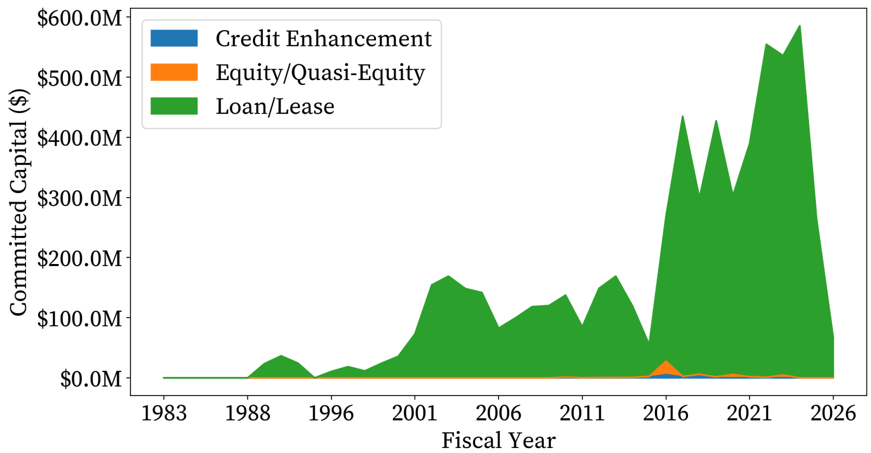
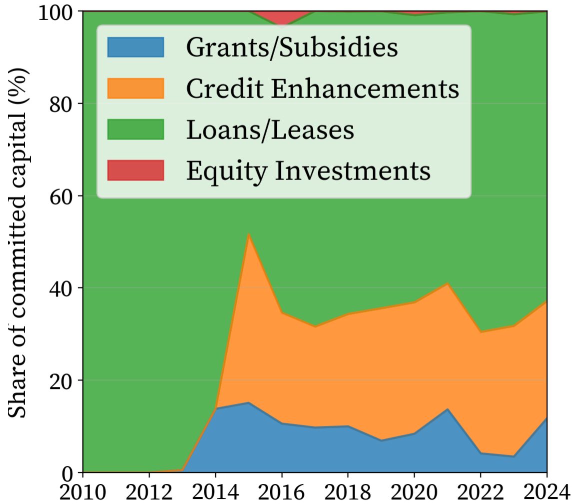


Figure 4: Committed Capital by Instrument Type, U.S. Green Banks.

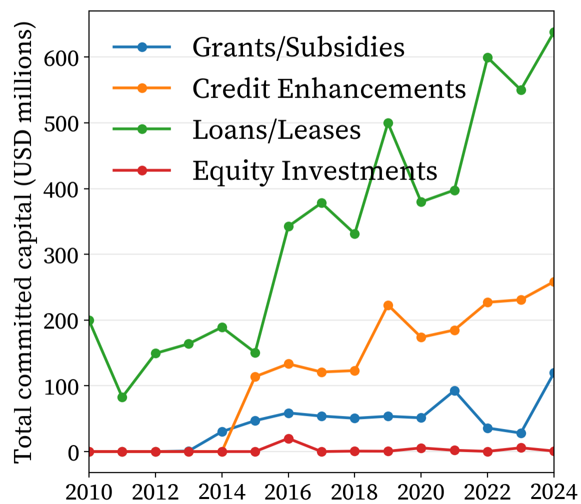
Notes: This figure reports the aggregate dollar volume of capital commitments made by U.S. Green Banks between fiscal years 2010 and 2024, disaggregated by instrument type. "Committed capital" refers to the face value of financing approved for deployment through loans, leases, credit enhancements, and other repayable instruments. Conduit bond issuances are excluded to focus on balance-sheet or directly intermediated activity. Instrument types are mutually exclusive and follow the harmonized taxonomy in Section 3. Fiscal years correspond to each institution's own reporting calendar. All amounts are shown in nominal dollars.

Figure 4 shows that Green Bank activity is dominated by loans and leases throughout the sample, with credit enhancements and equity/quasi-equity appearing only intermittently and at much smaller scales. Aggregate committed volumes are modest in the early years, then rise sharply from the mid-2010s onward, with notable surges around the late 2010s and again in the early 2020s. The composition remains stable even as totals grow: lending expands while equity and guarantees remain secondary tools. Interpreted jointly, the pattern is consistent with Green Banks operating primarily as balance-sheet lenders that recycle capital through repayable instruments rather than as equity investors, while deploying targeted credit enhancements episodically. Because conduit bond programs are excluded, the figure focuses on directly intermediated activity and therefore understates total mobilization channels that run through conduit structures.

Figure 6 shows the private share of total project capital by fiscal year. For each year, the share equals the sum of project totals minus Green Bank committed amounts, divided by the sum of project totals, excluding "Conduit Debt" to focus on balance-sheet or directly intermediated financing. Higher values indicate more non–Green Bank capital relative to total costs. GBs show a clear upward trend in the private share of total project capital over the last 14 years. Interpreted literally, these dynamics suggest a growing ability of Green Bank activity to crowd in non-Green



(a) Share of committed capital



(b) Total committed capital

Figure 5: Composition and volume of committed capital by instrument type.

Notes: Panel (a) shows the annual share of Green Bank committed capital accounted for by each instrument category (grants/subsidies, credit enhancements, loans/leases, and equity investments). Panel (b) plots the corresponding total volumes in millions of U.S. dollars. Data are aggregated across all institutions in the baseline sample for fiscal years 2010–2024.

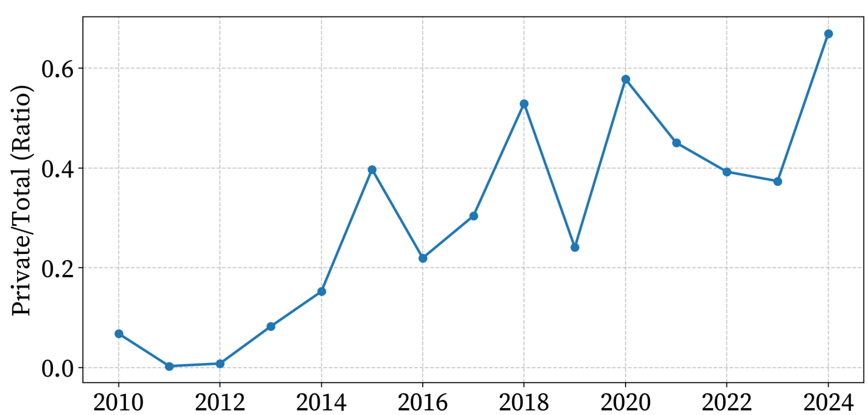


Figure 6: Mobilization leverage.

Notes: The series plots the aggregate mobilization leverage for the GB in my sample, i.e., the private share of total project capital by fiscal year. For each year, this share is computed as the sum of project totals minus the Green Bank's committed amounts, divided by the sum of project totals. The numerator captures non-Green Bank (private and other non-GB) capital mobilized. "Conduit Debt" projects are excluded to focus on balance-sheet or directly intermediated activity. When the total project cost is missing, it is treated as the GB's committed capital for the construction of the series. Fiscal years follow each institution's reporting calendar. Amounts are nominal, and ratios are transaction-sum weighted (not simple averages).

Bank resources over time, alongside sensitivity to the mix and timing of large transactions. Because "Conduit Debt" is excluded, the figure focuses on balance-sheet or directly intermediated activity and omits mobilization channeled through conduit bond programs. Finally, when a project's total cost is missing I set it equal to the Green Bank's committed amount; this assigns a zero private share to those observations and makes the aggregate series a conservative (lower-bound) estimate of private mobilization.

5 Model [preliminary and incomplete]

In this section I develop a simple baseline model of a nonprofit Green Bank that finances climate-related investment by leveraging private sector co-investment. The interaction between the Green Bank and private lenders is modeled as a Stackelberg game. The Green Bank acts as a leader, choosing the amount of public capital it will deploy and the share of the project it seeks to co-finance through private capital. Private banks respond by deciding whether to participate, depending on risk-adjusted returns.

Project financing and capital structure. Let L^{GB} denote the amount of capital that the Green Bank invests in a project. The Green Bank selects a co-financing share $\mu \in [0, 1)$, which determines the total size of the project:

$$L = \frac{L^{GB}}{1 - \mu} \tag{1}$$

The Green Bank finances its investment using tax-exempt debt D and internal funds E (e.g., grants, retained surpluses, or philanthropic contributions), subject to a regulatory leverage constraint:

$$L^{GB} = D + E, \tag{2}$$

$$D \leq \lambda L^{GB} \tag{3}$$

λ is a statutory cap on the debt share. I assume the cap binds in equilibrium, consistent with convex debt costs and the mission orientation of Green Banks.

Borrowing costs are increasing in the Green Bank's leverage ratio, reflecting political, administrative, or reputational risks. Specifically, the cost of debt is modeled as:

$$r_D = r_0 + \phi \left(\frac{D}{D+E} \right)^2, \tag{4}$$

where r_0 is the base cost of capital and $\phi > 0$ is the convexity parameter of borrowing costs.

In addition, co-financing introduces coordination frictions that rise with the scale and complexity of private sector involvement (μ), and of the project size (L). These costs are given by:

$$F(\mu, L) = \chi \mu^2 L \tag{5}$$

where $\chi > 0$ reflects the per-unit marginal cost of managing public-private project delivery.

The Green Bank maximizes a utility function that combines environmental and social impact with financial sustainability. The first component reflects total project size (mission), while the second captures net financial surplus after accounting for debt servicing and coordination costs (financial performance). The objective is:

$$\max_{L^{GB},\mu} \ \theta \log \left(\frac{L^{GB}}{1-\mu} \right) + (1-\theta) \log \left[\rho L^{GB} - r_D D - F(\mu, L) \right], \tag{6}$$

where $\theta \in (0, 1)$ is the relative weight the Green Bank places on mission versus financial performance, $\rho > 0$ denotes the return on every dollar invested in green projects, and the remaining terms reflect costs associated with leverage and coordination.

After observing the Green Bank's proposal (L^{GB}, μ), a private bank (PB) decides whether to provide the complementary capital μL. It earns an expected return per dollar of investment equal to:

$$R^{PB} = \rho - \gamma(\mu, L), \tag{7}$$

where γ captures risk-adjusted coordination costs and is increasing in the scale of private participation. I model coordination costs as rising in total deal scale, reflecting fixed transaction costs and the complexity of multi-party negotiations. Coordination costs for the Private Bank are modelled as:

$$\gamma(\mu, L) = \psi\mu L \tag{8}$$

with $\psi > 0$ denoting the sensitivity of private bank costs to the scope of their involvement. The private bank invests only if the risk-adjusted return exceeds its required return r^{PB}:

$$\rho - \gamma(\mu, L) \geq r^{PB} \tag{9}$$

This yields a participation constraint:

$$\mu \cdot \frac{L^{GB}}{1-\mu} \leq \frac{\rho - r^{PB}}{\psi} \tag{10}$$

Definition 5.1 (Equilibrium)**.** The Stackelberg equilibrium is a pair (L^{GB*}, μ^*) such that the Green Bank maximizes its utility function (6), subject to the following constraints and (1):

$$\begin{aligned}
&L^{GB} = D + E, \\
&D \leq \lambda L^{GB}, \\
&\mu \cdot \frac{L^{GB}}{1-\mu} \leq \frac{\rho - r^{PB}}{\psi} \quad \text{(Private bank participation constraint)}
\end{aligned}$$

The Green Bank acts as a Stackelberg leader: it anticipates the private bank's response to any co-financing proposal (L^{GB}, μ) and chooses its strategy accordingly. The equilibrium characterizes the optimal allocation of public capital and co-investment share, ensuring participation by private banks while balancing the Green Bank's mission and financial objectives.

Proposition 5.1 (*Stackelberg Equilibrium in Green Co-Financing*)**.** Let the Green Bank choose its investment level L^{GB} and co-financing share $\mu \in [0, 1)$ to maximize its utility function (6), subject to (2), (3), and (10). Then, the unique Stackelberg equilibrium is characterized by:

$$\mu^* \text{ solves } \mu^2(2\theta - 1)\chi + \mu\theta A - A = 0, \quad 0 < \mu^* < 1,$$

and

$$L^{GB*} = K\,\frac{1-\mu^*}{\mu^*}, \qquad D^* = \lambda\, L^{GB*}, \qquad L^* = \frac{L^{GB*}}{1-\mu^*},$$

where

$$\bar{r}_D = r_0 + \phi\lambda^2, \quad A = \rho - \lambda\bar{r}_D, \quad K = \frac{\rho - r^{PB}}{\psi} > 0,$$

with $A > 0$, $\rho > r^{PB}$, $\theta > \frac{1}{2}$[5], and

$$\chi\,(2\theta - 1) > (1-\theta)\,A \tag{$*$}$$

Lemma 5.1 (Comparative statics of μ^* in χ and λ)**.** Let $\mu^* \in (0,1)$ solve the GB's optimization problem, with $\theta \in (\frac{1}{2}, 1)$, $\chi > 0$, $A > 0$, $r_0 > 0$, $\phi > 0$, and $\lambda > 0$. Then:

$$\frac{\partial \mu^*}{\partial \chi} < 0, \qquad \frac{d\mu^*}{d\lambda} < 0$$

Proposition 5.1 pins down a unique interior co-financing share in this simple model. As shown in Lemma 5.1, μ^* decreases in both the marginal coordination cost of coordination, χ, and the GB's leverage ratio cap, λ. The comparative statics are intuitive: a higher coordination-friction parameter makes each extra unit of crowd-in more costly, so the GB chooses a lower crowd-in share ($\partial\mu^*/\partial\chi < 0$). Because K is fixed, a lower μ mechanically requires a larger project size L^* and, therefore, more GB capital, L^{GB}. Similarly, raising GB's leverage, λ increases the GB's debt cost r_D and shrinks the surplus A; with less surplus to "share," the optimal crowd-in share falls ($\partial\mu^*/\partial\lambda < 0$), again implying a larger project L^* and heavier GB balance-sheet usage. Policywise, lowering co-financing frictions ($\downarrow \chi$) or debt cost convexity ($\downarrow r_0$, $\downarrow \phi$) would mobilize the same private dollars with less GB capital tied up per project, freeing GB capacity to back more deals.

Testable implication. If debt becomes more expensive or constrained, the Green Bank optimally lowers the private crowd-in share (μ) but not the dollars the private bank puts in at the optimum (the PB constraint binds). Empirically, when the GB faces higher leverage costs or tighter leverage, we should observe (i) a lower μ on subsequent deals and (ii) higher GB dollars per deal, while private dollars per deal remain roughly flat within short windows where the PB hurdle K is stable. A simple elasticity test follows directly from the model's identities: with $L^{GB} = K(1-\mu)\mu$

[5] If $\theta = \frac{1}{2}$, the quadratic term in the first-order condition vanishes and the Green Bank chooses $\mu^* \to 1^-$ with $L^{GB*} = 0$.

and $L = K/\mu$.

6 Empirical results

6.1 Extensive and Intensive Margins of Co-Financing

The model delivers comparative statics for the green bank's optimal crowd-in share of private capital, $\mu^\star$, which declines when (i) balance-sheet leverage becomes more costly and (ii) coordination frictions with private lenders increase. Empirically, I observe both (i) whether a project secures any private co-financing (participation, i.e., the extensive margin) and (ii) the intensity of private participation relative to public dollars when it occurs (the intensive margin). I therefore estimate a two-part empirical design.

Part I: Extensive margin (participation). Define the indicator

$$\text{Cofinanced}_{ibt} \in \{0, 1\},$$

which equals one if project i at green bank b in year t involves at least one private lender. I estimate the probability of crossing this participation hurdle as a function of leverage costs and coordination frictions:

$$\Pr(\text{Cofinanced}_{ibt} = 1) = F\Big(\alpha + \beta_1 \,\text{LeverageCost}_{bt} + \beta_2 \,\text{Coordination}_{ibt} + \beta_3' X_{ibt} + \gamma_b + \delta_t\Big), \quad (11)$$

where $F(\cdot)$ is a logit or probit CDF; X_{ibt} includes project controls (CBI sector dummies and instrument type); and γ_b, δ_t are green bank and year fixed effects. Standard errors are clustered at the bank level. Consistent with the Stackelberg logic, the model implies $\beta_1 < 0$ and $\beta_2 < 0$.

As a robustness check allowing for high-dimensional fixed effects (e.g., GB$\times$state or county), I also estimate a linear-probability model:

$$\text{Cofinanced}_{ibt} = \alpha + \beta_1 \,\text{LeverageCost}_{bt} + \beta_2 \,\text{Coordination}_{ibt} + \beta_3' X_{ibt} + \gamma_b + \delta_t + \varepsilon_{ibt}, \qquad (12)$$

with heteroskedasticity-robust standard errors clustered at the bank level. The signs of $\widehat{\beta}_1, \widehat{\beta}_2$

should mirror the marginal effects from (11).

Part II: Intensive margin (private/public ratio). Conditional on participation, the model predicts that tighter constraints raise the green bank's dollars per deal (private dollars are locally pinned by the participation hurdle), so intensity should reflect leverage costs and coordination frictions. I measure intensity using the ratio of private to public dollars mobilized,

$$L_{ibt}^{\text{priv/public}} = \frac{\text{Private}_{ibt}}{\text{Public}_{ibt}},$$

and estimate:

$$L_{ibt}^{\text{priv/public}} = \alpha' + \theta_1 \,\text{LeverageCost}_{bt} + \theta_2 \,\text{Coordination}_{ibt} + \theta_3' X_{ibt} + \gamma_b' + \delta_t' + \varepsilon_{ibt}'. \tag{13}$$

I report (i) pooled OLS, (ii) OLS with year and instrument fixed effects, and (iii) a within-bank specification that demeans continuous regressors and the dependent variable at the GB level, absorbing bank-specific averages. The model implies $\theta_1 > 0$ and $\theta_2 > 0$ when conditioning on participation.[6]

6.2 Interpretation and discussion

Signs and statistical significance. Across specifications, the coefficient on `gb_leverage_ratio` is negative, and in Model (2) it is large and statistically significant. This is consistent with the model: tighter financing conditions (higher leverage or higher marginal cost of leverage) are associated with *lower* private dollars per public dollar on a project, holding sector and instrument fixed. The *Co-financed (dummy)* coefficient is positive and highly significant in all columns, indicating that projects with any private participation exhibit substantially higher private/public ratios than projects without private partners, as expected by construction.

Economic magnitude. Interpreting Model (2), a one-unit increase in the leverage ratio is associated with a 1.86-point decrease in the private/public ratio. Without loss of generality, if the private/public ratio is near one on average, this magnitude is economically meaningful: moving

[6] In practice, the sample includes projects with $L_{ibt}^{\text{priv/public}} = 0$ when no private dollars are mobilized; I therefore also report specifications that include a co-financing dummy as a conditioning regressor.

Table 3: Intensive Margin: Private/Public Mobilization vs. Green-Bank Leverage

	(1) Pooled OLS	(2) OLS + FE	(3) Within-GB
Green Bank Leverage Ratio	-0.427	-1.862***	-0.598
	(0.371)	(0.235)	(0.463)
Co-financed (dummy)	0.776***	0.513***	0.241***
	(0.090)	(0.108)	(0.009)
Median County Income (10k)	-0.063	0.013	0.026
	(0.041)	(0.006)	(0.014)
County Population (100k)	-0.005	0.004	0.004
	(0.005)	(0.003)	(0.002)
Per Capita Income (10k)	0.017	-0.007**	-0.011*
	(0.014)	(0.002)	(0.005)
Year FE	No	Yes	Yes
Instrument FE	No	Yes	Yes
Green Bank FE	No	No	Yes (demeaned)
Observations	612	461	461
R^2	0.256	0.195	0.031

Notes: The dependent variable is the private-to-public mobilization ratio. "Co-financed (dummy)" is a participation indicator equal to 1 if any private partner is present on the deal. Models are OLS with standard errors clustered by Green Bank (in parentheses). Model (1) is pooled; Model (2) adds year and instrument fixed effects; Model (3) is a within-bank specification that demeans continuous regressors and the dependent variable at the GB level, absorbing bank averages. A negative coefficient on `gb_leverage_ratio` indicates that higher balance-sheet leverage is associated with lower private mobilization per public dollar (intensive margin), consistent with the model's prediction that tighter constraints depress $\mu^{\star}$. Stars denote significance at the 10% (*), 5% (**), and 1% (***) levels.

from a relatively low- to a relatively high-leverage environment for the GB materially depresses the intensity of private crowd-in at the deal level. Because Model (3) absorbs bank-level averages, the negative (though imprecise) within-bank estimate suggests that time-variation in leverage within a bank also correlates with lower private intensity.

Link to the participation (extensive) margin. The two-part logic maps closely to the theory. First, higher leverage costs and coordination frictions reduce the probability that any private lender participates ($\beta_1, \beta_2 < 0$). Second, conditional on participation, tighter constraints translate into higher reliance on GB dollars per deal and thus a lower private/public ratio ($\theta_1, \theta_2 > 0$ in the model, but realized here as a lower private share when leverage is high). Empirically, the intensive-margin result in Table 3 aligns with this mechanism. The participation regressions (not reported here; see Appendix) show the expected negative association with leverage costs and frictions.

Overall, the evidence indicates that tighter GB financing conditions are associated with *both* a lower likelihood of private participation (extensive margin) and a lower intensity of private capital per public dollar (intensive margin). These patterns are consistent with the model's comparative statics and suggest that policies which relax leverage constraints or reduce coordination frictions (standardized contracts, arranger support, or blended-finance facilities) can increase private crowd-in.

6.3 Identification Strategy

A central concern in estimating equations (11)–(13) is that the Green Bank's leverage cost, LeverageCost_{bt}, is endogenous to private mobilization outcomes. Projects that attract little private capital may leave the Green Bank carrying a larger share of the financing, mechanically raising leverage. Conversely, favorable project environments could reduce both leverage and the private/public ratio, confounding the relationship. To recover the causal effect of financing constraints on crowd-in, I exploit exogenous variation in conduit bond issuance.

[To be completed]

7 Conclusions

[To be completed]

Appendix

A (Public) Green Bank Programs

A.1 Connecticut Green Bank

The Connecticut Green Bank (CGB), created in 2011 as the successor to the Clean Energy Finance and Investment Authority, is recognized as the first state-level Green Bank in the United States (Connecticut General Assembly (2011)). Established as a quasi-public entity, its statutory mandate is to mobilize private capital for clean energy investment, a mission expanded in 2021 to encompass broader environmental infrastructure such as climate adaptation, land conservation, and waste management (Connecticut General Assembly (2021)). CGB has become a national model for leveraging limited public funds to unlock larger volumes of private investment in energy efficiency, renewable generation, and resilience projects.

CGB delivers this mandate through a diverse set of financing platforms. These include statewide **C-PACE** financing for commercial properties, the **Smart-E** loan program for households in partnership with local lenders, and a suite of multifamily finance products targeting affordable housing providers. More recent initiatives include **Solar MAP+** for municipal and nonprofit solar aggregation, an **Energy Storage Solutions** program launched in 2022, and the **Green Liberty Notes and Bonds**, which extend participation opportunities to retail investors. Together, these instruments combine credit enhancements, direct lending, and innovative public offerings to broaden the reach of clean energy finance and ensure access across both households and institutions.

A.2 New York Green Bank

The New York Green Bank (NYGB) was launched in 2013 as a division of the New York State Energy Research and Development Authority (NYSERDA), capitalized with US $1 billion in uncommitted ratepayer funds (New York State Public Service Commission (2013)). It was designed as a self-sustaining investment entity with operational autonomy, mandated to recycle capital and build an enduring financing institution. Its mission is twofold: to accelerate the deployment of clean energy and sustainable infrastructure by mobilizing private investment, and to establish a permanent financial platform capable of addressing persistent market gaps in distributed energy, efficiency, and other climate-related sectors.

NYGB pursues this mission through flexible lending and credit products tailored to overcome underwriting frictions, particularly in markets where small scale, performance uncertainty, or lack of aggregation discourage private lenders. Its portfolio has included construction loans, blended construction-plus-term facilities, standalone debt and equity-like investments, and warehousing structures that enable loan aggregation and eventual securitization. Instruments are often structured as delayed-draw facilities, ensuring that capital is deployed only once milestones are met, while contingent credit enhancements such as subordinated debt or loan-loss reserves are used to de-risk private participation.

A.3 Rhode Island Infrastructure Bank

The Rhode Island Infrastructure Bank (RIIB), originally established in 1989 as the Clean Water Finance Agency and restructured in 2015 (Rhode Island Legislature (2015)), serves as the state's central quasi-public authority for environmental and climate finance. Its remit extends beyond water quality to include clean energy, resilience, and brownfield redevelopment. RIIB manages federally capitalized State Revolving Funds and issues labelled green bonds, while also operating revolving loan pools such as the Efficient Buildings Fund and the Clean Energy Fund. These mechanisms provide long-tenor, subsidized, and flexible financing that allows municipalities, utilities, and private actors to pursue climate mitigation and adaptation projects.

In addition to infrastructure lending, RIIB administers a range of specialized programs that crowd in private capital and target local priorities. The statewide C-PACE program finances 100% of energy and renewable upgrades through property-based assessments, while the Brownfields Revolving Loan Fund and Stormwater Project Accelerator channel upfront capital into remediation and green infrastructure. The Municipal Resilience Program supports planning and competitive grants for locally identified projects, complemented by retail-scale offerings such as septic system, sewer tie-in, and drinking-water loans. By combining federal transfers, state appropriations, and credit-enhanced securitization, RIIB has become a versatile platform for advancing both climate mitigation and resilience across Rhode Island.

A.4 California Infrastructure and Economic Development Bank (IBank)

The California Infrastructure and Economic Development Bank (IBank), created in 1994 as a state-owned financing authority within the Governor's Office of Business and Economic Development, provides low-cost capital to support economic development, environmental quality, and public infrastructure (California Legislature (2020)). Its green finance activities span several programs: the **Infrastructure State Revolving Fund (ISRF)**, which extends low-interest loans to local governments, schools, special districts, and nonprofits for renewable energy, efficiency, water conservation, and resilience projects; the **Climate Catalyst Fund**, launched in 2021 to deliver flexible financing and credit enhancements in priority sectors such as sustainable agriculture, wildfire mitigation, zero-emission transport, and building electrification; and the **California Lending for Energy and Environmental Needs (CLEEN)** Center, which issues bonds and direct loans for clean energy and water infrastructure at both distributed and utility scale. IBank also administers revenue-bond programs for public agencies and nonprofits, giving large-scale green projects access to capital markets. Together these platforms position IBank as California's primary public lender for climate-aligned infrastructure, blending revolving funds, catalytic credit support, and capital-markets issuance to crowd in private investment.

A.5 DC Green Bank

The DC Green Bank (officially the District of Columbia Green Finance Authority) was created on July 2018 (Council of the District of Columbia (2018)), and began operations in April 2020 as an independent instrumentality of the DC government. The institution's mandate is to mobilize private capital through a full suite of financial tools (loans, loan guarantees, credit enhancements, bonds, and other mechanism) for a broad spectrum of "sustainable projects and programs" including clean energy, clean transportation, stormwater, energy and water efficiency, water infrastructure, and green infrastructure.

The DC Green Bank, formally established in 2018 (Council of the District of Columbia (2018)) and operational since 2020 as an independent instrumentality of the District government, is mandated to mobilize private capital for a wide spectrum of sustainable projects, including clean energy, transportation, stormwater, water efficiency, and green infrastructure. Its financing toolbox spans **C-PACE** loans that cover up to 100% of project costs; pre-development loans to support feasibility and early-stage design; structured lending products such as the **Commercial Loan for Energy Efficiency & Renewables (CLEER)**; and a forthcoming Small Business Loan Fund developed with community partners.

A.6 California Pollution Control Financing Authority (CPCFA)

The California Pollution Control Financing Authority (CPCFA), created in 1972 and housed within the State Treasurer's Office, began as a conduit issuer of tax-exempt bonds for environmental projects but has since evolved into a broader green finance intermediary. In addition to continuing its private-activity bond program for solid-waste, water, wastewater, recycling, and now carbon-capture facilities, CPCFA administers the **California Capital Access Program (CalCAP)**, a set of loan-loss-reserve and collateral-support schemes that share credit risk with private lenders and are now partly capitalized with federal SSBCI funds. CalCAP has supported small-business working-capital and equipment loans since the 1990s, collateral-support facilities since 2013, and, more recently, a pilot for zero-emission heavy-duty vehicles and charging infrastructure, while earlier clean-transport programs have sunset. A third platform, **CALReUSE**, provides revolving loans and remediation grants for brownfield revitalization, financed through recycled repayments and cap-and-trade proceeds. Taken together with CAEATFA's equipment finance and IBank's direct lending, CPCFA anchors one arm of California's multi-agency "green bank" structure, combining conduit issuance, credit enhancements, and targeted grants to channel state, federal, and private resources into the climate transition.

A.7 Atlanta Development Authority d/b/a Invest Atlanta

The Atlanta Development Authority, which operates under the name Invest Atlanta, is the City of Atlanta's official economic development agency. Established as a public authority with bonding powers, Invest Atlanta was designated as the city's Green Bank in 2020, with a mandate to advance clean energy, resilience, and equitable access to climate finance. Its approach combines traditional development finance tools with targeted programs to expand green investment in both commercial and community-serving projects.

Green financing initiatives include the city's Commercial Property Assessed Clean Energy (C-PACE) program, which enables property owners to finance up to 100% of eligible efficiency, renewable energy, and resilience improvements through long-term property assessments. Invest Atlanta also deploys low-interest revolving loan funds and credit enhancements to support small businesses, affordable housing providers, and nonprofits undertaking sustainability projects. In addition, the authority leverages its bonding powers and public-private partnerships to channel investment into renewable energy, stormwater management, and resilience infrastructure, aligning climate goals with inclusive economic development.

A.8 Illinois Finance Authority (Illinois Climate Bank)

The Illinois Finance Authority (IFA), created in 2004 through the consolidation of seven legacy financing bodies, is a self-supporting, quasi-public conduit issuer with broad authority to support economic development and public-purpose infrastructure. In 2021 it was redesignated as the Illinois Climate Bank, reflecting a mandate to accelerate private capital investment in clean energy projects with attention to geographic and demographic equity (Illinois Environmental Protection Agency (2021)).

The Authority's climate finance toolkit combines capital-markets issuance of tax-exempt and green bonds, credit enhancement facilities capitalized with federal State Small Business Credit Initiative (SSBCI) funds, and statutory authority to extend direct, low-rate loans to public entities. Key initiatives include the **SSBCI Participation Loan Program**, which provides subordinated, low-coupon IFA participations alongside senior bank debt, with enhanced terms for disadvantaged or very small businesses; a statewide **C-PACE** program that enables up to 100% long-term financing of energy, renewable, EV charging, and resilience improvements; and Clean Water Initiative green bonds that replenish state revolving loan pools. Since 2023, the Climate Bank Loan Financing Act has further authorized IFA to lend directly to local governments for qualifying clean-energy infrastructure.

A.9 Maryland Clean Energy Center

The Maryland Clean Energy Center (MCEC), established by the General Assembly in 2008, is a quasi-public instrumentality charged with advancing clean energy, efficiency, and climate resilience. The 2022 Climate Solutions Now Act formally designated it as the state's Green Bank, expanding its mission to mobilize private capital and scale inclusive climate finance.

MCEC delivers this mandate through three complementary platforms: the **Maryland Clean Energy Capital (MCAP)** program, which provides long-term, lower-cost financing for large institutional projects undertaken by governments, universities, hospitals, and nonprofits; **Maryland PACE (MD-PACE)**, the statewide commercial property assessed clean energy program that enables owners to finance renewable and efficiency upgrades through tax assessments while leveraging private capital; and the **Clean Energy Advantage (CEA)** program, a residential partnership with local credit unions that offers households low-rate loans for heat pumps, solar, storage, and weatherization, supported by loan-loss reserves and interest rate buy-downs.

A.10 Massachusetts Clean Energy Center

The Massachusetts Clean Energy Center (MassCEC) was created by the 2008 Green Jobs Act. MassCEC is a quasi-public component unit of the Commonwealth with a mandate to accelerate clean-energy innovation, deployment, and workforce development.

MassCEC blends grant making, catalytic investments, pilot programs, and selected repayable instruments. The four program pillars are Climatetech Innovation & Investments, Accelerating Decarbonization (buildings, clean transportation, net-zero grid), Large-Scale Deployment (offshore wind and related infrastructure), and Clean Energy & Climate Workforce. In addition to grants and pilots, MassCEC operates credit enhancements (e.g., loan-loss reserves) and venture-style equity investments; it also manages and operates major offshore-wind assets (New Bedford Marine Commerce Terminal and the Salem Offshore Wind Terminal PPP).

A.11 Massachusetts Community Climate Bank

The Massachusetts Community Climate Bank (MCCB) was announced in 2023 as the nation's first statewide climate bank focused on housing, capitalized with an initial commitment of $50 million from MassHousing. Administratively housed within MassHousing, MCCB's mandate is to support decarbonization in the residential housing sector, particularly for low- and moderate-income households.

As of FY2024, MCCB's sole program has been the **Energy Saver Home Loan Program**, which offers low-interest second mortgages to homeowners undertaking eligible energy-saving and decarbonization improvements. Examples include insulation, heat pumps, high-efficiency windows, and other measures that reduce household carbon footprints. MCCB has not financed multifamily or commercial projects to date, and its activity is limited to these homeowner-level loans.

A.12 Environmental Improvement and Energy Resources Authority (EIERA)

The Missouri Environmental Improvement and Energy Resources Authority (EIERA) was created in 1972 as an independent, self-supporting body corporate and politic, administratively housed in the Department of Natural Resources. Its statutory mandate is to finance, acquire, construct, and equip projects that reduce, prevent, or control pollution and to support the development of the State's energy resources. The primary tool for fulfilling this mandate is the issuance of tax-exempt revenue bonds, through which the Authority provides low-cost capital to municipalities, utilities, and private borrowers for environmentally beneficial projects.

The Authority administers the **Missouri Market Development Program**, funded by solid waste tipping fees, which supports businesses that convert recycled materials into marketable products. It also manages the State Revolving Fund (SRF) in partnership with the Department of Natural Resources and the U.S. Environmental Protection Agency, providing subsidized loans to communities for clean water and drinking water infrastructure. The **Brownfields Revolving Loan Fund**, capitalized with EPA grants, offers loans and subgrants to remediate contaminated properties, while the newer **Solid Waste Infrastructure for Recycling (SWIFR)** program supports improvements in recycling and post-consumer materials management.

A.13 New Jersey Economic Development Authority

The New Jersey Economic Development Authority (NJEDA), established in 1974 as a self-supporting quasi-public authority, was designated the state's Green Bank in 2019 with a mandate to channel private capital toward renewable energy, clean transportation, and climate-resilience investments.

Major initiatives include the Zero-Emission Incentive Program (NJ ZIP), which provides vouchers to reduce the cost of medium- and heavy-duty electric vehicles; co-lending facilities that blend NJEDA and private capital for small business and community clean energy projects; and offshore wind supply-chain investments in ports, manufacturing, and logistics. In addition, NJEDA administers the state's Commercial Property Assessed Clean Energy (C-PACE) program, enabling municipalities to offer long-term financing for energy efficiency, renewable energy, and resilience improvements.

A.14 Ohio Air Quality Development Authority

The Ohio Air Quality Development Authority (OAQDA) was created by the Ohio General Assembly in 1970 as an independent state agency with a dual mandate: to improve air quality and to support economic development across Ohio. Its longstanding role has been that of a conduit issuer (i.e., structuring and placing tax-exempt and taxable bonds on behalf of eligible borrowers), without assuming repayment risk on its own balance sheet. Revenues to the Authority derive largely from administration fees, federal grants, and targeted subsidy programs rather than from loan repayments.

The Authority's flagship vehicle is the **Clean Air Improvement Program (CAIP)**, which replaced the earlier **Project Development Assistance Fund (PDAF)** and channels capital to private borrowers for pollution-control, clean energy, and air quality projects through conduit bond issuance. For smaller enterprises, OAQDA operates the **Clean Air Resource Center (CARC)** and the **Small Business Assistance Program**, which combine state EPA grant dollars and federal allocations with loan-loss reserves and interest subsidies to de-risk private lending. OAQDA has also managed allocations of **Qualified Energy Conservation Bonds (QECBs)**, refinancing issues, and stimulus-era clean energy financings. Lastly, OAQDA acted only as administrator of the **Advanced Energy Loans Program** which was a short-lived (2009–2011), state funded loan program financed with Ohio revenue bonds; OAQDA issued loans but remitted all principal and interest to the Development Services Agency and retaining just admin/operations fees.

While historically OAQDA has not revolved capital on its own balance sheet in the manner of a traditional green bank, the Authority's role is evolving. With new federal inflows, such as the EPA's Solar for All and National Clean Investment Fund (NCIF) awards in 2024, OAQDA is positioned to manage dedicated pools of public capital that can be lent, repaid, and recycled over time.

B Proofs

B.1 Stackelberg Equilibrium in Green Co-Financing.

Let the Green Bank choose its investment level L^{GB} and co-financing share $\mu \in [0, 1)$ to maximize it's utility function (6), subject to the financing constraint (2), the leverage constraint (3), and the private bank's participation constraint (10). Then, the unique Stackelberg equilibrium is characterized by:

$$\mu^* = \frac{-\theta A + \sqrt{\theta^2 A^2 + 4(2\theta - 1)\chi A}}{2(2\theta - 1)\chi}, \qquad 0 < \mu^* < 1,$$

and

$$L^{GB*} = K\,\frac{1 - \mu^*}{\mu^*}, \qquad D^* = \lambda\, L^{GB*}, \qquad L^* = \frac{L^{GB*}}{1 - \mu^*}.$$

where,

$$\bar{r}_D = r_0 + \phi\lambda^2, \qquad A = \rho - \lambda\bar{r}_D, \qquad K = \frac{\rho - r^{PB}}{\psi} > 0.$$

with $A > 0$, $\rho > r^{PB}$, $\theta > \frac{1}{2}$[7], and

$$\chi\,(2\theta - 1) > (1 - \theta)\,A \tag{$*$}$$

Proof. From the Green Bank's problem, the first-order condition with respect to μ is:

$$\mu^2(2\theta - 1)\chi + \mu\theta A - A = 0, \tag{14}$$

where $A > 0$, $\theta > \frac{1}{2}$, and $\chi > 0$. Since $\theta > \frac{1}{2}$, equation (14) is a quadratic in μ with positive leading

[7] If $\theta = \frac{1}{2}$, the quadratic term in the first-order condition vanishes and the Green Bank chooses the maximal feasible crowd-in $\mu^* \to 1^-$ with $L^{GB*} = 0$.

coefficient.

Solving (14) for μ yields:

$$\mu = \frac{-\theta A \pm \sqrt{\theta^2 A^2 + 4(2\theta - 1)\chi A}}{2(2\theta - 1)\chi}.$$

The negative root violates $\mu \in (0,1)$, so the admissible solution is:

$$\mu^* = \frac{-\theta A + \sqrt{\theta^2 A^2 + 4(2\theta - 1)\chi A}}{2(2\theta - 1)\chi}.$$

Given μ^*, the Green Bank's leverage constraint (3) implies:

$$L^{GB*} = K\,\frac{1-\mu^*}{\mu^*}, \quad D^* = \lambda L^{GB*}, \quad L^* = \frac{L^{GB*}}{1-\mu^*}.$$

Finally, the condition $(*)$ ensures the discriminant in (14) is positive and $\mu^* \in (0,1)$. □

B.2 Comparative statics of μ^* in χ and λ

Let $\mu^* \in (0,1)$ solve

$$(2\theta - 1)\chi\,(\mu^*)^2 + \theta A\,\mu^* - A = 0, \qquad A(\lambda) = \rho - \lambda\big(r_0 + \phi\lambda^2\big),$$

with $\theta \in (\frac{1}{2}, 1)$, $\chi > 0$, $A > 0$, $r_0 > 0$, $\phi > 0$, and $\lambda > 0$. Then:

$$\frac{\partial \mu^*}{\partial \chi} = -\frac{(2\theta - 1)(\mu^*)^2}{2\mu^*(2\theta - 1)\chi + \theta A} \;<\; 0, \qquad \frac{d\mu^*}{d\lambda} = \frac{1 - \theta\mu^*}{2\mu^*(2\theta - 1)\chi + \theta A}\,\big(-r_0 - 3\phi\lambda^2\big) \;<\; 0.$$

Hence, μ^* is strictly decreasing in both χ and λ.

Proof. Define $F(\mu, \chi, A) = (2\theta - 1)\chi\mu^2 + \theta A\mu - A$. At μ^*, $F(\mu^*, \chi, A) = 0$ and

$$\frac{\partial F}{\partial \mu} = 2\mu(2\theta - 1)\chi + \theta A > 0 \quad \text{since } \mu \in (0,1),\ \theta > \tfrac{1}{2},\ \chi > 0,\ A > 0.$$

Effect of χ. Holding A fixed,

$$\frac{\partial \mu^*}{\partial \chi} = -\frac{\partial F/\partial \chi}{\partial F/\partial \mu} = -\frac{(2\theta - 1)\mu^2}{2\mu(2\theta - 1)\chi + \theta A} < 0.$$

Effect of λ. Since $A(\lambda) = \rho - \lambda(r_0 + \phi\lambda^2)$, we have $\frac{dA}{d\lambda} = -(r_0 + 3\phi\lambda^2) < 0$. By the chain rule,

$$\frac{d\mu^*}{d\lambda} = \frac{\partial \mu^*}{\partial A} \cdot \frac{dA}{d\lambda}, \quad \frac{\partial \mu^*}{\partial A} = -\frac{\partial F/\partial A}{\partial F/\partial \mu} = \frac{1 - \theta\mu}{2\mu(2\theta - 1)\chi + \theta A} > 0,$$

because $1 - \theta\mu > 0$ when $\mu \in (0, 1)$ and $\theta < 1$. Therefore $d\mu^*/d\lambda < 0$. □

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