Green Debt Transition: From Issuances to Emissions

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Motivation

- Transition to a green economy has become a pressing global priority
- Policymakers and investors have fostered the development of green debt instruments as an important tool to facilitate this transition
- Consequently, the green debt market has become one of the fastest-growing segments of the financial sector
- The literature has studied this market but …
  - In isolation from the well-established corporate debt market
  - Focusing mainly on green bonds, not on green syndicated loans, mainly up to 2018
  - Focusing on micro consequences on CO2 intensity without studying the links with firm size
  - Omitting aggregate effects
- We try to fill these gaps in the literature

This paper

- We collect and match detailed data on the issuance of green and conventional corporate bonds and syndicated loans by non-financial companies worldwide between 2012-2022
- How has the green debt market contributed to the transition to a green economy?
  - How has the green debt market evolved relative to the conventional market?
  - Which firms issue green debt? How do they use green debt?
  - What are the micro and macro (global) environmental consequences of green debt issuances?
- We focus on the allocation across the firm size distribution
  - Firm size is a natural benchmark
  - Firm size is a key determinant of access to conventional debt markets
  - Firm size is key for firms' environmental footprint

Key messages

- Significant surge in the issuance of green debt worldwide after 2018
  - Conventional debt issuances have either remained stable or declined
  - Green debt share of total issuances has risen from 2% in 2018 to 12% in 2022
  - The green loan market has surpassed the green bond market, across countries and industries
- Green debt markets are largely driven by larger and more polluting firms than those issuing only conventional debt
  - Consistent pattern across regions and industries, accentuating over time
  - These large green debt issuers are also active in conventional debt markets (hybrid issuers)
  - These hybrid issuers have become more reliant on green debt over time

Key messages

- Micro and macro effects …
- Green bond issuances are more likely to be followed by expansions in firm debt and income (scale) than green loan issuances
  - Green bonds more likely to complement conventional issuances rather than substitute for them
- Green bonds and loans tend to be followed by improvements in CO2 efficiency
- Combination of scale and efficiency effects have made green loans more closely associated with reductions in firm-level emissions
- At the global level, green debt issuances have contributed importantly to reducing CO2 emissions, especially green loans

Outline

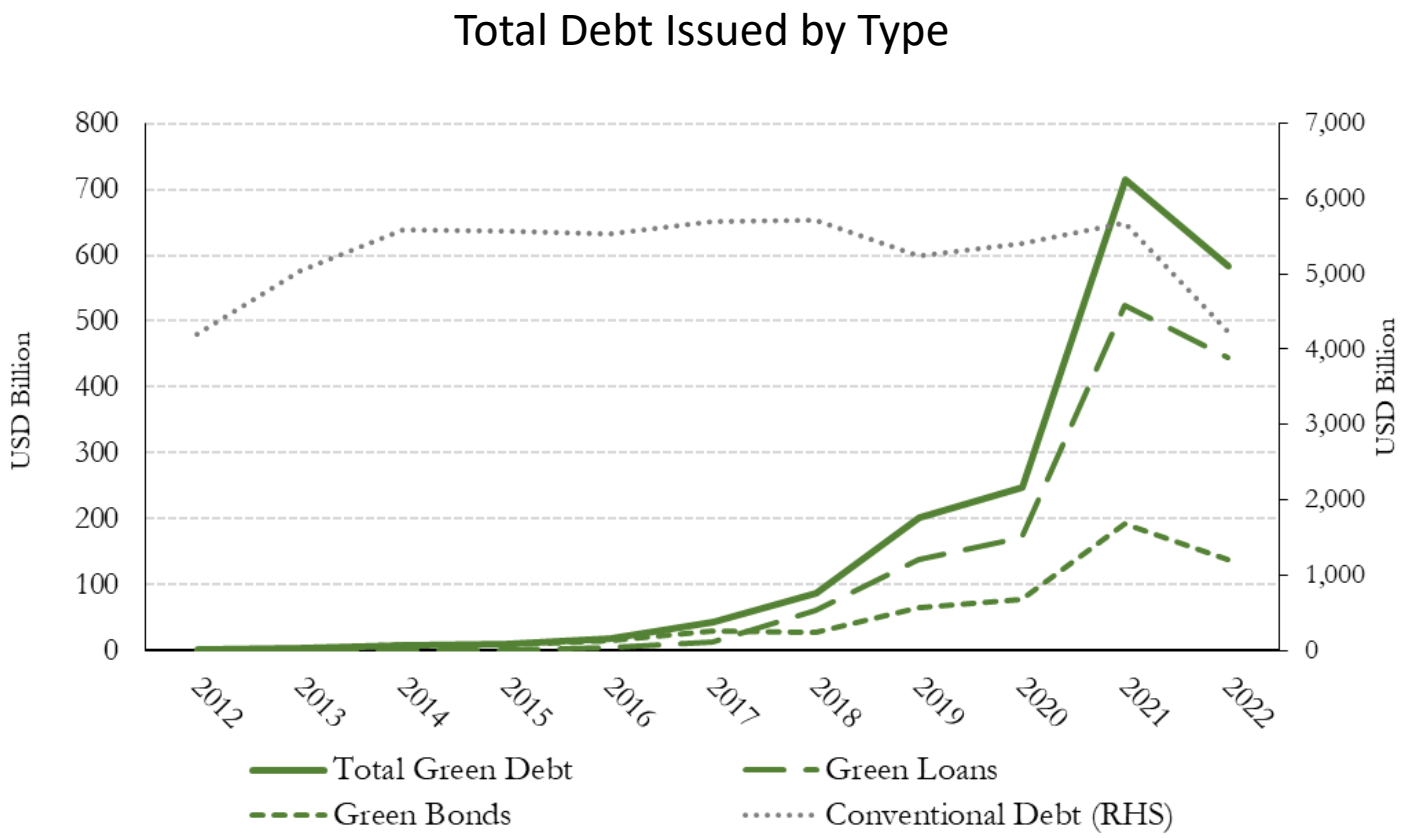
- Data
- Debt issuance trends
- Which firms issue green debt?
- Firm-level outcomes
- Global outcomes
- Conclusions

Data

Type of Debt Instrument	Period	Total Issued (USD, Billion)	Number of Quarterly Issuances	Self Labeled, %
Conventional	2012-17	31,600	67,780	N/A
	2018-22	26,300	61,150	N/A
Green	2012-17	81	262	27%
	2018-22	1,835	3,852	17%

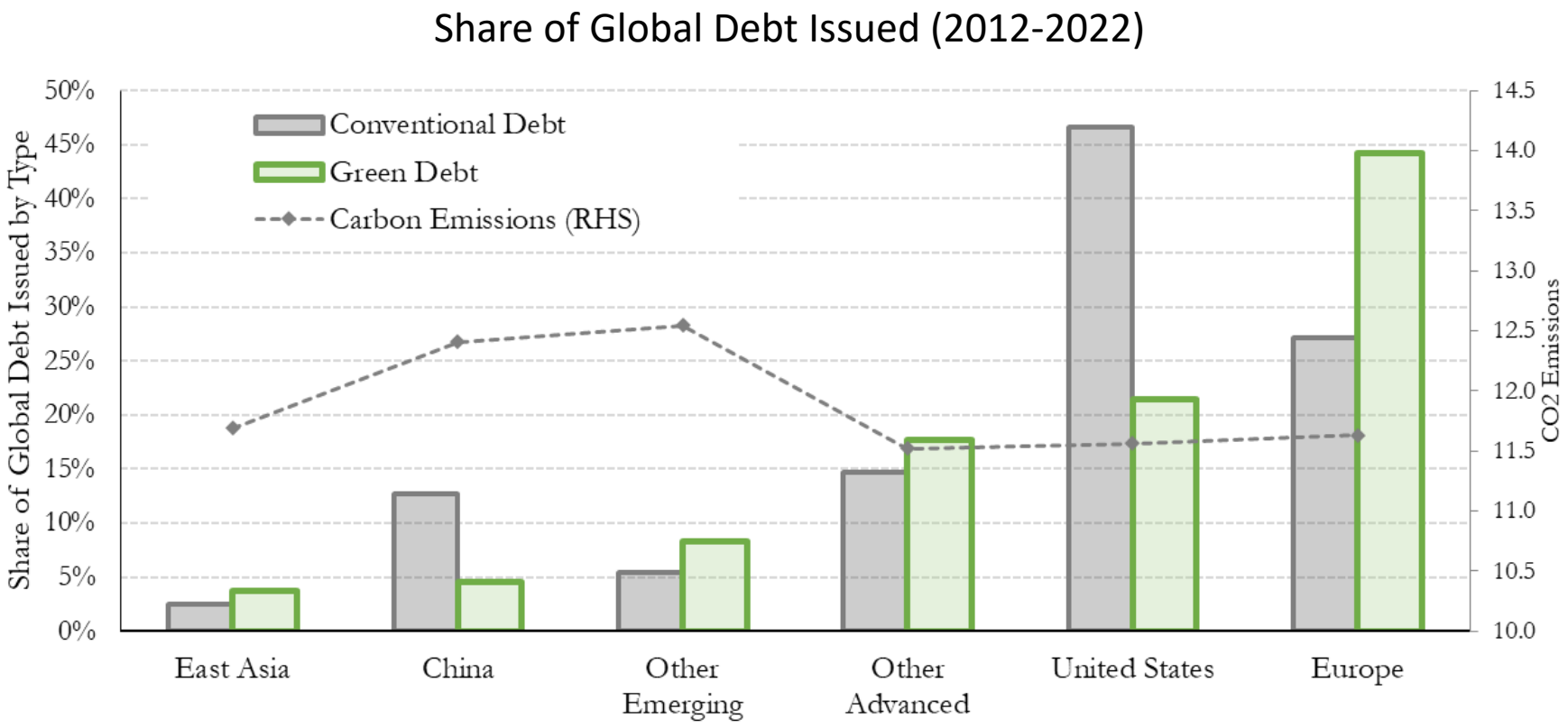
Debt issuance trends

Surge in green debt after 2018 across debt products



- Important to consider the most recent period
- More pronounced for green loans than green bonds
- Amid a stagnant conventional debt market
- Share of green debt issuance increased from 2% in 2018 to 12% in 2022

Debt distribution across regions

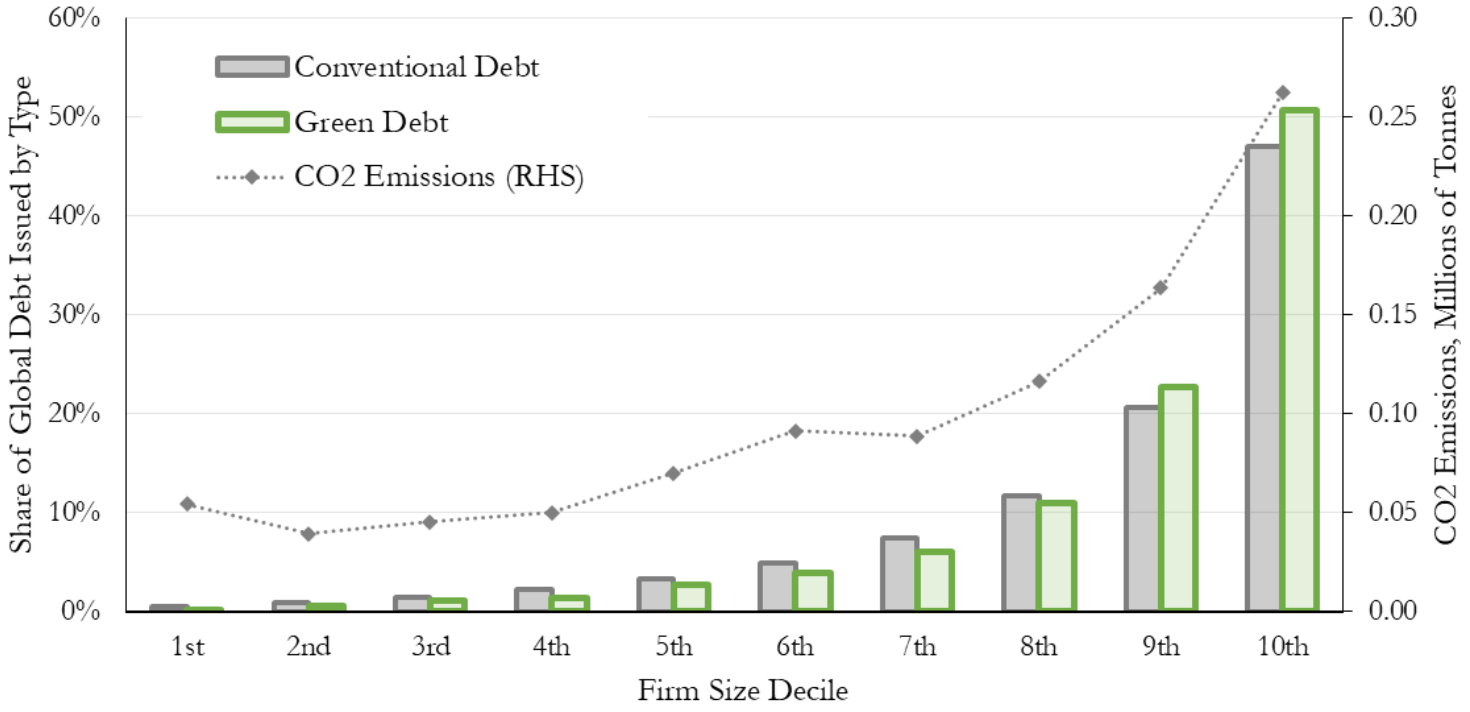


- Debt issuance tilted toward green debt except in the U.S. and China

Which firms issue green debt?

Green debt issuers are larger and more pollutant

Allocation of Green and Conventional Debt among Firms of Different Size



- Even relative to their conventional debt footprint

Green debt issuers are larger and more pollutant

Type of Debt Issuer	Number of Issuers			Amount Issued (Trillion USD)		Firm Size (Million USD)				Carbon Emissions	
	Total	Share Listed	Share Hybrid	Conventional	Green	Issuance Size Value	Total Debt	Total Assets	Total Income	Total	CO2 / Income
Conventional	44,350	22%	0%	46.4	0.0	107	276	1,026	839	0.1	61.7
Green	2,840	39%	66%	11.5	1.9	208	1,129	3,630	2,660	0.3	88.5

- Green issuers are 2 to 3 times larger, more likely to be listed, and more pollutant

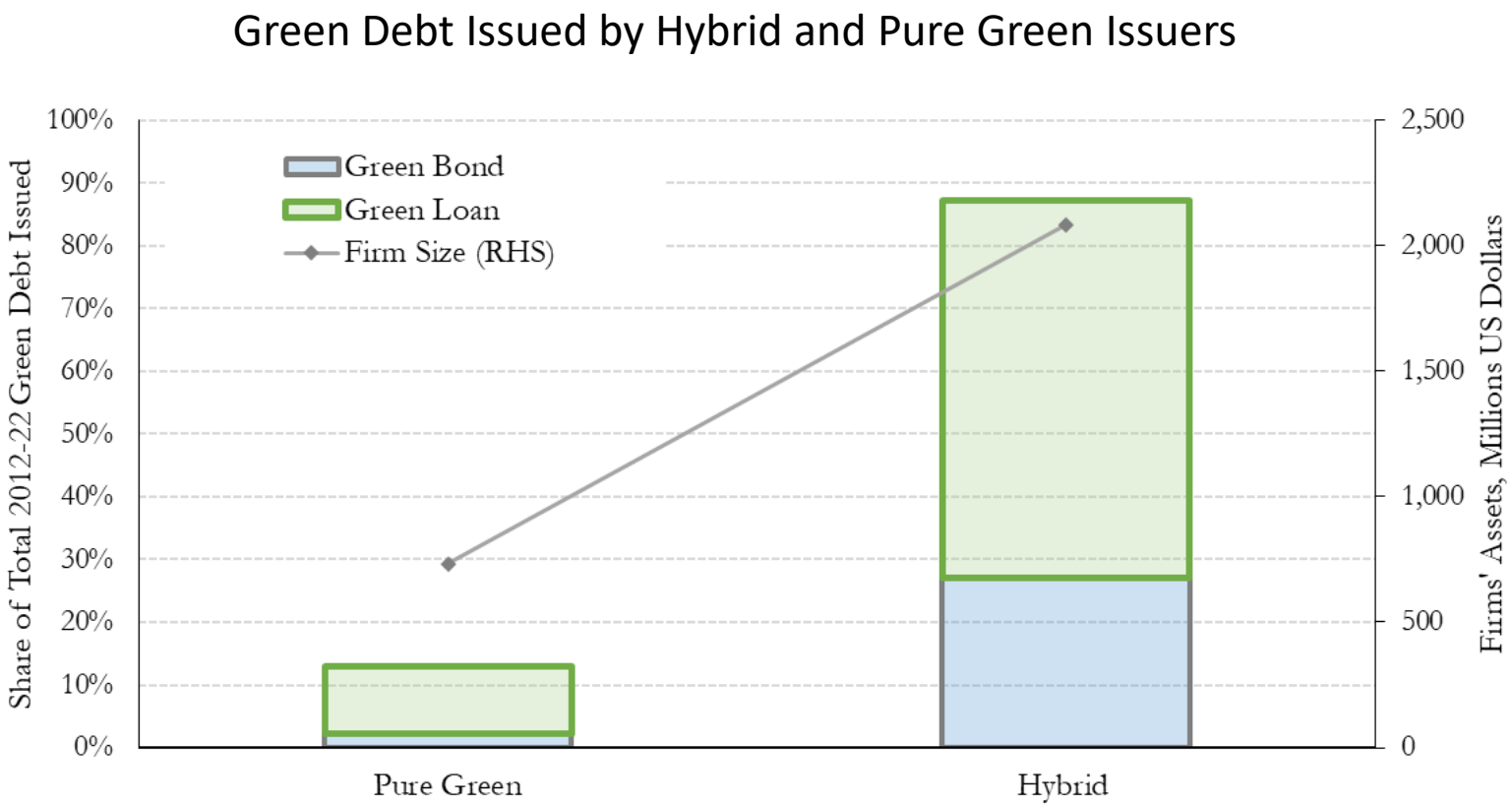
Green debt issuers are larger and more pollutant

$$GD_{i,t} = \alpha + \beta X_{i,t} + \theta_{s,t} + \theta_{c,t} + \epsilon_{i,t}$$

Dependent Variable:	Dummy = 1 if Green Debt Issuer in Year t and 0 if Conventional Debt Issuer														
Base Value (*Av. Prob. of Green Debt over Conventional Debt*)	0.034 (3.4%)														
Log of Av. Issuance Size	0.011***	0.014***	0.014***												
	[0.00]	[0.00]	[0.00]												
Log of Lagged Assets				0.018***	0.017***	0.015***									
				[0.00]	[0.00]	[0.00]									
Log of Lagged Income							0.014***	0.014***	0.013***						
							[0.00]	[0.00]	[0.00]						
Log of Lagged CO2 Emissions										0.009***	0.012***	0.010***			
										[0.00]	[0.00]	[0.00]			
Log of Lagged CO2 Emissions to Income													0.008***	0.009***	0.001
													[0.00]	[0.00]	[0.00]
Country-Time FE	No	No	Yes	No	No	Yes	No	No	Yes	No	No	Yes	No	No	Yes
Industry-Time FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Observations	86,003	85,941	85,938	25,846	25,766	25,747	30,634	30,544	30,521	14,577	14,512	14,473	14,629	14,559	14,521
No. of Firms	2,158	2,140	2,140	1,277	1,259	1,259	1,349	1,329	1,329	996	981	976	989	976	972
R-squared	0.01	0.13	0.17	0.02	0.21	0.26	0.01	0.20	0.25	0.01	0.22	0.26	0.00	0.22	0.26

- Doubling size increases probability of issuance by close to 2 p.p. (50% of baseline probability)
- Importance of size has strengthened over time, especially in 2021-22

Most green debt issuers also issue conventional debt



- Green debt instruments have had a limited impact on the access to bond markets
- While 96% of conventional issuers just issue conventional debt (4% are hybrid)

Firm level outcomes

What do firms do after issuing green debt?

- Focus on debt, income, and CO2 intensity
- Debt informs whether green debt complements or substitutes for conventional debt
- Debt issuances (green or conventional) can affect the terms determining CO2 emissions
- CO2 emissions can be decomposed into income and CO2 intensity

$$CO2_{i,t} = Income_{i,t} \times \left(\frac{CO2}{Income}\right)_{i,t}$$

- Literature typically focuses on within-firm CO2 intensity

Econometric model

- Local projection DiD (Dube et al., 2023)

$$y_{i,t+h} - y_{i,t-1} = \beta_h^{LPDiD} \times \Delta GD_{i,t} + \theta_{c,t}^h + \theta_{s,t}^h + \epsilon_{i,c,s,t}^h$$

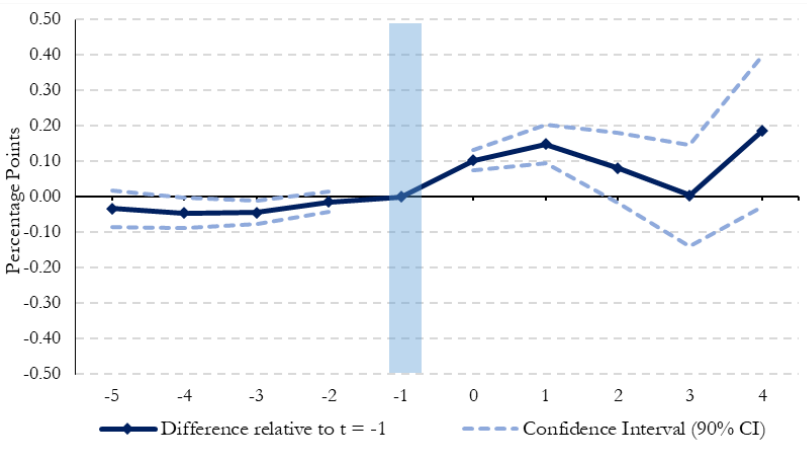
- Firm-year data
- $h = \{-4, .., 4\}$, where $h = -1$ is the issuance year
- $y_{i,t+h}$ = log of conventional debt issuance, total outstanding debt, income, CO2 emissions, and CO2 to income for firm i, h years before/after issuance
- Restricting the sample to observations that are either:
  - (1) newly treated ($\Delta GD_{i,t} = 1$: new green issuances, no issuance in previous 4 years)
  - (2) two alternative clean controls (no debt, conventional debt issuances)
- $\theta_{c,t}$ are country-time FE; $\theta_{s,t}$ are industry-time FE
- Caveat: properly controlling for counterfactuals reduces statistical power, recent surge limits ability to estimate long-term consequences

Green bond issuance related to higher overall debt

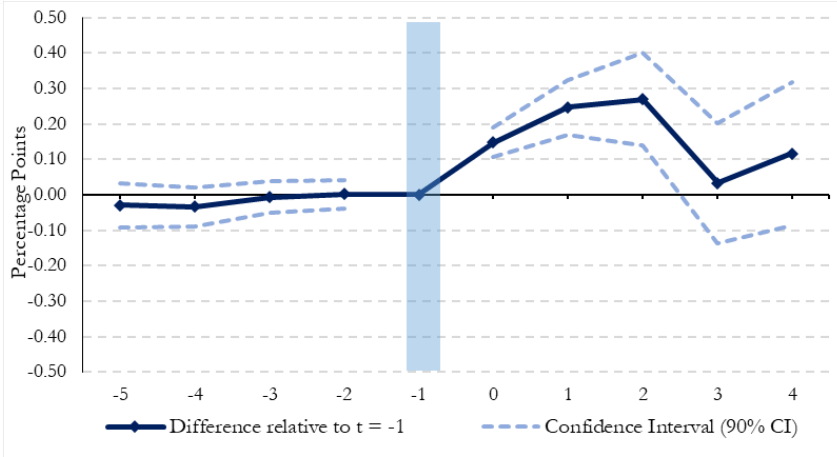
Local Projections Differences-in-Differences Green Debt, Bonds, and Loans vs. No Debt

Balance Sheet Debt

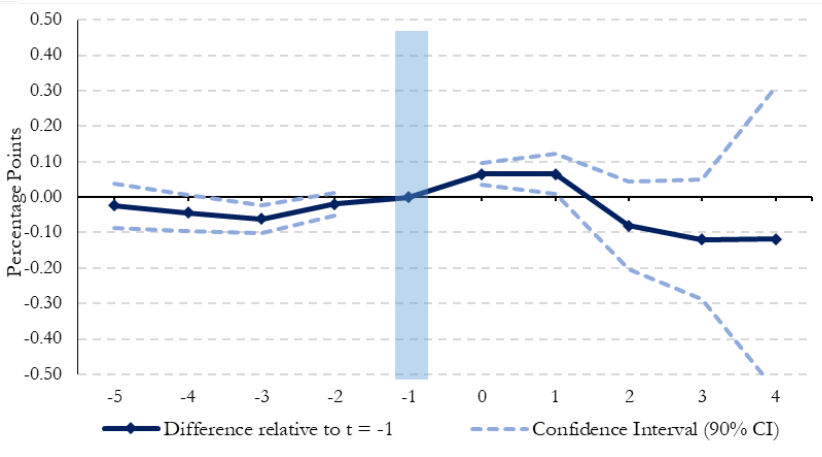
Green Debt



Green Bonds



Green Loans



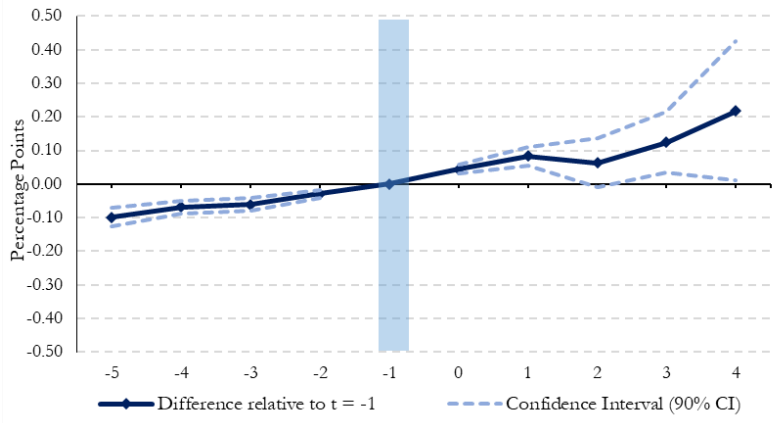
- Increase is mainly for green bonds
- Complementarity for green bonds and substitution for green loans

Green bond issuance associated with higher activity

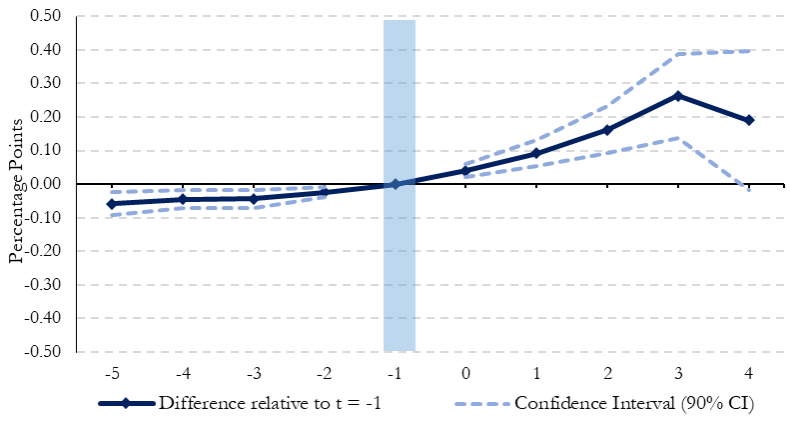
Local Projections Differences-in-Differences Green Debt, Bonds, and Loans vs. No Debt

Income

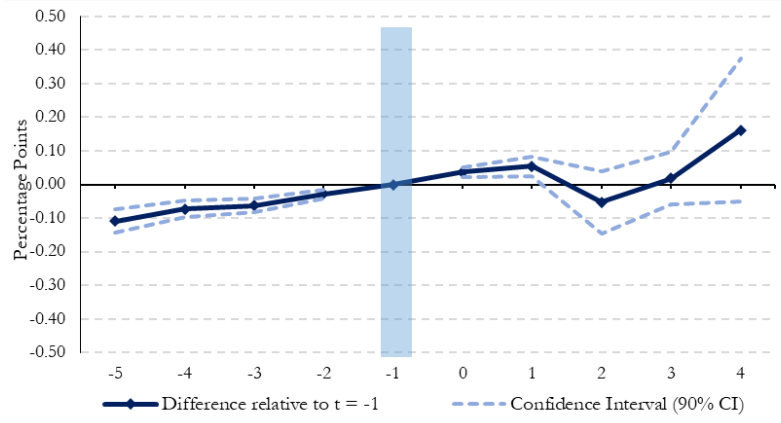
Green Debt



Green Bonds



Green Loans



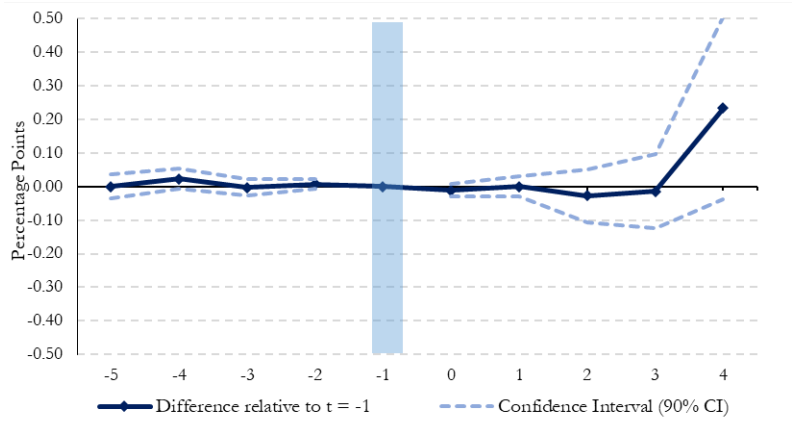
- Increase is more significant for green bonds

Green bond issuance associated with higher activity

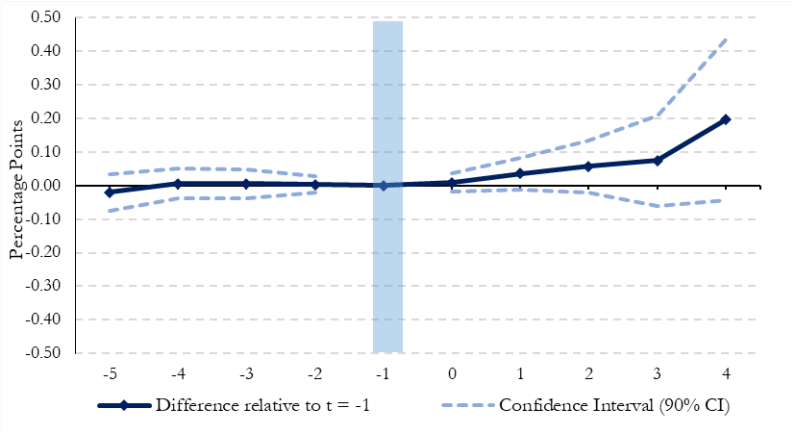
Local Projections Differences-in-Differences Green Debt, Bonds, and Loans vs. Conventional Debt

Income

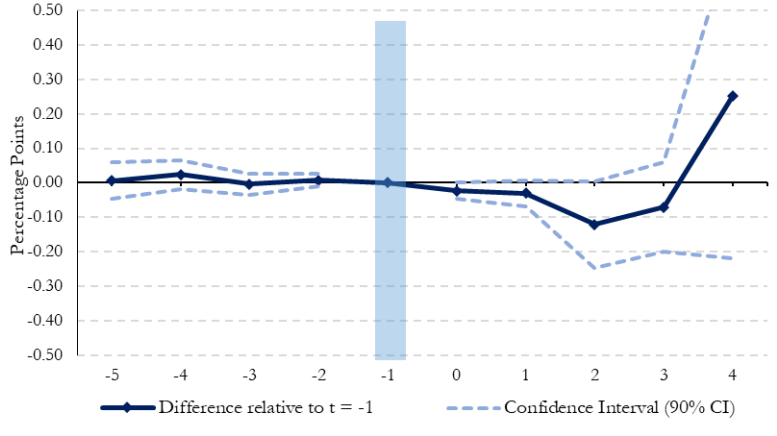
Green Debt



Green Bonds



Green Loans

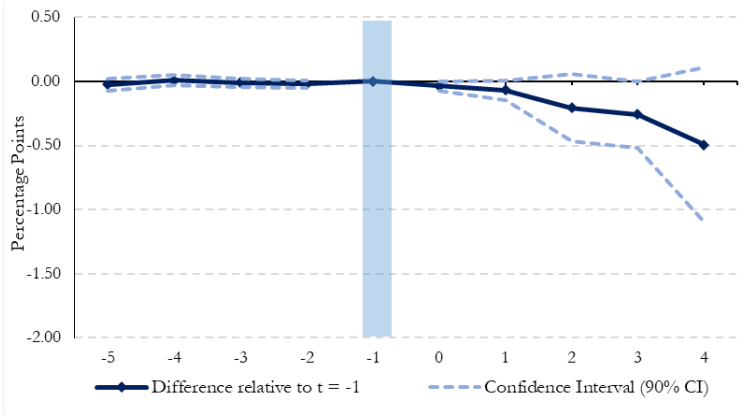


Green bond issuance associated with better CO2 efficiency

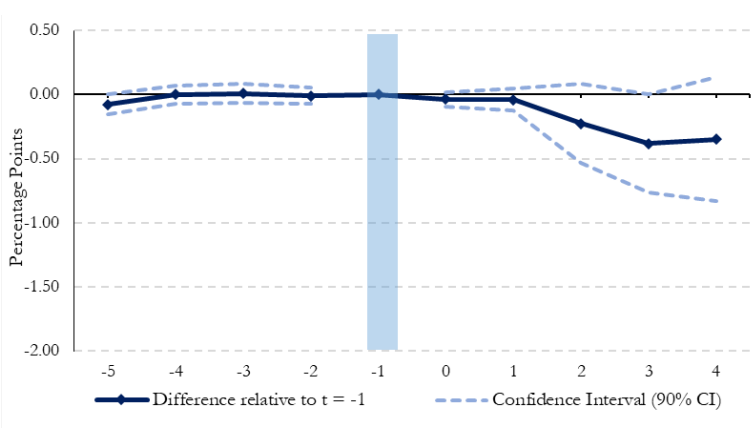
Local Projections Differences-in-Differences Green Debt, Bonds, and Loans vs. No Debt

CO2/Income

Green Debt



Green Bonds



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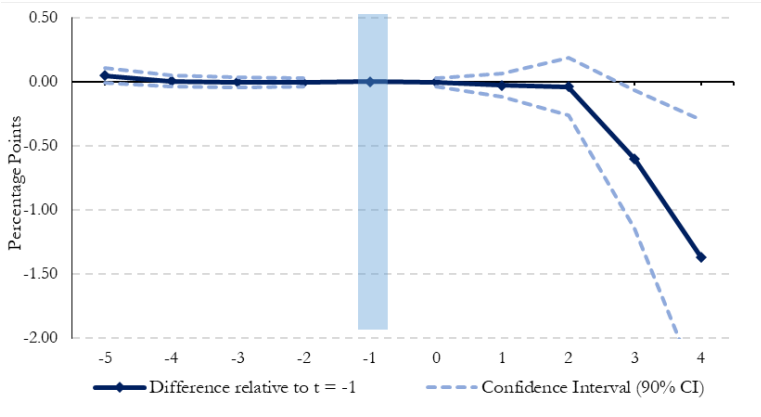


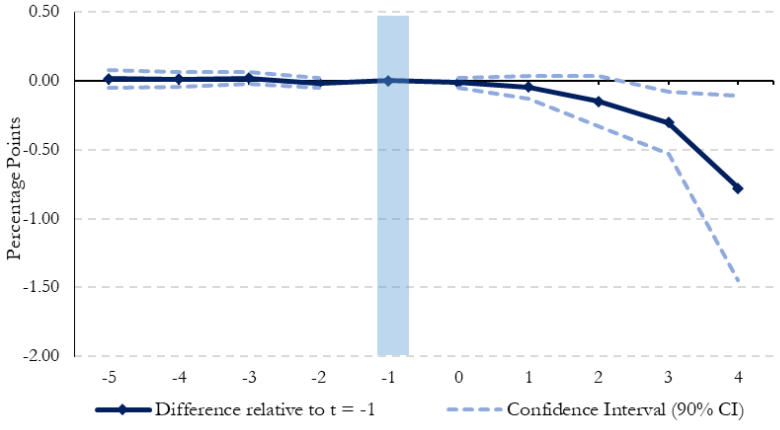
- Relative to non-issuance

Green debt issuance related with better CO2 efficiency

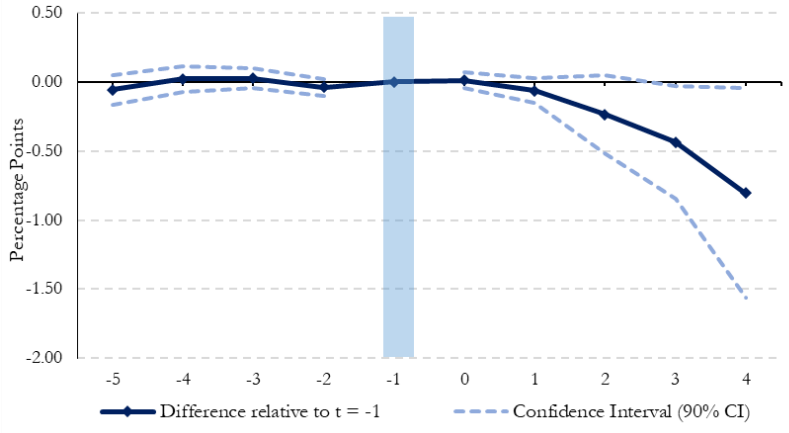
Local Projections Differences-in-Differences Green Debt, Bonds, and Loans vs. Conventional Debt

CO2/Income

Green Debt



Green Bonds



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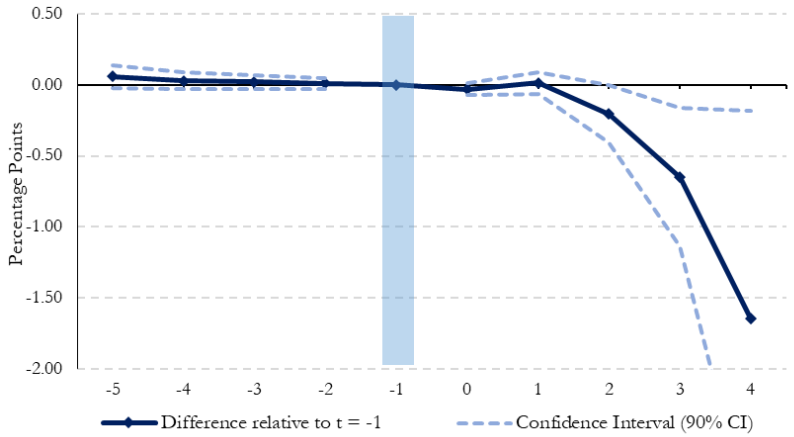


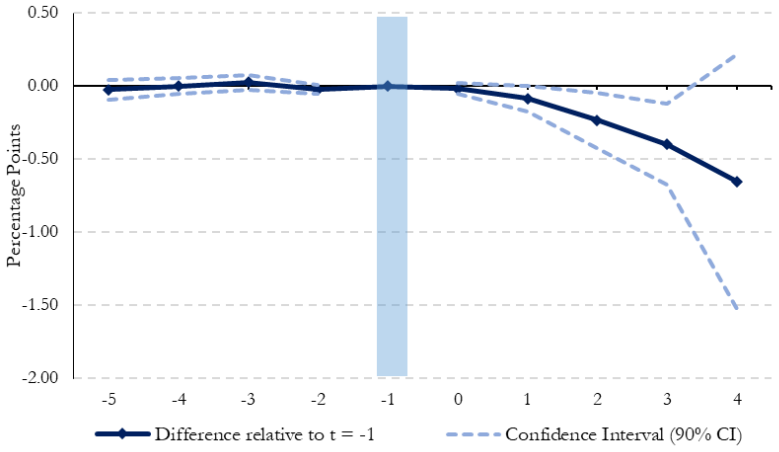
- More pronounced after green loan issuances

Overall, green debt leads to decline in CO2 emissions

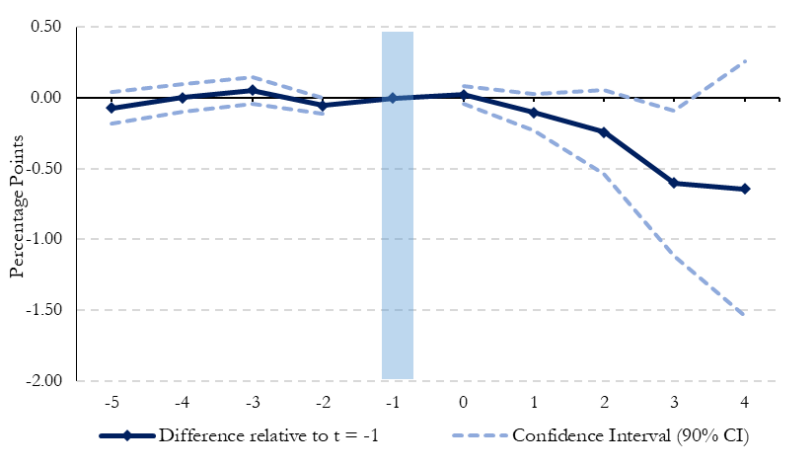
Local Projections Differences-in-Differences Green Debt, Bonds, and Loans vs. Conventional Debt

CO2 (tons)

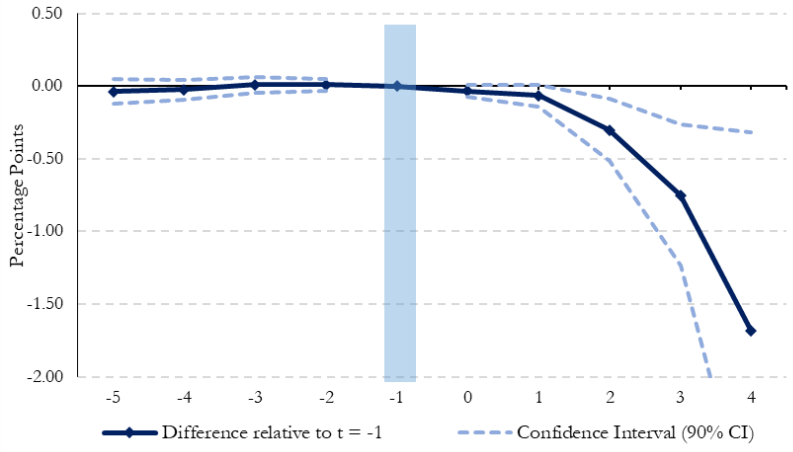
Green Debt



Green Bonds



Green Loans



- More pronounced for green loans, for which improvements in CO2 efficiency are not mitigated by increased in activity

Global outcomes

Global CO2 accounting

- What are the consequences of green debt issuances for global CO2 emissions?

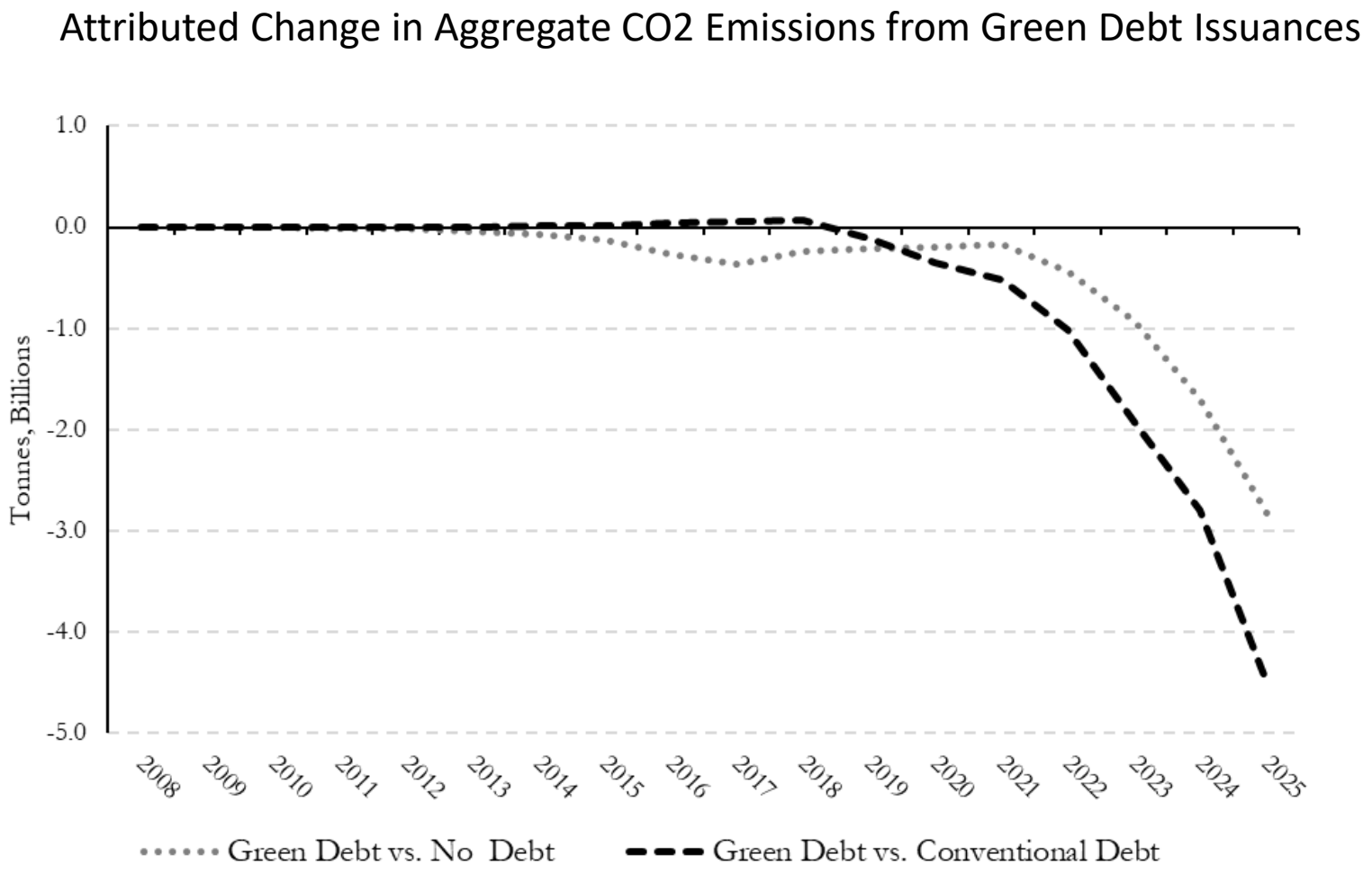
$$CO2_t = \sum_i \overbrace{s_{i,t}}^{Income} \underbrace{c_{i,t}}_{Intensity}$$

$$\Delta CO2_{t+h} = \underbrace{\sum_i \Delta\, s_{i,t+h} c_{i,t}}_{\Delta Income} + \underbrace{\sum_i \Delta\, c_{i,t+h} s_{i,t}}_{\Delta Intensity} + \underbrace{\sum_i \Delta\, c_{i,t+h} \Delta s_{i,t+h}}_{Cross-correlation}$$

- Based on micro-level estimates of trajectories of income and intensity

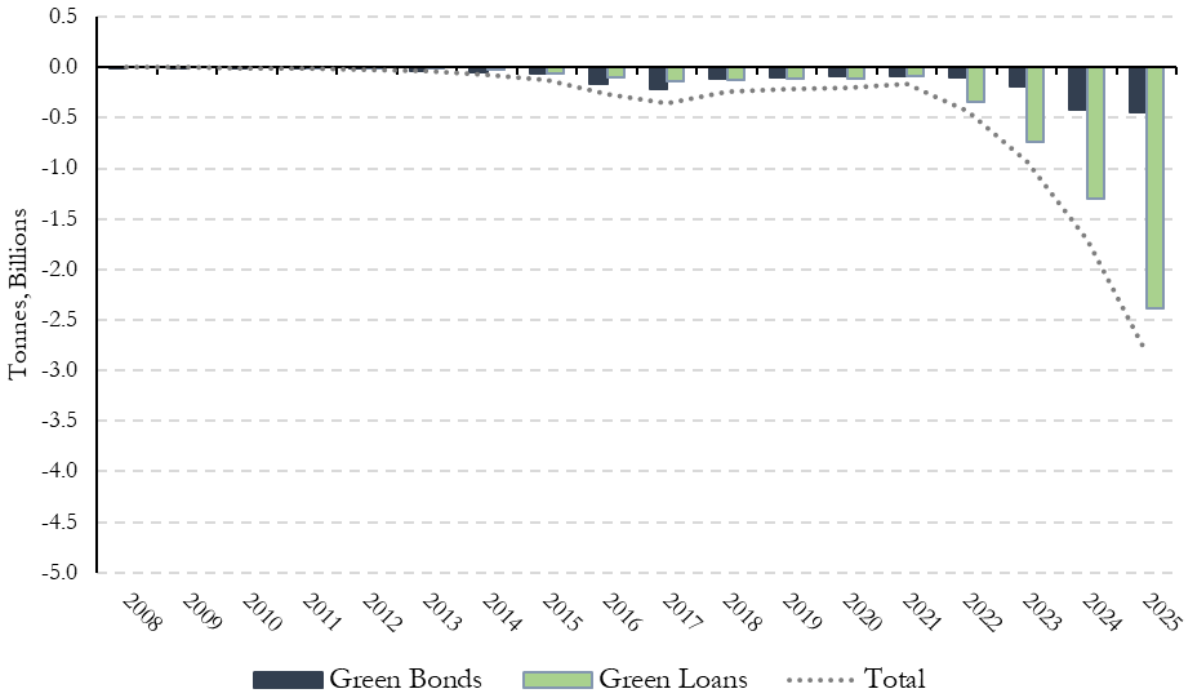
$$CO2_t - CO2_{t_0} = \sum_{h=1}^{t-t_0} \sum_i \left(\underbrace{\beta_{s,h} c_{i,t-h}}_{\Delta Income} + \underbrace{\beta_{c,h}\, s_{i,t-h}}_{\Delta Intensity} + \underbrace{\beta_{c,h}\, \beta_{s,h}}_{Cross-correlation} \right) I_{i,t-h}$$

Global-level CO2 accounting

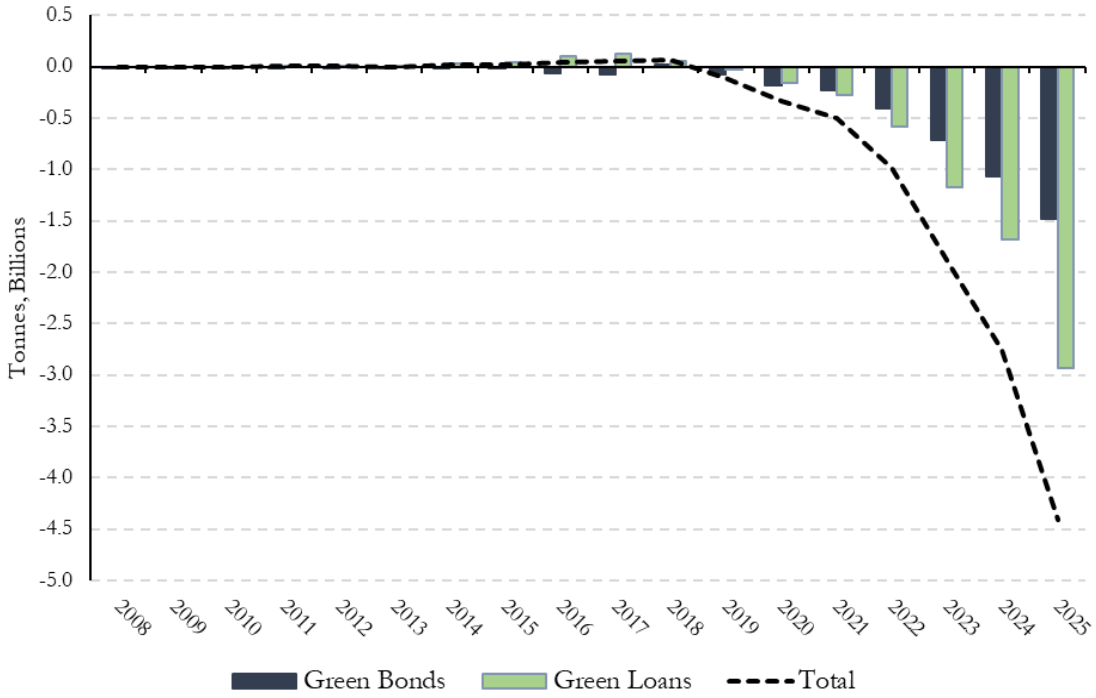


Global CO2 decline attributable to green debt

Green Debt vs. No Debt



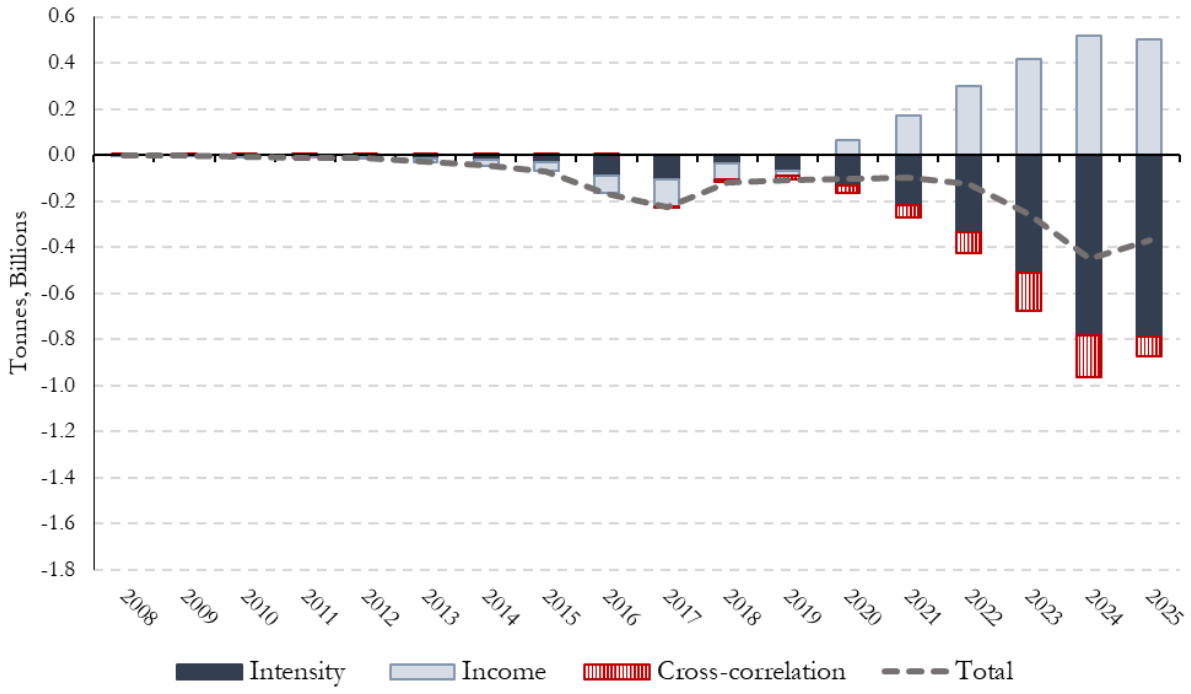
Green Debt vs. Conventional Debt



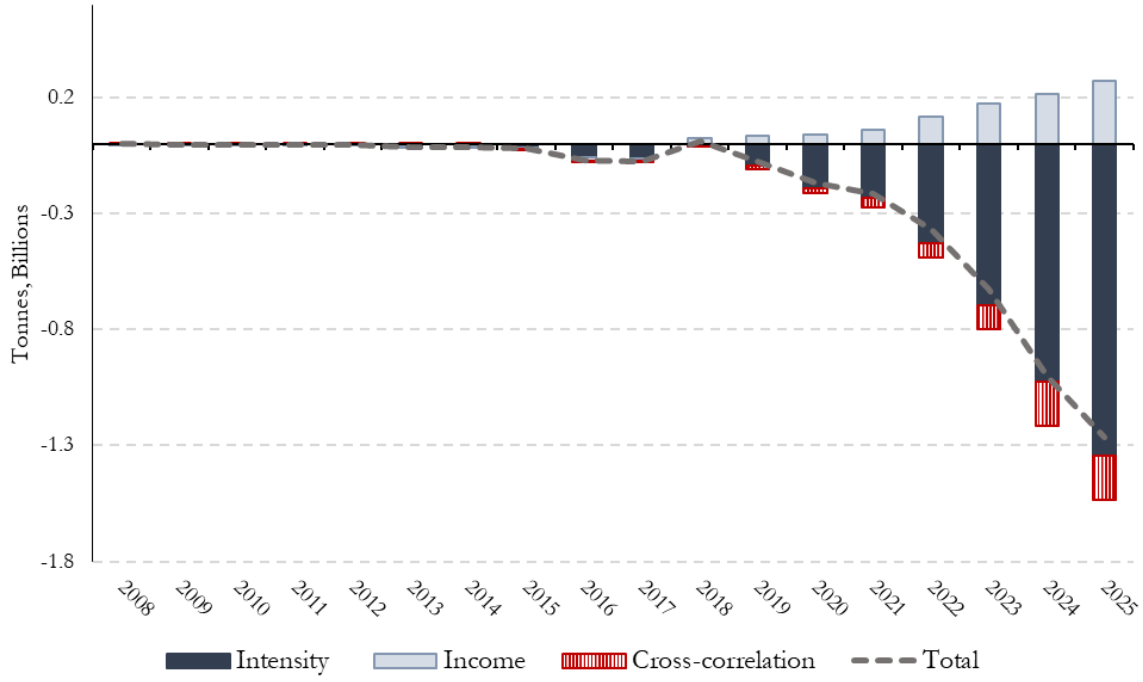
Income effect partly offsets intensity effect for bonds

Decomposition of Income and Intensity Effects for Green Bonds

Green Bonds vs. No Debt



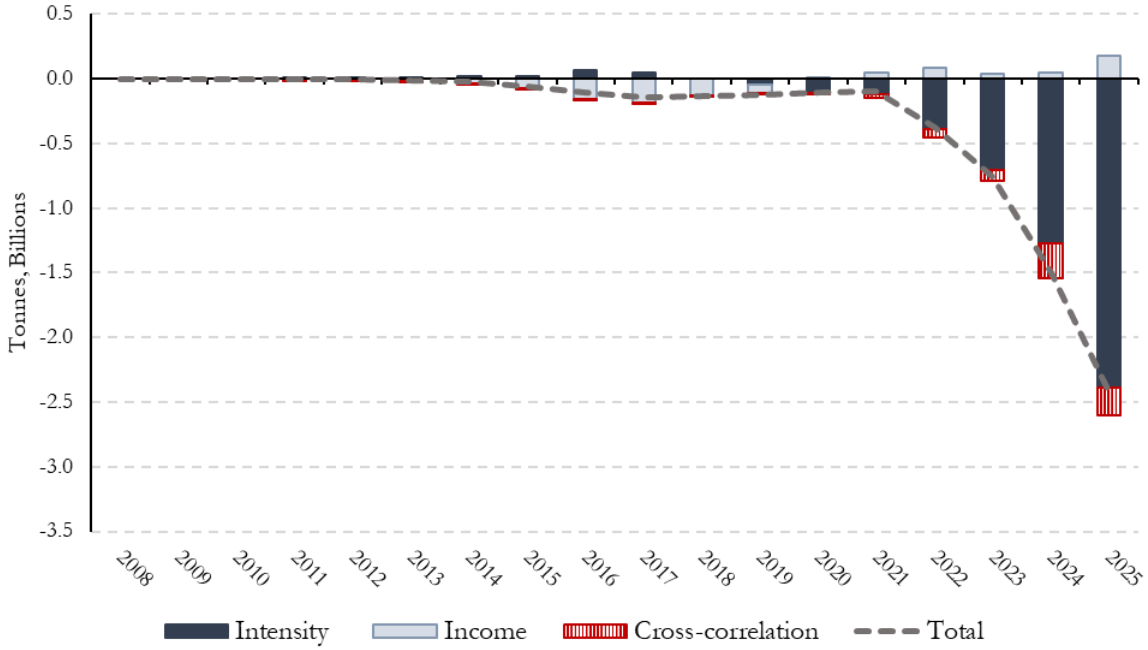
Green Bonds vs. Conventional Bonds



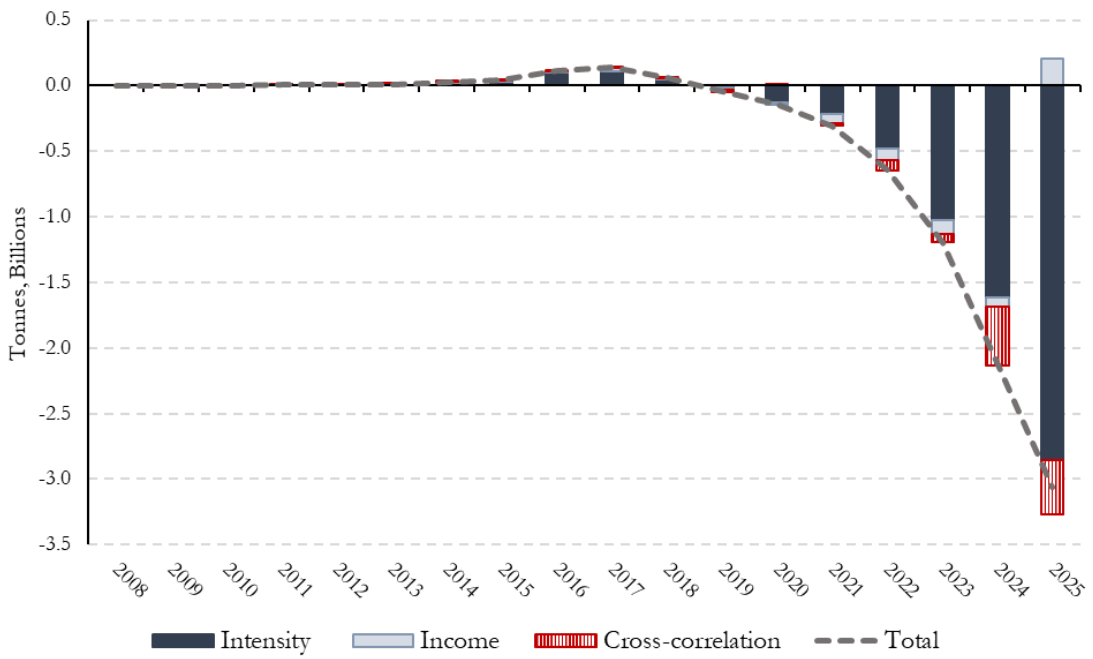
… but not for green loans

Decomposition of Income and Intensity Effects for Green Loans

Green Loans vs. No Debt



Green Loans vs. Conventional Loans



Conclusions

Policy discussion

- In defense of small firms
  - Small green issuers with financial constraints are left out of the market
  - Providing financing to large firms (carrot) is not the optimal tool; existence of carbon taxes (stick)
  - Investor subsidy goes only to large firms
- In defense of large firms
  - Intensity effect (reduction in CO2 emissions) is larger given their initial size
  - Income effect could be smaller given the impact of additional financing for large firms and the higher likelihood of refinancing conventional debt
  - Large financial issuers could finance smaller firms directly

Research agenda

- Framework
  - First paper to link financing activity with real outcomes at the micro and macro level
  - Statistical power is limited by available data
  - But the paper provides a tool for future analyses
- Green issuers vs. conventional issuers
  - Partition conventional issuers by size
- Counterfactuals
  - Alternative allocation of green debt issuances toward smaller firms
  - Alternative of all green loan financing instead of green bonds and loans

Thank you!