Carbon Emissions and the Bank-Lending Channel

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Climate Debate

- Global warming is a key social debate and is at the forefront of policy actions
  - Tight link between carbon emissions and temperature changes (Hasselmann-Manabe, NP 2021)
  - COP21 (Paris Agreement) and **decarbonization policies**
  - The stated objective is to reduce carbon emissions sufficiently to avoid an average temperature rise of more than 1.5 degrees Celsius by 2050 (net neutrality)

- Active debate on how to control emissions
  - Various stakeholders involved (coordination costs/political economy). **Financial sector** as a major player to provide discipline
    - Evidence from capital markets: cost of capital channel (dominant), activism, etc.
  - Less evidence/focus on **"does it actually work?"**

- **This paper:** takes an integrated view in the context of the **banking sector**

The Role of Banks

- Banking sector **can be an important player** in the climate discussion
  - Key for resource allocation to **brown/green firms via its ability to impose costs through loan volume and price**
  - Affects broader scope of economic activity (public vs. private firms) and geography, and bank (loan) decisions are more lasting (greater adjustment costs), as compared to capital markets

- Increasing **pressure on the banking sector to decarbonize**
  - Central banks' actions affect banks (QE, collateral, capital requirements), including pressure to disclose more information on banks' climate exposures (climate stress tests by BoE & ECB) due to transition and physical risks
  - Gradual expansion of bank involvement via bank commitments (Net Zero Banking Alliance; 04/2021)

- **But decarbonization in the banking sector is still in its early days**
  - 60 major banks have allocated $4.6 trillion into fossil fuel industry since 2015; $742bn into oil-gas-coal in 2021
  - Lending is sticky; transition risk is still not fully clear; large firm-level heterogeneity in emissions within industries

Questions and Identification

- Do banks decarbonize their portfolios?

- Does **bank decarbonization trigger real adjustments in non-financial firms**?
  - Effects on corporate real and financial decisions
  - Effects on emissions

Empirical Context: **Bank commitments**

- Some banks formally commit to decarbonization. We use these commitments for:
  - **Questions**: Are bank commitments greenwashing or are they associated with change in behavior?
  - Do they drive changes in the real sector?

  - **Identification**: we can compare changes in different banks' willingness to lend to brown/green firms with the aim to identify a bank lending (credit supply) channel
    - Firms that borrowed ex ante from these banks will be potentially shocked by these banks' commitments
    - Staggered diff-in-diff (we test for pretends and for firm selection based on observables & unobservables)

Datasets

- We track firms' exposures to bank commitments through Dealscan data on syndicated loans

- Firm-level info from *Compustat* (Chava and Roberts, 2008)
  - Total debt, leverage, total assets, CAPEX, …

- Nonbank debt and % of (outstanding) bank debt from Capital IQ

- Firm-level data on pollution from S&P Global Trucost (Bolton and Kacperczyk, 2021)
  - *Main focus*: scope 1 (S1) carbon emissions
    - Scope 1 greenhouse gas (GHG) emissions occur from sources that are controlled or owned by a firm
  - Also scope 2 and scope 3

- Firm-level data on ESG metrics from MSCI

SBT Commitment Initiative

- Science Based Targets initiative:
  - A joint initiative by CDP, the UN Global Compact, the World Wide Fund for Nature (WWF), and the World Resources Institute (WRI)
  - Set to define and promote net-zero targets in line with the climate science
  - Induces companies to commit to decarbonization pathways to increase the chance that global emissions can be reduced to a level that limits average temperature rise below 1.5C
  - Paris Agreement's Article 2.1(c): "making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development."
  - Since its launch in 2015, the number of companies joining the SBTi has been rising steadily and now comprises just over 2000 companies in 60 countries, with a combined value of $20.5 trillion

Commitments in our Data

- Some banks formally commit to carbon net neutrality
  - Commitments often triggered by stakeholders' pressure (institutional ownership, loyalty by clients, board size)
  - These pressures may be uneven across geographic and size spectra
  - Most commitments involve absolute and intensity of emissions
  - No specific targets in our data but more and more banks set those nowadays
  - These are early days in the decarbonization of banking, so it is not clear whether commitments have had any effects, nor what the size of these effects might be

- We call a firm committed if at least one of its (previous) lenders commits to SBTi
  - Alternative proxies
    - Condition commitment on the subset of *lead arrangers*
    - Intensive margin (% of committed banks and lead arrangers)

Details

- 22 banks during our sample period have made SBTi commitments to reduce carbon emissions
  - These lenders participate in at least one loan for about 60% of the sample
  - The baseline sample includes banks active in the syndicated loan market and for which their borrowers have carbon emissions data
  - Banks mainly commit in our sample in mid 2015 and mid 2016

Our Sample

- 2113 non-financial companies
  - 630 firms located in the US; 347 in the EU; 191 in the UK, and 945 elsewhere
- 1481 firms in Treatment group → previously (before our sample) indebted to committing banks
  - Cumulatively, 477 firms treated in 2015Q2 and 1,239 in 2016Q2
- 632 firms in Control group → not (priorly) indebted to committing banks
- Examine the years around commitments: 2013-2018 (also examine 2019 for some regressions on carbon emissions and 2000-12 for lending connections between firms and banks)
- High heterogeneity in carbon pollution (S1) across firms
  - We use the (*pre-determined*) average levels
  - An average firm emits 3.4 million tons of CO2e
  - One standard deviation of emission levels equals 15.8 million tons of CO2e
- Treatment vs. control groups
  - Treated firms are larger. Emissions, debt, leverage, risk and revenue growth are not different
  - Results suggest no selection along (firm) unobservables (Altonji et al., 2005; Oster, 2019)
  - Firm-time (year:quarter) fixed effects in firm-bank (loan) regressions
  - Committed vs non-committed banks are different in size (not in capital, profits…)

Baseline Empirical Model

- *Identification*: Staggered diff-in-diff, comparing outcomes across firms
  - Linked ex-ante to committed banks, or not ($treat_f$)
  - Before and after the bank commitment, and hence treated firm shock ($post_{f,t}$)
  - Depending on pre-determined pollution levels as of 2013 ($logS1_f$)

- Baseline model:

$$y_{f,t} = b_1 logS1_f + b_2 treat_f + b_3 post_t + b_4 logS1_f treat_f + b_5 post_t * logS1_f + b_6 post_{f,t} + \mathbf{b_7} post_{f,t} * LogS1_f + \Omega Controls_f + \Gamma_f + \Gamma_t + e_{f,t}$$

- $\mathbf{b_7}$ → effect on y for treated firms (as compared to a control group) conditional on logS1
  - Firm and time fixed effects absorb some of the coefficients
  - Firm controls are ex ante log total assets and revenue growth (interacted with treat and post)
- Note: staggered commitment across banks → so shocks to firms over time
  - The treatment date is firm specific (via firm's previous bank lending): $post_{f,t}$
  - We set $post_t$=1 if date >= 2015Q2 (first treatment period)

Empirical Findings I

Debt Effects

Debt Channel: Baseline Results

	(1)	(2)	(3)	(4)	(5)
VARIABLES			Total Debt		
$Post_{f,t}$* Log-$S1_f$	-0.0278*	-0.0323**	-0.0313**	-0.0255***	-0.0240***
	(0.0167)	(0.0129)	(0.0130)	(0.0082)	(0.0082)
$Post_{f,t}$	0.3131***	0.0945	0.0593	0.1764	0.1180
	(0.0375)	(0.2774)	(0.2786)	(0.2220)	(0.2227)
$Post_t$ * Log-$S1_f$	-0.0221*	0.0009	0.0001	-0.0033	-0.0049
	(0.0125)	(0.0108)	(0.0108)	(0.0081)	(0.0081)
$Treat_f$* Log-$S1_f$	-0.0529**	-0.0165	-0.0169		
	(0.0260)	(0.0188)	(0.0189)		
$Post_t$	-0.0392	0.7298***		0.4459**	
	(0.0278)	(0.2570)		(0.1915)	
$Treat_f$	0.3551***	-1.0275**	-1.0189**		
	(0.0619)	(0.4105)	(0.4103)		
Log-$S1_f$	0.3629***	0.0515***	0.0519***		
	(0.0216)	(0.0165)	(0.0165)		
Observations	41,450	41,450	41,450	41,450	41,450
R-squared	0.3066	0.7044	0.7055	0.9042	0.9053
Econ effect 1sd	-.074	-.086	-.083	-.068	-.064
Firm Controls	No	Yes	Yes	Yes	Yes
Time FE	No	No	Yes	No	Yes
Firm FE	No	No	No	Yes	Yes

Standard errors are clustered at the firm level. ***p<.01, **p<.05, *p<.1

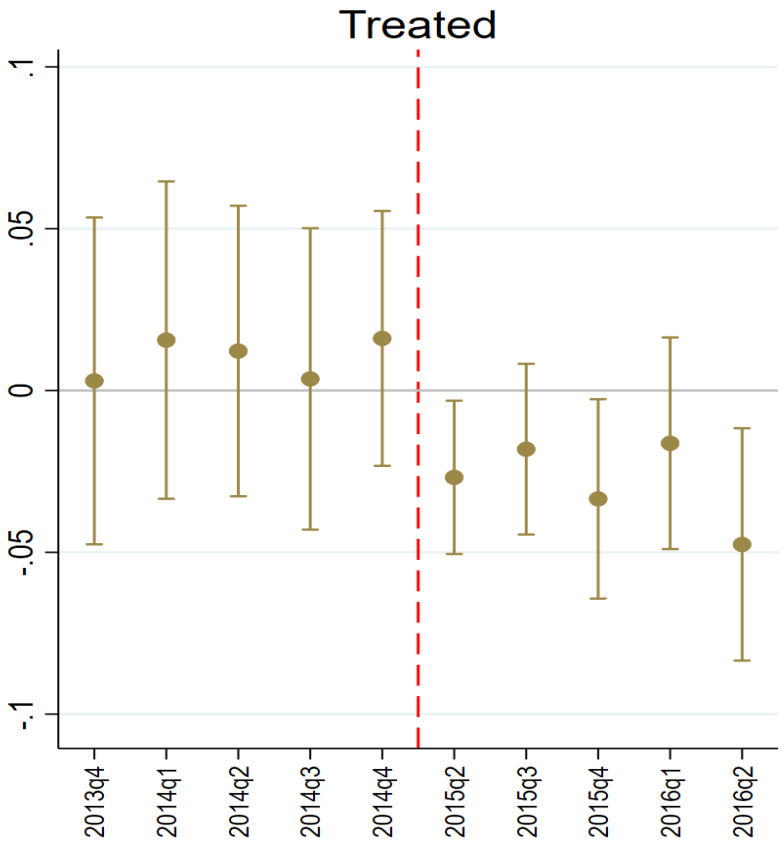
Bank Debt *vs* Non-Bank Debt

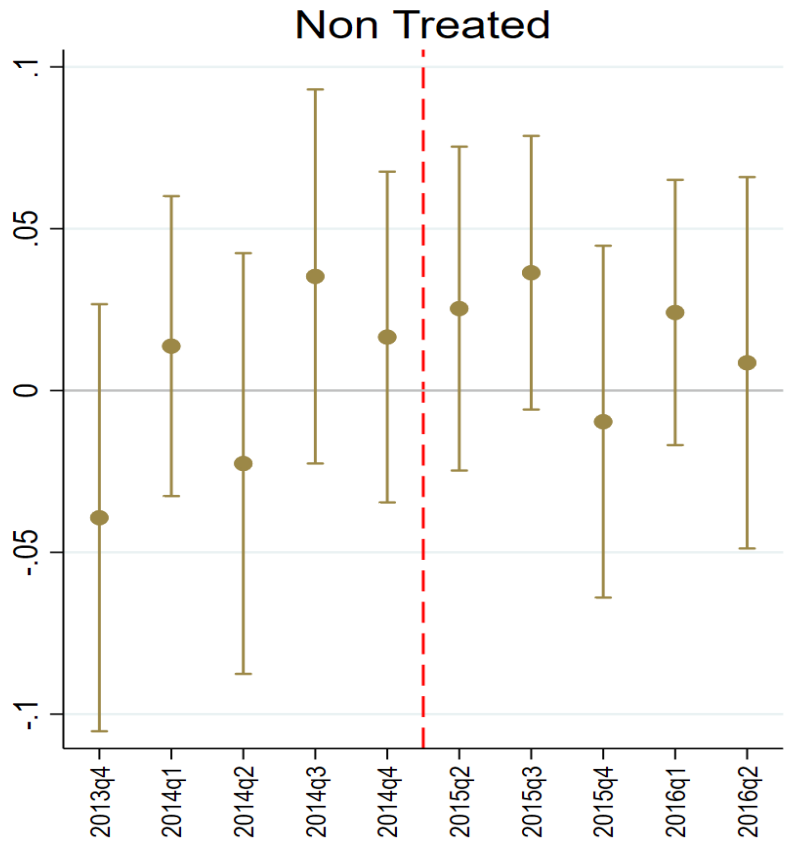
VARIABLES	(1) Total Debt	(2) Bank Debt	(3) Non-Bank Debt
$Post_{f,t}$* Log-$S1_f$	-0.0215***	-0.0456*	-0.0050
	(0.0073)	(0.0237)	(0.0218)
$Post_{f,t}$	0.1850	-0.1558	0.2067
	(0.2392)	(0.4757)	(0.4933)
$Post_t$ * Log-$S1_f$	-0.0074	-0.0046	-0.0120
	(0.0066)	(0.0187)	(0.0200)
Observations	32,828	32,828	32,828
R-squared	0.9127	0.7456	0.8014
Econ effect 1sd	-.057	-.122	-.013
Firm Controls	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes

Standard errors are clustered at the firm level. ***p<.01, **p<.05, *p<.1

- A 1sd increase in ex-ante emissions triggers a debt reduction for firms linked to committed banks by 6.5 % as compared to firms not connected prior to our sample to committed banks
- Key: results driven by bank debt, which contracts by roughly 12 %, and no discernible effect on nonbank debt

Other Robustness Tests. Robustness I: Parallel Trends: *Bank Debt*





Loan-level Results (controlling for firm unobservables)

VARIABLES\ MODEL	(1) Intensive+ Extensive	(2) Intensive + Extensive	(3) Intensive + Extensive	(4) Intensive + Extensive	(5) Intensive	(6) Extensive
$Post_{b,t}$* Log-$S1_f$	-0.0159*	-0.0302**	-0.0238*	-0.0308**	0.0337	-0.0055*
	(0.0091)	(0.0140)	(0.0132)	(0.0137)	(0.0220)	(0.0030)
Observations	60,907	60,907	35,189	60,907	6,964	60,907
R-squared	0.4085	0.4088	0.5130	0.4735	0.8933	0.4762
Econ effect 1sd	-.041	-.079	-.062	-.080	.088	-.014
Firm Controls	No	Yes	Yes	Yes	Yes	Yes
Bank Controls	No	No	Yes	-	-	-
Firm-Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	No	No	No	Yes	Yes	Yes

Overall, committed banks green out their asset portfolios by 32% of their initial carbon footprint

Debt Price via Firm-Level Interest Expenses

- Column 1 coefficient: 1 SD in Log-S1 → 2% of mean, 4% of SD

	(1)	(2)
VARIABLES	Interest Expense	
Commit Measure	I(Any Bank Commits)	%Committed Banks
$Post_{f,t}$* Log-S1$_f$	0.0001	0.0007**
	(0.0001)	(0.0003)
$Post_{f,t}$	-0.0009	0.0034
	(0.0018)	(0.0061)
$Post_t$ * Log-S1$_f$	0.0001	0.0001
	(0.0001)	(0.0001)
Observations	36,946	36,946
R-squared	0.5452	0.5460
Firm Controls	Yes	Yes
Firm FE	Yes	Yes
Time FE	Yes	Yes

Empirical Findings II
Real Effects

Do Firms Internalize Credit Shocks in their Decisions?

VARIABLES	(1) Bank Debt	(2) Total Debt	(3) Leverage	(4) Assets	(5) Equity	(6) CAPEX	(7) LIQAT	(8) ROA
$Post_{f,t}$* Log-$S1_f$	-0.0545**	-0.0269***	-0.0024**	-0.0081**	0.0001	-0.0160**	0.0013**	0.0010***
	(0.0253)	(0.0087)	(0.0012)	(0.0040)	(0.0060)	(0.0080)	(0.0006)	(0.0080)
$Post_{f,t}$	-0.2232	0.0978	0.0317	0.1364	0.0965	-0.0511	0.0035	0.0015
	(0.4774)	(0.2223)	(0.0262)	(0.0863)	(0.1258)	(0.1759)	(0.0152)	(0.0052)
$Post_t$ * Log-$S1_f$	0.0003	-0.0057	-0.0002	-0.0077**	-0.0067	-0.0198**	-0.0198**	-0.0006***
	(0.0184)	(0.0085)	(0.0011)	(0.0035)	(0.0051)	(0.0079)	(0.0079)	(0.0002)
Observations	32,828	41,450	41,450	41,450	40,316	38,126	38,126	38,126
R-squared	0.7456	0.9054	0.8276	0.9722	0.9267	0.8896	0.8896	0.3446
Econ effect 1sd	-.138	-.068	-.006	-.02	0	-.043	.003	.002
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Results consistent with a model of financial inflexibility (e.g., Bolton et al. 2019) due to external finance shocks

- Leverage, investments, and assets go down
- Liquid assets go up
- Auxiliary prediction: ROA goes up (least profitable projects are cut)

Pollution and Green Activities

- Do firms respond to bank pressure by changing their decarbonization and ESG activity?

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
VARIABLES	Log-S1$_{t+1}$	Log-S$_{t+2}$	Log-S1$_{t+3}$	Log-S1 $_{(t+1, t+2)}$	Log-S1 $_{(t+1, t+3)}$	Committed	ESG Score	Env Score	Env Exp$_{t+1}$	Env Exp$_{t+1}$/TA	Renewable
Post$_{ft}$* Log-S1$_f$	-0.0002	-0.0106	-0.0013	0.0017	-0.0047	-0.0003	0.0090	0.0362**	-0.0161	-0.0392	0.0005
	(0.0122)	(0.0121)	(0.0146)	(0.0132)	(0.0104)	(0.0012)	(0.0104)	(0.0184)	(0.0330)	(0.0962)	(0.00463)
Post$_{ft}$	-0.3554*	-0.3452*	-0.2330	-0.3114**	-0.3134**	-0.0724***	-0.0316	0.4246	-0.0029	0.5622	0.0642
	(0.1998)	(0.1918)	(0.2412)	(0.1584)	(0.1490)	(0.0254)	(0.2106)	(0.4332)	(0.5998)	(1.1263)	(0.0836)
Post$_t$ * Log-S1$_f$	-0.0309***	-0.0013	-0.0073	-0.0258*	-0.0162*	-0.0021**	0.0442***	0.0140	-0.0374	-0.0942*	-0.0089**
	(0.0113)	(0.0116)	(0.0076)	(0.0137)	(0.0097)	(0.0010)	(0.0107)	(0.0168)	(0.0252)	(0.0567)	(0.0039)
Observations	8,638	6,882	5,157	6,843	5,096	41,450	31,668	31,668	1,911	1,911	35,112
R-squared	0.9699	0.9765	0.9813	0.9822	0.9914	0.3555	0.8455	0.8568	0.9670	0.7361	0.8421
Econ effect 1sd	-.001	-.028	-.004	.005	-.013	-.001	.024	.097	-.043	-.104	.001
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

ESG Sub-Components

VARIABLES	(1) ESG	(2) Env	(3) Soc	(4) Gov	(5) Climate	(6) Natural Res	(7) Waste	(8) Env Ops.	(9) Carbon
$Post_{f,t}$ * Log-$S1_f$	0.0090	0.0362**	0.0138	0.0074	0.0286	-0.0429*	-0.0105	0.0732***	-0.0102
	(0.0104)	(0.0184)	(0.0192)	(0.0242)	(0.0277)	(0.0252)	(0.0199)	(0.0220)	(0.0262)
$Post_{f,t}$	-0.0316	0.4246	-0.3034	-0.3941	0.4837	-0.3337	-0.7551	0.7134	0.7986
	(0.2106)	(0.4332)	(0.3571)	(0.4999)	(0.6441)	(0.5880)	(0.4982)	(0.5046)	(0.5963)
$Post_t$ * Log-$S1_f$	0.0442***	0.0140	-0.0331	-0.0399	-0.0273	-0.1304***	-0.1731***	0.0471**	-0.0512**
	(0.0107)	(0.0168)	(0.0202)	(0.0277)	(0.0249)	(0.0258)	(0.0203)	(0.0210)	(0.0248)
Observations	31,668	31,668	31,668	31,666	29,247	24,570	23,933	13,413	26,582
R-squared	0.8455	0.8568	0.7607	0.5967	0.8595	0.8008	0.8519	0.8027	0.8774
Econ effect 1sd	.024	.097	.037	.02	.076	-.114	-.028	.195	-.027
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Non-Linear Effects Conditional on Scope 1 Emissions

VARIABLES	(1) Total Debt	(2) Bank Debt	(3) Nonbank Debt	(4) CAPEX	(5) Log-S1
$Post_{f,t}$ * Quintile 1_f	0.1508**	0.5053**	0.0364	0.1782**	0.0168
	(0.0611)	(0.1972)	(0.1835)	(0.0696)	(0.0747)
$Post_{f,t}$ * Quintile 2_f	0.1946***	0.2277	0.2903*	0.0703	-0.0041
	(0.0549)	(0.1647)	(0.1593)	(0.0593)	(0.0716)
$Post_{f,t}$ * Quintile 3_f	0.1201**	0.0176	0.2145	0.0732	0.0281
	(0.0486)	(0.1651)	(0.1422)	(0.0557)	(0.0657)
$Post_{f,t}$ * Quintile 4_f	0.0148	-0.0887	0.2357	0.0146	0.0657
	(0.0455)	(0.1479)	(0.1501)	(0.0551)	(0.0577)
$Post_{f,t}$	-0.3239	-0.8954	0.0126	-0.4828**	-0.2562
	(0.2896)	(0.5572)	(0.6062)	(0.2430)	(0.1953)
Observations	32,838	32,838	32,838	30,351	32,838
R-squared	0.9140	0.7473	0.8024	0.8818	0.9708
Firm Controls	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes
Size Quintile-Time FE	Yes	Yes	Yes	Yes	Yes

Summary: Main Results and Contribution to the Literature

- (Committing) banks do condition their credit decisions on firm emissions
  - Credit supply mechanism
  - No full substitution with other lenders + nonbank debt stable = total debt and leverage cut

- Firms internalize this effect in their corporate decisions (but less so in their decarbonization actions):
  - The reduction in bank lending to brown firms lowers firm real investments & assets
  - *No* firm-level cut in carbon emissions or increase in future commitments (hard choice/data)
  - Greenwashing: some positive effects on E-scores but driven largely by *potential* expenditures on green activities
  - Firms tend to cut the least profitable projects (an increase in average ROA)
  - Banks affect carbon emissions via credit reallocation from brown to green firms rather than via providing loans to brown firms for the investment necessary to cut carbon emissions

- **Contribution to the literature:** integrated analysis of decarbonization process via the banking sector => a new role of banks in the markets