Climate Change-Related Regulatory Risks and Bank Lending

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Motivation

In the near term (2021-2040) global warming reaching 1.5°C would cause unavoidable increases in multiple climate hazards and present multiple risks to ecosystems and humans. [...] Considering all scenarios assessed, there is at least a greater than 50% likelihood that global warming will reach or exceed 1.5°C in the near-term"
(IPCC, 2022)

- Transitioning to a greener economy in the near future is a priority.
- This transition relies on extensive regulatory intervention $\rightarrow$ Firms face regulatory risks. $\rightarrow$ Mitigating these risks will require massive investments.
- But how do loan volumes adjust depending on firms' regulatory risks?
- Role of the financial sector: setting incentives and providing funding. How does bank lending respond to these risks?

The set-up in a nutshell:

- Difference-in-differences design
- Paris Agreement → shifting point for banks' and firms' awareness of the impact of climate change and the need for regulatory intervention (Krueger et al., 2020)
  - 196 nations agree to coordinate actions to limit global warning to below 2 degrees
  - Anticipation: 2015 Agreement unlikely and extent unforeseen
- International sample of firms and banks → All active syndicated loans between 2010 and 2019
- Identification of firms that are positively/negatively exposed to climate change-related regulatory risks
  - Firms' exposure to climate change-related regulatory risks **(Sautner et al., 2022)**
  - Exposure captures *frequency of occurence* of topic and *sentiment* of conversations in quarterly earning conference calls ▸ Firm Exposure
  - Three groups of firms: Positive, negative and non-exposed firms

Highly unclear how the Paris Agreement impacts equilibrium quantities:

Supply Side:

- Negatively exposed firms:
  - $\Downarrow$ - impact on firm outcomes (Selzer et al., 2020)
  - $\Uparrow$ Creaming off (Reghezza et al., 2021) or support of transition (Engle et al., 2020)
- Positively exposed firms:
  - $\Uparrow$ + impact on firm outcomes (Selzer et al., 2020)
  - $=$ Barriers to green finance (Holburn et al., 2012)

Demand Side:

- Negatively exposed firms:
  - $\Downarrow$ Conserve borrowing capacity (Kovacs et al., 2021)
  - $\Uparrow$ Compliance costs or transition investments
- Positively exposed firms:
  - $\Downarrow$ Changes in relative costs of financing sources (Alessi et al., 2021)
  - $\Uparrow$ Changes in risk/return balance might spur investments (Holburn et al., 2012)

Estimation strategy: Difference-in-differences design

Combination of Doerr and Schaz (JFE, 2020) and Degryse et al. (JFI, 2019)

$$\ln(\text{Credit})_{b,f,t} = \beta_1 \text{Positive}_f \times \text{Post}_t + \beta_2 \text{Negative}_f \times \text{Post}_t + \eta_{b,f} + \eta_{b,t} + \eta_{j,l,s,t} + \varepsilon_{b,f,t} \quad (1)$$

- $\ln(\text{Credit})_{b,f,t}$: Log of outstanding credit between bank b and firm f in quarter t
- $\text{Post}_t = 1$ from 2015q4 onwards (= after Paris) and zero otherwise
- $\text{Positive}_f = \begin{cases} 1 & \text{if } \overline{\text{CCExposure}}_f > 0 \\ 0 & \text{otherwise} \end{cases}$
- $\text{Negative}_f = \begin{cases} 1 & \text{if } \overline{\text{CCExposure}}_f < 0 \\ 0 & \text{otherwise} \end{cases}$
- Bank-firm ($\eta_{b,f}$), bank-time ($\eta_{b,t}$) and industry-location-size-time ($\eta_{j,l,s,t}$) fixed effects

▸ CCExposure ▸ Distribution ▸ Pre-trends ▸ Calls

A first look at equilibrium effects: The importance of local regulatory risk

	(1) Full sample	(2) Low Reg.Risk	(3) High Reg.Risk	(4) USA	(5) Europe	(6) ROW
Positive × Post	0.161	-0.123	0.803***	-0.251	0.795***	0.005
	(0.129)	(0.133)	(0.221)	(0.185)	(0.216)	(0.089)
Negative × Post	0.171**	0.288***	0.149	0.319***	0.133	0.122
	(0.066)	(0.071)	(0.122)	(0.081)	(0.112)	(0.099)
Observations	336,257	215,103	109,443	180,399	102,596	49,845
Bank-Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
ILST FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank-Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.921	0.921	0.921	0.901	0.911	0.929
Number of banks	307	206	195	121	164	189
Number of firms	2,096	1740	313	1553	292	247
Clustering	Bank	Bank	Bank	Bank	Bank	Bank

▸ Controls ▸ Robustness ▸ Spread ▸ Trump ▸ Size

A closer look: Within-region regulatory risk

	(1) USA	(2) USA	(3) Europe
Indicator for ***Stringent****:*	Adaption	Democratic	High CCPI
Positive × Post	-0.211	-0.181	0.426**
	(0.223)	(0.205)	(0.190)
Positive × Post × ***Stringent***	-0.085	-0.288	
	(0.287)	(0.308)	
Negative × Post	0.409***	0.375***	0.552***
	(0.097)	(0.091)	(0.196)
Negative × Post × ***Stringent***	-0.410***	-0.335***	-0.793***
	(0.119)	(0.120)	(0.206)
Observations	180,399	180,399	100,087
Bank-Firm FE	Yes	Yes	Yes
ILST FE	Yes	Yes	Yes
Bank-Time FE	Yes	Yes	Yes
Adjusted R^2	0.901	0.901	0.912
Number of banks	121	121	163
Number of firms	1,553	1,553	281
Clustering	Bank	Bank	Bank

A look at the supply side: Are all banks the same?

The role of banks' exposure and other heterogeneity

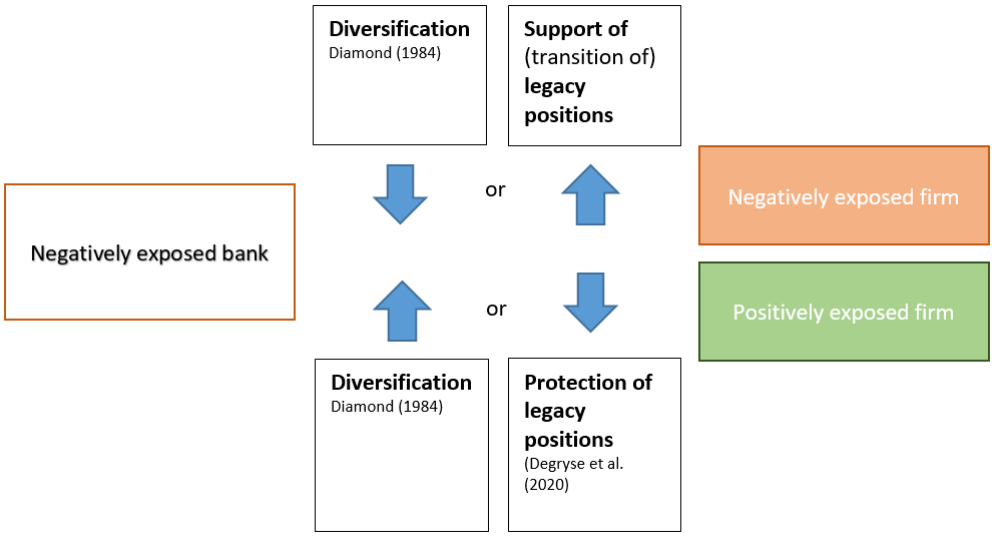
Banks might adjust their lending differentially based on certain traits:

- Banks' own exposure: **NegBank**
  $\Rightarrow$ Identification of banks' exposure via lending portfolio composition:

$$\text{Bank Exposure}_b = \sum_{f=1}^{N} \left(\frac{\text{lending}_{b,f}}{\text{lending}_b} \times \overline{CCExposure_f} \right).$$

- Banks' significance: **GSIB**
- Banks' preferences for sustainable lending: **UNEP**
- Banks' location: **Home**

Hypotheses: The role of banks' own exposure



Differential credit supply responses: Does banks' own exposure play a role?

- Inclusion of firm-time fixed effects to control for changes in demand + interaction with NegBank.
- The more negatively exposed a bank is the more it increases its credit supply to negatively exposed firms in Europe (relatively to the control group).
- At the 90th percentile of NegBank this corresponds to 26%.

	(1) USA	(2) Europe
Positive × Post × NegBank	0.637	-0.162
	(1.210)	(1.925)
Negative × Post × NegBank	0.404	2.785***
	(0.706)	(0.824)
Observations	177,702	102,483
Bank-Time FE	Yes	Yes
Bank-Firm FE	Yes	Yes
Firm-Time FE	Yes	Yes
Adjusted R^2	0.908	0.914
Number of banks	119	163
Number of firms	1454	289
Clustering	Bank	Bank

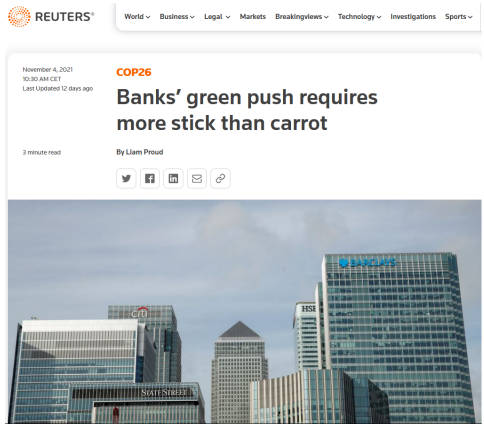
Differential credit supply responses: Other bank heterogeneity

- Do individual bank traits lead to differential adjustments?
- Horse race between negative exposure, significance, preferences and location.
- In Europe: Negatively exposed, GSIBs and European banks supply relatively more credit to negatively exposed firms.

	(1) USA	(2) Europe
Positive ×Post × NegBank	0.959	1.469
	(1.223)	(2.338)
Negative ×Post × NegBank	0.246	3.524***
	(0.550)	(0.746)
Positive × Post × GSIB	-0.064	-0.069
	(0.056)	(0.089)
Negative × Post × GSIB	0.027	0.090**
	(0.029)	(0.042)
Positive × Post × UNEP	-0.015	0.134
	(0.074)	(0.086)
Negative× Post ×UNEP	-0.049	0.003
	(0.043)	(0.040)
Positive × Post ×Home	-0.077	0.129
	(0.071)	(0.095)
Negative × Post ×Home	-0.031	0.163***
	(0.044)	(0.050)
Observations	177702	102483
Bank-Firm FE	Yes	Yes
Bank-Time FE	Yes	Yes
Firm-Time FE	Yes	Yes
Adjusted R^2	0.908	0.915
Number of banks	119	163
Number of firms	1454	289
Clustering	Bank	Bank

Understanding the role of banks

Do lending adjustments of different bank types facilitate or hinder the transition?



Links: BBC, Reuters

Is banks' behavior hindering the transition?

- Is lending to negatively exposed firms directed towards firms that show a higher ex-ante likelihood to transition?
- Degree of negative exposure as proxy: less negatively exposed might be better able/more likely to adapt their business model.
- No evidence that negatively exposed banks and GSIBs increase credit supply to firms with a higher likelihood to transition.

	Europe			
	(1)	(2)	(3)	(4)
Indicator for Bank Type:	NegBank	GSIB	UNEP	Home
Positive × Post × *Bank Type*	-0.162	-0.017	0.126*	0.148
	(1.923)	(0.080)	(0.074)	(0.101)
LessNegative × Post ×*Bank Type*	2.796***	0.067	0.007	0.098*
	(0.927)	(0.047)	(0.044)	(0.057)
VeryNegative × Post × *Bank Type*	2.969**	0.123**	0.068	0.072
	(1.190)	(0.062)	(0.060)	(0.070)
Observations	104,022	104,022	104,022	104,022
Bank-Firm, Firm-Time FE, Bank-Time	Yes	Yes	Yes	Yes
Adjusted R^2	0.913	0.913	0.913	0.913
Number of banks	163	163	163	163
Number of firms	297	297	297	297
Clustering	Bank	Bank	Bank	Bank

Conclusions

We investigate how regulatory risks related to climate change affect credit volumes and banks' lending behavior.

Equilibrium effects: Following the Paris Agreement credit volumes change depending on firms' positive or negative exposure as well as stringency of the regulatory environment:

- in low stringency environments negatively exposed firms receive more credit
- in high stringency environments positively exposed firms receive more credit

Do individual bank traits lead to differential changes in credit supply?

- In Europe: Negatively exposed, GSIBs and European banks supply relatively more credit to negatively exposed firms.
- Negatively exposed banks and GSIBs may be hindering the transition with their behavior.

Thank you for your attention

Firms' exposure to climate change-related regulatory risks

Construction by Sautner et al.(2020)

$$\text{CCExposure}_{f,t} = \frac{1}{\text{B}_{f,t}} \sum_{b}^{\text{B}_{f,t}} (1[b \in \mathbb{C}]) \times \sum_{b}^{\text{B} \in S} \tau(b) \tag{2}$$

- $b = 0, 1, ...\text{B}_{f,t}$ are the bigrams in firm f's conference call transcript in quarter t
- $1[.]$ = indicator function
- $\mathbb{C}$ = set of bigrams
- S represents the sentence containing $b = 0, 1, ...\text{B}_{f,t}$
- $\tau(b) = \begin{cases} 1 & \text{if } b \text{ has a positive tone} \\ -1 & \text{if } b \text{ has a negative tone} \\ 0 & \text{otherwise} \end{cases}$

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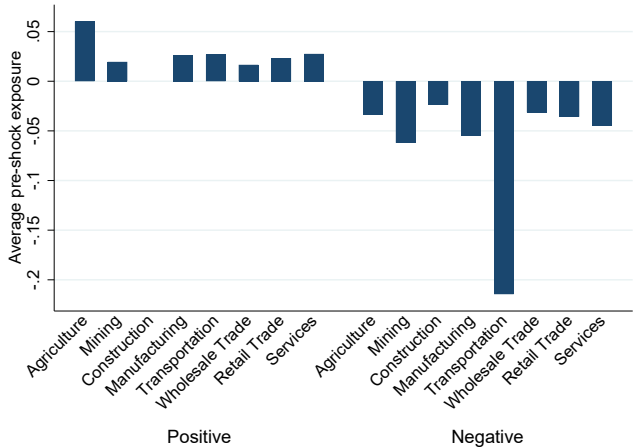
Distribution of firms' exposure



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Industry distribution of firms' exposure

	Mean	SD	Median	# of firms
Bottom-5 Industries				
49 Electric, Gas and Sanitary Svcs.	-0.197	0.313	-0.051	113
76 Miscellaneous Repair Svcs.	-0.110	0.164	-0.031	3
12 Coal Mining	-0.057	0.054	-0.063	11
45 Transportation by Air	-0.034	0.056	0.000	14
34 Fabricated Metal Prdcts	-0.029	0.075	0.000	24
Top-5 Industries				
25 Furniture and Fixtures	0.001	0.004	0.000	10
59 Miscellaneous Retail	0.001	0.006	0.000	47
56 Apparel and Accessory Stores	0.001	0.005	0.000	24
22 Textile Mill Prdcts	0.002	0.005	0.000	6
72 Personal Svcs.	0.002	0.007	0.000	8

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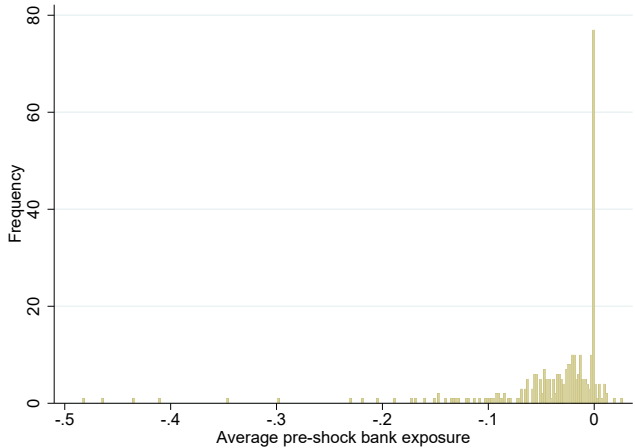
Distribution of banks' exposure



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Robustness checks

- Alternative specifications ▸ Controls
  - FE cascade and firm controls, + in paper: continuous exposure measures, alternative clustering schemes, alternative ILST specifications, loan controls.
- Potential confounders ▸ Timing, Location, Anticipation and Greenwashing
  - Location of regulation: Exclusion of loans from foreign subsidiaries
  - Timing of regulation: Exclusion of short-term loans
  - Anticipation effects: Shorter pre-shock period to avoid confounding events
  - Greenwashing: Sub-sample of cross-listed firms, subject to more scrutiny
- DealScan particularities ▸ DealScan
  - Considering only new issuances instead of outstanding volume, alternative lead arrangers definition exclusion of loans that are de facto no syndicate, exclusion of uncommon loan types
- Alternative exposure measures and control group ▸ Alt. exposure
  - Cumulative exposure measure, at least 4 consecutive observations, exclusion of firms with zero exposure
- Exclusion of alternative explanations ▸ Alternative Explanations
  - Rated and non-rated firms, energy sector, oil price fluctuations

▸ Go back

Robust: FE Cascade and Firm controls

	(1) No	(2) Bank-firm	(3) ILST	(4) Bank-time	(5) Firm controls	(6) Sample w controls
Positive	0.368***					
	(0.051)					
Positive × Post	-0.226***	-0.159***	0.199	0.161	-0.000	0.024
	(0.040)	(0.022)	(0.140)	(0.129)	(0.114)	(0.127)
Negative	0.225***					
	(0.029)					
Negative × Post	0.021	-0.005	0.190***	0.171**	0.502***	0.516***
	(0.028)	(0.018)	(0.069)	(0.066)	(0.088)	(0.093)
Post	0.336***	0.195***				
	(0.026)	(0.039)				
Observations	336,257	336,257	336,257	336,257	230,681	230,681
Bank-Firm FE	No	Yes	Yes	Yes	Yes	Yes
ILST FE	No	No	Yes	Yes	Yes	Yes
Bank-Time FE	No	No	No	Yes	Yes	Yes
Firm Controls	No	No	No	No	Yes	No
Adjusted R^2	0.023	0.842	0.918	0.921	0.926	0.926
Number of banks	307	307	307	307	265	265
Number of firms	2,096	2,096	2,096	2,096	1,800	1,800
Clustering	Bank	Bank	Bank	Bank	Bank	Bank

Firm time-varying controls: ROA, equity ratio, R&D inv. ratio, capital expenditure ratio, sales ratio.

◂ Go Back to Robustness ▸ Go back to Baseline

Trump election and Paris Agreement withdrawal

	USA			Europe
	(1) Obama period	(2) Trump period	(3) After anncmnt	(4) After anncmnt
Positive ×Post	-0.194	-0.341*	-0.340	1.753***
	(0.159)	(0.201)	(0.225)	(0.185)
Negative × Post	0.189***	0.386***	0.428***	0.124
	(0.071)	(0.104)	(0.113)	(0.123)
Observations	104443	159125	148105	86734
Bank-Firm FE	Yes	Yes	Yes	Yes
ILST FE	Yes	Yes	Yes	Yes
Bank-Time FE	Yes	Yes	Yes	Yes
Adjusted R^2	0.916	0.899	0.898	0.907
Number of banks	107	120	120	163
Number of firms	1429	1550	1550	292
Clustering	Bank	Bank	Bank	Bank

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The pricing of firms' regulatory exposure

	(1) USA	(2) Europe
Positive × Post	-18.274	0.928
	(12.145)	(25.144)
Negative × Post	8.286*	31.134***
	(4.717)	(6.905)
Observations	177,030	101,135
Bank-Firm FE	Yes	Yes
ILST FE	Yes	Yes
Bank-Time FE	Yes	Yes
Adjusted R^2	0.956	0.959
Number of banks	118	164
Number of firms	1,536	288
Clustering	Bank	Bank

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Robust: Timing and location of regulation, anticipation effects and greenwashing

	(1) USA Timing	(2) USA Location	(3) USA Anticipation	(4) USA Greenwash	(5) Europe Timing	(6) Europe Location	(7) Europe Anticipation
Positive × Post	-0.268	-0.195	-0.251	-0.088	0.872***	0.530***	0.795***
	(0.182)	(0.190)	(0.185)	(0.331)	(0.210)	(0.174)	(0.216)
Negative × Post	0.290***	0.335***	0.319***	0.563***	0.171	0.111	0.133
	(0.081)	(0.072)	(0.081)	(0.117)	(0.107)	(0.122)	(0.112)
Observations	178,651	171,482	180,399	80,938	102,239	95,568	102,596
Bank-Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ILST FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.905	0.899	0.901	0.898	0.913	0.903	0.911
Number of banks	117	118	121	89	163	159	164
Number of firms	1543	1522	1553	522	290	291	292
Clustering	Bank	Bank	Bank	Bank	Bank	Bank	Bank

◂ Go Back to Robustness ▸ Go back to Baseline

Robust: Firms' rating and energy

	(1) USA Non-rated	(2) USA Rated	(3) USA Wo/energy	(4) USA Wo/highoil	(5) Europe Non-rated	(6) Europe Wo/energy	(7) Europe Wo/highoil
Positive × Post	-0.663***	-0.151	-0.097	-0.251	0.428**	1.052***	0.792***
	(0.203)	(0.225)	(0.334)	(0.185)	(0.190)	(0.131)	(0.216)
Negative × Post	0.361***	0.426***	0.455***	0.319***	-0.236***	0.130	0.129
	(0.085)	(0.097)	(0.164)	(0.080)	(0.072)	(0.113)	(0.112)
Observations	26,962	140,848	149,106	163,924	87,601	86,815	89,585
Bank-Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank-Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ILST FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.909	0.901	0.906	0.899	0.908	0.906	0.911
Number of banks	56	115	114	117	155	146	156
Number of firms	243	1,151	1,340	1,415	237	266	256
Clustering	Bank	Bank	Bank	Bank	Bank	Bank	Bank

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Robust: Alternative exposure measures + control group

	(1) USA Cum	(2) USA 4Seq	(3) USA Exposed	(4) Europe Cum	(5) Europe 4Seq	(6) Europe Exposed
Positive × Post	-0.251	-0.256	-0.924***	0.795***	0.796***	0.645***
	(0.185)	(0.185)	(0.254)	(0.216)	(0.222)	(0.189)
Negative × Post	0.319***	0.300***		0.133	0.134	
	(0.081)	(0.081)		(0.112)	(0.123)	
Observations	180,399	179,540	55,288	102,596	102,159	41,262
Bank-Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
ILST FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank-Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.901	0.900	0.899	0.911	0.911	0.910
Number of banks	121	120	68	164	163	112
Number of firms	1,553	1,543	403	292	287	90
Clustering	Bank	Bank	Bank	Bank	Bank	Bank

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Parallel trends

	Negative		*Zero exposure*		*Positive*		*Normalized diff*	
	Mean	SD	Mean	SD	Mean	SD	Neg-No	Pos-No
Panel A: Bank-firm level								
Δ Loan volume	0.200	0.686	0.179	0.664	0.178	0.682	0.022	-0.001
Δ Loan spread	0.049	0.249	0.037	0.219	0.030	0.237	0.036	-0.023
Δ Loan maturity	0.025	0.127	0.016	0.106	0.020	0.123	0.052	0.024
Panel B: Firm level								
Δ Total assets	0.132	0.195	0.141	0.229	0.127	0.221	-0.029	-0.044
Δ ROA	-0.266	2.205	-0.097	2.430	-0.389	2.232	-0.052	-0.088
Δ Equity ratio	-0.035	0.474	-0.024	0.660	-0.021	0.627	-0.013	0.003
Δ R&D inv. ratio	-0.115	0.588	-0.061	0.480	-0.025	0.343	-0.070	0.062
Δ Capital exp. ratio	0.189	0.887	0.321	1.085	0.261	0.979	-0.094	-0.041
Δ Sales Ratio	0.012	0.079	0.020	0.098	0.021	0.083	-0.057	0.012
Panel C: Bank-firm level								
Δ Total assets	0.032	0.058	0.035	0.057	0.030	0.057	-0.035	-0.057
Δ ROA	-0.087	0.843	-0.055	0.808	-0.096	0.848	-0.027	-0.034
Δ Equity ratio	0.070	0.059	0.069	0.057	0.068	0.057	0.011	-0.010
Δ Retained earnings	0.619	1.672	0.515	1.506	0.737	1.922	0.046	0.091
Δ Short-term debt ratio	0.412	1.375	0.323	1.208	0.350	1.263	0.049	0.016

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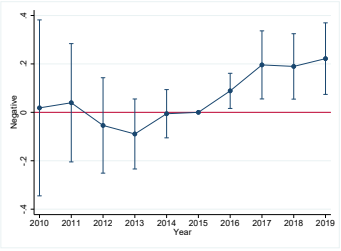
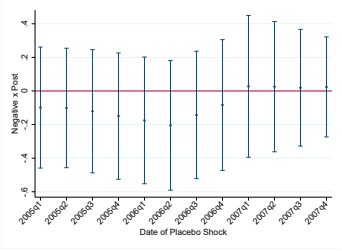
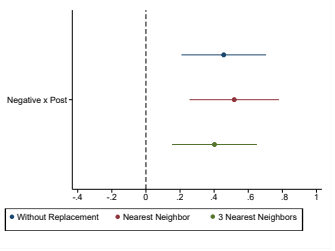
Parallel trends



(a) Effect over time



(b) Placebo tests



(c) Propensity Score Matching

Earning Conference Calls Examples:

Example of Negatively Exposed: GenOn Energy 2012Q1: *"Total projected cost for compliance with the Maryland Healthy Air Act remains at $1.674 billion, the remaining $83 million is expected to be paid this year." ... "Other environmental expenditures are estimated at $64 million this year and $124 million for 2013. These expenditures principally relate to environmental projects at Kanema, Kendall, Sayreville and Warner."*

Example of Positively Exposed: Fortum Oyj 2015q2 : *"Then regarding the future investments. As we have said earlier, so we really develop and target to develop the Company according to our strategy. And once we invest in the core technologies that we know: hydropower which is really, really good renewable, CO2 free, flexible production capacity, (inaudible) we also have a lot of knowledge. And heating business, combined heat and power production, where we use quite a lot of biofuels, waste fuels. So also use material (inaudible) which is at least partly renewable. So those are examples of the areas where we want to – or those are the focus areas where we want to invest. [...] Renewables really is of course the way to go in the future."*

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Magnitude of the effects:

On average Δ loan volumes between the pre- and post-shock periods is US$ 69.6 million.

Low regulatory stringency: Negatively exposed firms receive 28.8% more credit after the shock relative to firms with zero exposure.
This corresponds to $0.288 \times 69.6 = 20.04$ million more at the bank-firm pair level.

High regulatory stringency: Positively exposed firms receive 80.3% more credit after the shock relative to firms with zero exposure.
This corresponds to $0.803 \times 69.6 = 55.89$ million more at the bank-firm pair level.

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