



University of
Zurich ^{UZH}

Department of Banking and Finance

Being Stranded on the Carbon Bubble?

Climate Policy Risk and the Pricing of Bank Loans

Kathrin de Greiff (*University of Zurich, SFI*)

Manthos D. Delis (*Montpellier Business School*)

Steven Ongena (*University of Zurich, SFI, KU Leuven, CEPR*)

Geneva Summit on Sustainable Finance

Geneva, December 2018

Motivation – A Carbon Bubble?

Carbon bubble

«A hypothesized overvaluation of fossil fuel reserves and related assets due to neglecting the possibility of those assets becoming unusable or “unburnable”»

(First appeared in Le Page 2011 and Carbon Tracker Initiative 2011)

- Limiting the rise in global warming to 2°C compared to pre-industrial levels will leave the **majority of fossil fuel reserves as stranded assets**.
(McGlade and Ekins 2015; Carbon Tracker Initiative 2011, 2013)
 - Nevertheless, listed oil, gas, and coal companies still largely invest into locating and developing new fossil fuel reserves.
(Carbon Tracker Initiative 2013)
- **Financial markets might carry a carbon bubble**

Contribution

- Climate risks \Rightarrow potentially large **revaluations** of financial assets if not anticipated (Carney (2015), Batten et al (2016), Dietz et al (2016))

If risk of stranded fossil fuel reserves is NOT (or inadequately) priced

- **Revaluation of fossil fuel assets can pose financial stability risks**

(Weyzig et al 2014; Bank of England 2015; ESRB 2016; Battiston et al 2016)

- However: **limited empirical evidence** on the **existence of a carbon bubble**

- Missing insights on the pricing of climate policy risk in the equity market (Batten, Sowerbutts, and Tanaka 2016; Byrd and Cooperman 2016)

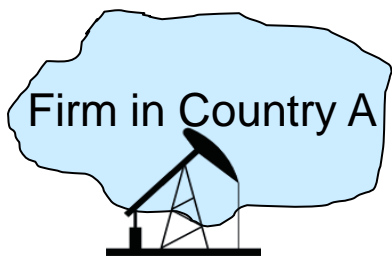
- **We examine the existence of a carbon bubble using the corporate loan market**

- ***Do banks price in the risk that fossil fuel reserves will become stranded?***

Measuring Risk of Stranded Fossil Fuel Reserves

We proxy the **risk of stranded fossil fuel reserves** by the **stringency of a country's climate policy**:

↑ climate policy stringency ⇒ risk of stranded assets ↑



Actively implementing climate policies

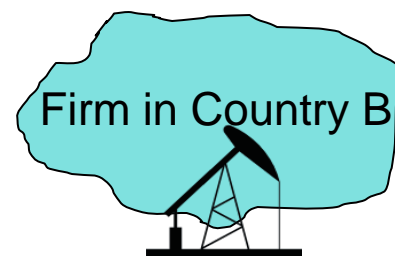


eventually



HIGHER
risk of stranded fossil fuel reserves

VS.



Less actively implementing climate policies



LOWER
Risk of stranded fossil fuel reserves

What We Do

And compare:

The cost of credit of fossil fuel firms

- to the cost of credit of non-fossil fuel firms
- and according to their different country-specific climate policy exposure

Data:

- *hand-collected* firm-year data on the **fossil fuel reserves** of firms across countries
- country-year **climate policy indices** (indicating higher climate policy risk)
- **global syndicated loan data**

What We Find

Pre 2015: climate policy risk does **not significantly** affect cost of credit

- **Suggests the existence of a carbon bubble**

Post 2015: the risk is priced

- Owing fossil fuel reserves in countries with stricter climate policy ↑ cost of credit:

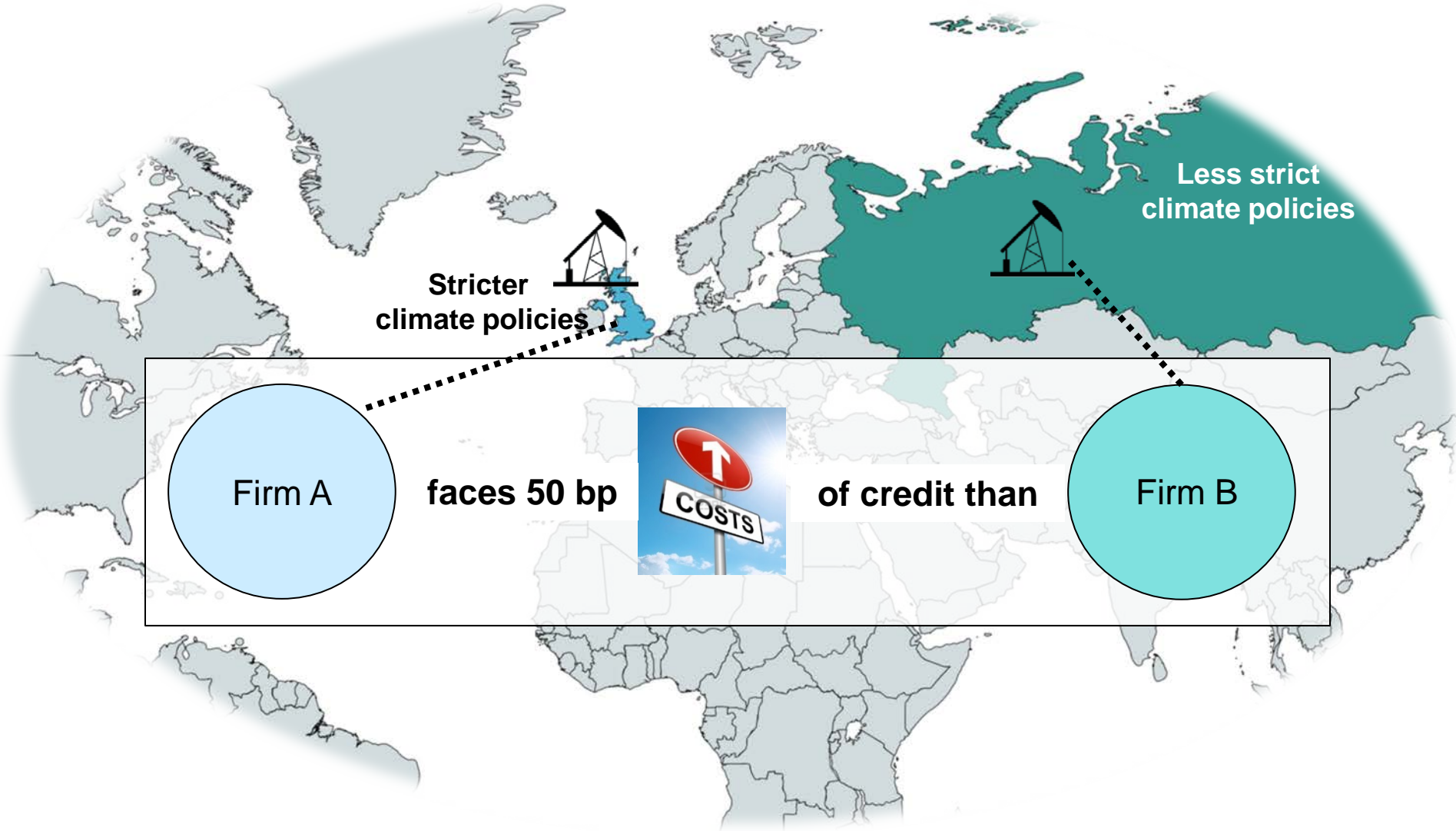
1 std. dev. ↑ **of climate policy exposure** ⇒ **cost of credit** ↑ on average by **2 bp**

- Owing **more fossil fuel reserves relative to total assets** ↑ exposure to climate policy risks, and thus, ↑ cost of credit:

1 std. dev. ↑ **of climate policy exposure** ⇒ **cost of credit** ↑ on average by **16 bp** for the firm with mean fossil fuel reserves over total assets

- **Salient evidence that banks start pricing the relevant risk post 2015**

What We Find – Post 2015



*assuming every other firm characteristics equal

Conclusions

We provide insights on the existence of a carbon bubble in the corporate loan market

Post 2015: the risk is priced, especially for firms holding more fossil fuel reserves

- **Salient evidence that banks start pricing the relevant risk post 2015**

Policy takeaways:

- A commitment to climate targets can alter market participants perception of climate risks
 - ⇒ Climate risks are started to be priced
- **Open question: Are the risks adequately assessed and priced?**



**University of
Zurich** ^{UZH}

Department of Banking and Finance

Thank you!



**University of
Zurich** ^{UZH}

Department of Banking and Finance

Appendix

Identification

$$\text{Cost of credit}_{lbft} = a_1 \text{FossilFuel}_{ft} \times \text{Post2015}_t \times \text{Climate policy exposure}_{ft} \\ + a_2 \text{all interaction terms}_{ft} + a_3 C_{lft} + a + u_{lbft}$$

- **FossilFuel**: dummy=1 for fossil fuel firms,
- **Post2015**: dummy=1 if year>2015
- **C**: control variables: loan, firm, and macro
- **a**: fixed effects vector

Hypothesis

If banks price the risk of stranded fossil fuel reserves post 2015, then we should observe $a_1 > 0$.

Climate Policy Exposure in Recent Years

	(1)	(2)	(3)	(4)
(in basis points)				
	Cost of Credit	Cost of Credit	Cost of Credit	Cost of Credit
FossilFuel* Post2015 *Climate Policy Exposure (CCPI)	1.917* (1.831)	1.985* (1.917)		
Reserves over Assets* Post2015 *Climate Policy Exposure (CCPI)			25.501*** (9.412)	26.364*** (15.110)
Loan Controls	Yes	Yes	Yes	Yes
Firm Controls	Yes	Yes	Yes	Yes
Macro Controls	Yes	Yes	Yes	Yes
Observations	9,650	9,645	9,407	9,402
Adjusted R-Squared	0.570	0.570	0.571	0.571
Bank*Year, Loan Type & Purpose Effects	Yes	Yes	Yes	Yes
Year, Firm's Country & Bank's Country Effects	.	Yes	.	Yes
Clustered Standard Errors by Bank & Firm	Yes	Yes	Yes	Yes

t statistics in parentheses; * p<0.10, ** p<0.05, *** p<0.01; for readability, control variables are left out.

Robustness Checks

- Impact on **commitment fees**, of the **location of reserves** (in one versus multiple countries), of our **measure of fossil fuel reserves**, **disclosure of fossil fuel reserves on regional level** (well-known firms), on **oil and gas firms only**
 - Find similar results
- Impact of **general political and policy uncertainty** measured by the State Fragility Index
 - Does not derive our results
- Measure public awareness using the Google-search of “carbon bubble”
 - When public awareness ↑ cost of credit ↑
- Effect on loan maturity (↑ climate policy risk for long-term loans)
 - Impact of loan maturity is very small
- Effect on loan amount (↓ access to equity for ↑ climate policy exposure)
 - Economically small increase of loan amount for fossil fuel firms with higher climate policy exposure
- “Greener banks” (participating in UNEPFI) ↑ cost of credit slightly more

Summary Statistics – Fossil Fuel Sector

	Obs.	Mean	Std. Dev.	Min.	Max.
AISD	1,942	287.70	194.07	1	1,330
AISU	706	47.68	35.83	2	500
Loan Amount	1,942	19.37	1.34	14.20	23.27
Maturity	1,942	3.78	0.60	0	5.65
Collateral	1,942	0.15	0.36	0	1
Number of Lenders	1,942	8.27	7.38	1	60
Performance Provisions	1,942	0.17	0.38	0	1
General Covenants	1,942	0.56	1.01	0.00	4.00
Firm Size	962	8.44	2.64	2.22	17.74
Market to Book	786	244	2935	0	40,664
Leverage	961	32	20	0	149
Tangibility	932	2	2	0	30
GDP per Capita	1,938	43,911	17,876	856	102,910
GDP Growth	1,936	2.15	2.53	-7.82	25.05
Climate Policy Exposure (C3I)	813	44.22	7.99	31.30	64.77
Climate Policy Exposure (CCPI)	769	54.68	1.05	46.56	60.19
Total Fossil Fuel Reserves (MMBOE)	803	1,965.33	5,755.31	0.002	46,400
Proved Reserves (million USD)	623	4,679.24	12,240.5	5.33	137,896
Proved Reserves over Total Assets	614	0.65	0.47	0.001	5.08

Country of Headquarters of Fossil Fuel Firms

Country	Frequency	Percent
Argentina	3	0.36
Australia	21	2.49
Bermuda	10	1.19
Canada	79	9.37
China	1	0.12
Gabon	3	0.36
India	11	1.3
Indonesia	15	1.78
Israel	4	0.47
Mexico	15	1.78
Mongolia	2	0.24
Nigeria	1	0.12
Norway	7	0.83
Papua New Guinea	1	0.12
Romania	3	0.36
Russia	25	2.97
Singapore	4	0.47
Sweden	1	0.12
USA	619	73.43
United Kingdom	14	1.66
Venezuela	3	0.36
Yemen	1	0.12

Relative Fossil Fuel Reserves by Country - I

	Obs.	Mean	Std. Dev.	Min.	Max.
Number of countries in which firms own oil, gas and/or coal reserves	1,445	1.39	1.02	1	13
<i>Country:</i>					
Algeria	6	0.28	0.42	0.01	0.82
Angola	5	0.01	0.00	0.01	0.01
Argentina	17	0.23	0.37	0.03	1.00
Australia	77	0.49	0.43	0.00	1
Azerbaijan	3	0.04	0	0.04	0.04
Bangladesh	6	0.17	0.02	0.15	0.22
Brazil	2	0.07	0.08	0.02	0.13
Bulgaria	5	0.07	0.06	0.00	0.14
Canada	500	0.82	0.29	0.02	1
China	16	0.31	0.43	0.00	1
Colombia	46	0.66	0.37	0.00	1
Congo, Rep.	1	0.00	.	0.00	0.00
Côte d'Ivoire	2	0.06	0	0.06	0.06
Croatia	5	0.85	0.01	0.85	0.86
Czech Republic	2	0.53	0.03	0.51	0.55
Denmark	1	0.00	.	0.00	0.00
Ecuador	2	0.06	0.05	0.03	0.09
Egypt, Arab Rep.	32	0.16	0.21	0.00	0.76
Equatorial Guinea	3	0.11	0.01	0.09	0.11
France	15	0.30	0.04	0.25	0.38
Gabon	11	0.63	0.43	0.01	1
Germany	2	0.04	0.01	0.03	0.04
India	38	0.88	0.19	0.54	1
Indonesia	52	0.63	0.40	0.02	1
Iraq	1	0.06	.	0.06	0.06
Ireland	13	0.16	0.02	0.13	0.17
Israel	8	0.74	0.36	0.27	1
Italy	7	0.16	0.18	0.02	0.39

Relative Fossil Fuel Reserves by Country - II

	Obs.	Mean	Std. Dev.	Min.	Max.
Kazakhstan	5	0.42	0.53	0.03	1
Libya	4	0.01	0.01	0.00	0.02
Malaysia	12	0.14	0.17	0.02	0.55
Mauritania	7	0.00	0.00	0.00	0.00
Mexico	20	1	0	1	1
Mongolia	5	1	0	1	1
Morocco	2	0.30	0	0.30	0.30
Myanmar	3	0.06	0	0.06	0.06
Netherlands	18	0.10	0.15	0.01	0.70
New Zealand	13	0.07	0.06	0.05	0.26
Nigeria	5	0.79	0.19	0.62	1
Norway	43	0.43	0.41	0.00	1
Oman	1	1	.	1	1
Pakistan	7	0.10	0.01	0.09	0.12
Papua New Guinea	7	0.65	0.45	0.00	1
Peru	9	0.37	0.47	0.01	1
Poland	4	0.70	0.26	0.45	0.94
Romania	3	0.97	0.00	0.96	0.97
Russian Federation	41	0.97	0.10	0.64	1
South Africa	2	0.00	0.01	0.00	0.01
Sudan	4	0.07	0.06	0.04	0.16
Syrian Arab Republic	9	0.12	0.03	0.03	0.14
Thailand	6	0.63	0.21	0.44	1
Trinidad and Tobago	9	0.30	0.26	0.03	0.96
Tunisia	7	0.20	0.15	0.00	0.37
Turkey	3	0.35	0.56	0.03	1.00
United Kingdom	65	0.39	0.37	0.00	1
United States	793	0.88	0.26	0.00	1
Venezuela, RB	4	0.76	0.48	0.04	1
Vietnam	16	0.08	0.06	0.00	0.14
Yemen, Rep.	2	0.62	0.53	0.24	1

Climate Policy Exposure and the Cost of Credit: Baseline Results CCPI

	(1)	(2)	(3)	(4)
(in basis points)	Cost of Credit	Cost of Credit	Cost of Credit	Cost of Credit
FossilFuel*Climate Policy Exposure (CCPI)	0.053 (0.206)	0.125 (0.337)	0.304 (0.784)	0.277 (0.679)
Loan Controls	Yes	.	Yes	Yes
Firm Controls	.	Yes	Yes	Yes
Macro Controls	.	Yes	Yes	Yes
Observations	45,106	9,739	9,650	9,645
Adjusted R-Squared	0.571	0.558	0.569	0.569
Bank*Year Effects	Yes	Yes	Yes	Yes
Loan Type Effects	Yes	Yes	Yes	Yes
Loan Purpose Effects	Yes	Yes	Yes	Yes
Bank's Country Effects	.	.	.	Yes
Time Effects	.	.	.	Yes
Firm's Country Effects	.	.	.	Yes
Clustered Standard Errors by Bank, Year, Firm	Yes	Yes	Yes	Yes

t statistics in parentheses; * p<0.10, ** p<0.05, *** p<0.01; for readability, control variables are left out.

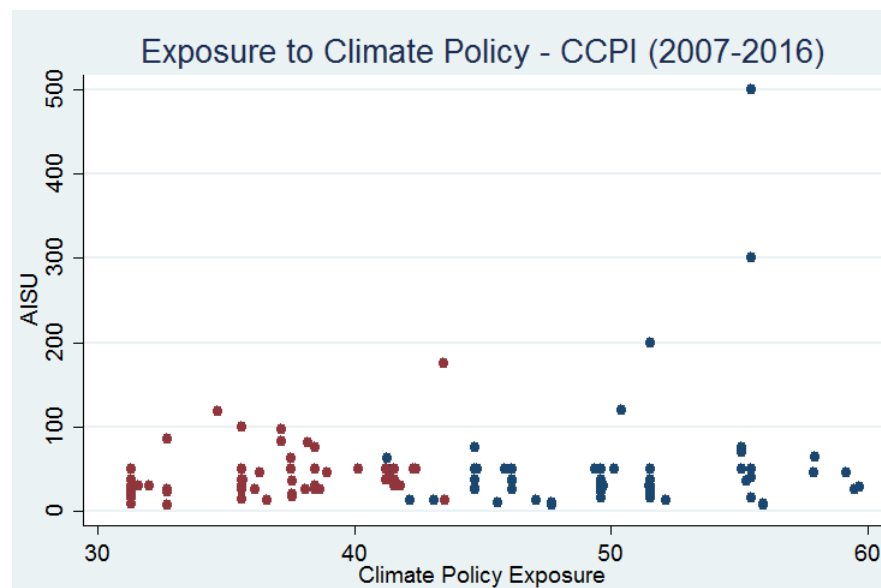
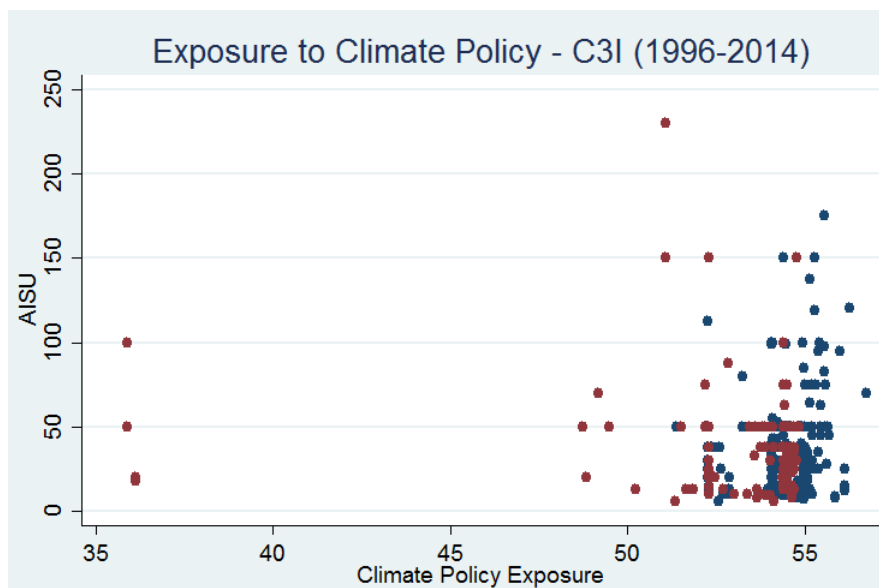
Climate Policy Exposure in Recent Years: Results C3I

(in basis points)	(1)	(2)	(3)	(4)	(5)	(6)
	Cost of Credit	Cost of Credit	Cost of Credit	Cost of Credit	Cost of Credit	Cost of Credit
FossilFuel*Post2011	13.337 (0.575)	13.987 (0.598)				
FossilFuel*Post 2011 *Climate Policy Exposure (C3I)	0.387 (0.950)	0.355 (0.873)				
FossilFuel*Post2012			24.602 (0.859)	24.765 (0.833)		
FossilFuel*Post 2012 *Climate Policy Exposure (C3I)			0.343 (0.688)	0.306 (0.603)		
FossilFuel*Post2013					14.109 (0.704)	18.961 (0.870)
FossilFuel*Post 2013 *Climate Policy Exposure (C3I)					0.719 (1.452)	0.621 (1.217)
Observations	8,259	8,252	8,259	8,252	8,259	8,252
Adjusted R-Squared	0.572	0.571	0.572	0.572	0.572	0.572
Year, Firm's Country & Bank's Country Effects	.	Yes	.	Yes	.	Yes
Clustered Standard Errors by Bank, Year, Firm	Yes	Yes	Yes	Yes	Yes	Yes

t statistics in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$;

all specifications include loan, firm, and macro controls, loan & supply-side FE; for readability, control variables are left out.

Climate Policy Exposure and Credit Fees



● Above yearly mean exposure ● Below yearly mean exposure

Climate Policy Exposure and Credit Fees: Results CCPI

	(1)	(2)	(3)	(4)
(in basis points)	AISU	AISU	AISU	AISU
FossilFuel*Climate Policy Exposure (CCPI)	0.063 (1.167)	0.046 (0.729)	0.076 (1.239)	0.061 (1.033)
Loan Controls	Yes	.	Yes	Yes
Firm Controls	.	Yes	Yes	Yes
Macro Controls	.	Yes	Yes	Yes
Observations	14,650	5,610	5,587	5,582
Adjusted R-Squared	0.441	0.477	0.485	0.485
Bank*Year Effects	Yes	Yes	Yes	Yes
Loan Type Effects	Yes	Yes	Yes	Yes
Loan Purpose Effects	Yes	Yes	Yes	Yes
Bank's Country Effects	.	.	.	Yes
Time Effects	.	.	.	Yes
Firm's Country Effects	.	.	.	Yes
Clustered Standard Errors by Bank & Firm	Yes	Yes	Yes	Yes

t statistics in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; for readability, control variables are left out.

Identification

$$\text{Cost of credit}_{lbft} = a + a_1 \text{FossilFuel}_{ft} + a_2 \text{Climate policy exposure}_{ft} + a_3 \text{FossilFuel}_{ft} \times \text{Climate policy exposure}_{ft} + a_4 L_{lt} + a_5 F_{ft} + a_5 M_{ft} + u_{lbft}$$

- **FossilFuel**: dummy=1 for fossil fuel firms,
- **L** loan controls: amount, maturity, collateral, number of lenders, performance
- **F** firm controls: firm size, market-to-book ratio, tangibility, leverage
- **M** macro controls: GDP per capita, GDP growth
- fixed effects vector **a**
 - bank*year fixed effects → eliminate supply-side effects

Hypothesis

If the cost of credit is affected by the risk of stranded fossil fuel reserves, then we should observe $a_3 > 0$.

Climate Policy Exposure and the Cost of Credit: Baseline Results C3I

	(1)	(2)	(3)	(4)
(in basis points)	Cost of Credit	Cost of Credit	Cost of Credit	Cost of Credit
FossilFuel*Climate Policy Exposure (C3I)	0.057 (0.253)	0.219 (0.836)	0.351 (1.195)	0.325 (1.027)
Loan Controls	Yes	.	Yes	Yes
Firm Controls	.	Yes	Yes	Yes
Macro Controls	.	Yes	Yes	Yes
Observations	37,249	8,337	8,259	8,252
Adjusted R-Squared	0.565	0.560	0.572	0.571
Bank*Year Effects	Yes	Yes	Yes	Yes
Loan Type Effects	Yes	Yes	Yes	Yes
Loan Purpose Effects	Yes	Yes	Yes	Yes
Bank's Country Effects	.	.	.	Yes
Time Effects	.	.	.	Yes
Firm's Country Effects	.	.	.	Yes
Clustered Standard Errors by Bank & Firm	Yes	Yes	Yes	Yes

t statistics in parentheses; * p<0.10, ** p<0.05, *** p<0.01; for readability, control variables are left out.