

Fuelling fossil fuel: Bond to bank substitution in the transition to a low- carbon economy

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Motivation: Debt financing ⇒ credit allocation ⇒ sustainable development ?

- Role of bank-based vs. market-based financing in promoting sustainable allocation of risk and funding. Literature has focused on banks vs. stock markets.

Diamond & Rajan, AER 2009; Langfield & Pagano, EP 2016; De Haas & Popov, 2019

- Stranded assets risk – Credit risk related to the re-valuation of carbon-intensive assets as a result of the transition to a low-carbon economy –Priced?

Batten et al., 2016; Schotten et al., 2016; Caldecott et al., 2016; European Systemic Risk Board, 2016

- Banks start pricing climate policy exposure only post Paris 2015 Climate Accord.

Delis et al., 2018

⇒ This paper:

Allocation of corporate bond financing and syndicated bank loan towards fossil fuel firms

Syndicated bank loans vs. corporate bonds/equity

- Substitutability of syndicated loans and corporate bonds.

Becker & Ivashina, JME 2014; Kashyap et al., QJE 1994; Faulkender & Petersen, RFS 2006; Crouzet, RES 2018

- Bank sector development does not spur growth in innovative-intensive industries, but it has a significant effect on growth in industries with high external financing dependence.

Brown et al., JFI 2017; De Haas & Popov, 2019

- Bottom-up approach to climate action within the business community. While the impact of shareholder engagement is well supported in the literature, the impact of capital allocation is only partially supported.

Huynh and Xia, JFQA forthcoming; Kölbel et al. 2020

With the increasing risk of assets stranding

- Corporate bonds become more expensive, but the same cannot be said for syndicated bank loans.
- **Fossil fuel firms increasingly substitute bonds for syndicated bank loans when banks price the risk of stranded assets less than the bond market.**



Implications:

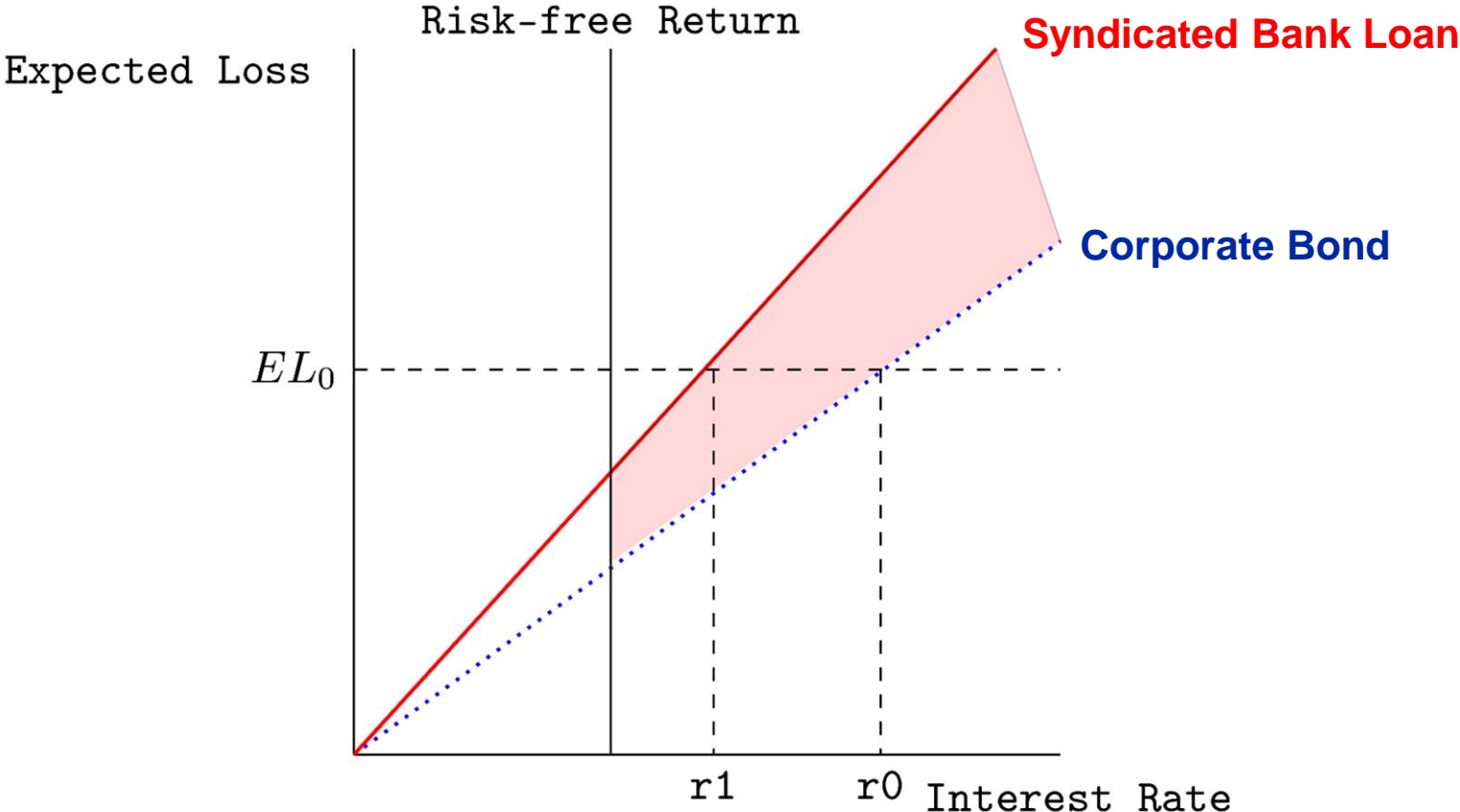
Banks continue to finance fossil fuel projects that the market would not finance as long as they do not price the risk of stranded assets.

This substitution mechanism between bond and bank financing could mitigate the capital constraints on fossil fuel firms imposed by markets.

Bottom-line

With increasing risk of stranded assets ...

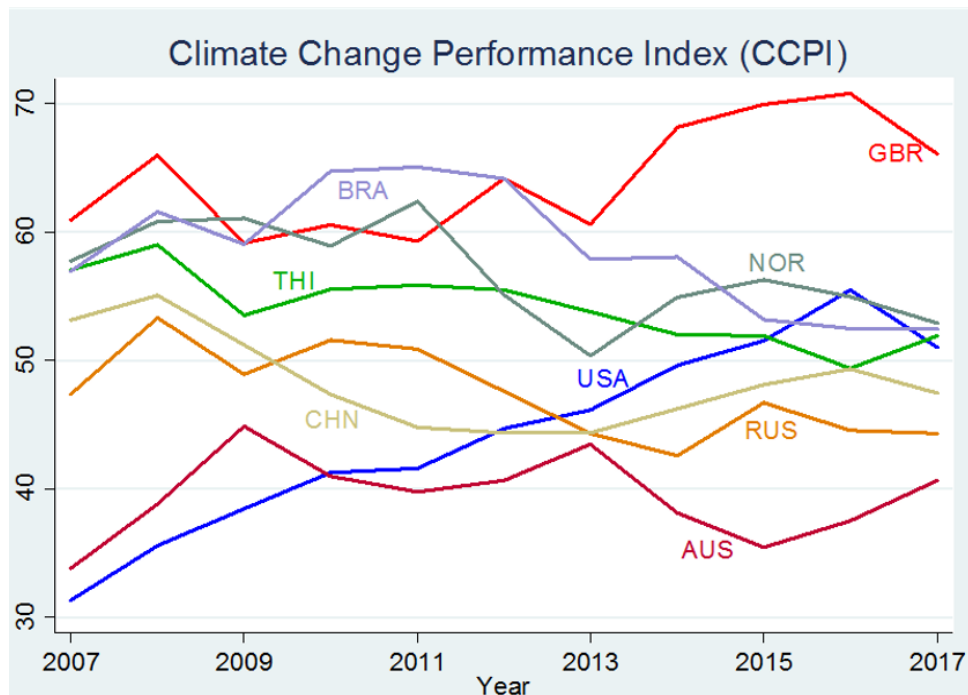
↑ Climate Policy Exposure ⇒ ↑ dExpected Loss



Climate Policy Exposure

- Hand-collected firm-year data on the fossil fuel reserves of firms across countries
- Country-year climate policy index: Climate Change Performance Index (CCPI) by [Burck, Hermwille, & Bals \(2016\)](#)

$$Climate\ Policy\ Exposure\ (CCPI)_{t,i} = \sum_c Relative\ Reserves_{t,i,c} \times CCPI_{t,c}$$



Summary of CCPI Composition

Country coverage	≤58
Time period	2007-2017
Emissions component	Trends, levels
Policy component	Expert assessments
Weighing of emissions relative to policy	80%/20%

Bernauer & Böhmelt (2013)

Climate Policy Exposure pricing in syndicated bank loans and corporate bonds

$$\text{Cost of Debt}_{f,t,i} = a + \beta_1 \text{Fossil Fuel Dummy}_{f,t} + \beta_2 (\text{Fossil Fuel Dummy}_{f,t} \times \text{Climate Policy Exposure}_{f,t}) + \lambda l_{t,i} + \gamma F_{f,t} + \varepsilon_{f,t,i}$$

	Syndicated bank loans	Corporate bonds																								
Source	Dealscan, Compustat	Thomson Reuters, Compustat																								
Coverage	2007-2018	2007-2018																								
Cost of Debt	All In Spread Drawn (AISD)																									
	Corporate bond spread																									
	<table border="1"> <thead> <tr> <th colspan="2">All loans</th> <th colspan="2">Fossil fuel loans</th> </tr> <tr> <th>mean</th> <th>sd</th> <th>mean</th> <th>sd</th> </tr> </thead> <tbody> <tr> <td>229.43</td> <td>159.48</td> <td>243.64</td> <td>156.74</td> </tr> </tbody> </table>	All loans		Fossil fuel loans		mean	sd	mean	sd	229.43	159.48	243.64	156.74	<table border="1"> <thead> <tr> <th colspan="2">All bonds</th> <th colspan="2">Fossil fuel bonds</th> </tr> <tr> <th>mean</th> <th>sd</th> <th>mean</th> <th>sd</th> </tr> </thead> <tbody> <tr> <td>193.20</td> <td>193.54</td> <td>377.13</td> <td>243.30</td> </tr> </tbody> </table>	All bonds		Fossil fuel bonds		mean	sd	mean	sd	193.20	193.54	377.13	243.30
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Debt-level controls	Amount, maturity, collateral #lender, #covenants, performance provisions	Amount, maturity, exchange-listed, secured																								
Firm-level controls	Firm size, leverage, tangibility	Firm size, leverage, tangibility																								
Fixed effects	Year, firm's country*year, loan type, bank*year, loan purpose	Year, firm's country*year, instrument type, bond purpose																								
Clustered SE	Firm's country	Firm's country																								

Climate Policy Exposure pricing in corporate bonds 2007-2014

	All corporate bonds			Exchange-listed bonds
	(1)	(2)	(3)	(4)
Fossil fuel	95.932*** (5.230)	103.215*** (4.706)	65.423** (2.353)	33.143 (0.804)
Fossil fuel*Climate Policy Exposure (CCPI)	0.565 (1.549)	1.335** (2.661)	1.226* (2.062)	2.183*** (2.995)
Amount issued	-18.140*** (-8.810)		45.049*** (18.116)	45.143*** (18.894)
Maturity	-1.511 (-1.021)		1.050 (1.112)	6.915*** (14.329)
Secured	185.792*** (14.308)		179.025*** (8.017)	140.834*** (3.809)
Exchange	-232.803*** (-46.607)		-165.307*** (-21.259)	
Firm Size		-54.569*** (-135.747)	-52.765*** (-30.429)	-51.212*** (-29.640)
Market-to-book		-53.110*** (-97.530)	-45.355*** (-29.938)	-42.413*** (-22.536)
Asset tangibility		-0.435*** (-16.563)	-0.263*** (-13.122)	-0.246*** (-11.348)
Leverage		2.782*** (35.115)	2.056*** (33.858)	2.022*** (23.357)
Crude oil price		-0.065 (-1.193)	-0.090* (-1.794)	-0.008 (-0.160)
Constant	803.694*** (16.099)	810.604*** (63.926)	21.145 (0.562)	-231.246*** (-5.892)
Firm's country*year	Yes	Yes	Yes	Yes
Use of proceeds FE	Yes	Yes	Yes	Yes
Instrument type FE	Yes	Yes	Yes	Yes
Cluster	Firm's country	Firm's country	Firm's country	Firm's country
Observations	3192	2536	2531	2241
R ²	0.506	0.541	0.636	0.487
R ² _{adj.}	0.490	0.525	0.622	0.467

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

1 std. dev. ↑ of Climate Policy Exposure



↑ cost of credit by 9bps (17bps), equivalent to 4.8% (8.6%) change of cost of credit relative to the mean.

No pricing in syndicated bank loans prior to 2015 (Delis et al., 2018).

Further analysis on Climate Policy Exposure pricing

When do bondholders/banks really start to consider the risk of stranded assets?

- **2015 Paris Climate Agreement** offers the opportunity to assess the impact of climate policy on the financial market. (Mukanjari & Sterner, 2018; Monasterolo & de Angelis, 2018; Pham et al, 2019)
 - CCPI-based climate policy exposure: No evidence for increased pricing post 2015.

Further checks:

- Alternative Climate Policy Index: Climate Change Cooperation Index (C3I)
- Development of crude oil price.
- LIBOR Swap rates instead of corporate bond spreads.
- Effect on debt maturity and debt amount.

Banks financing firms with Climate Policy Exposure

Bank incentives to finance fossil fuel:

- Syndicated bank loans involve large sums contracts \Rightarrow to avoid the realization of losses on their balance sheets. (Peek & Rosengren, AER 2003; Keuschnigg & Kogler, 2017)
- Banks expect a compensation mechanism for their stranded assets. (Sen & von Schickfus, 2019)
- Economies of scale with respect to the information collection within fossil fuel sector.

\Rightarrow Hypothesis: The larger the existing fossil fuel exposure of a bank, the more likely is this bank to continue to invest in fossil fuel firms with stranded asset risk to not undermine the profit it makes from its existing fossil fuel spread.

$$\text{Bank Fossil Fuel Exposure}_{b,t} = \frac{\# \text{ outstanding loans to the fossil fuel industry issued in } (t-5)-(t-1)}{\# \text{ total outstanding loans issued in } (t-5)-(t-1)}$$

$$\text{Cost of Loan}_{f,b,t,i} = a + \beta_1 \text{Climate Policy Exposure}_{f,t} + \beta_2 \text{Bank Fossil Fuel Exposure}_{b,t} + \beta_3 (\text{Climate Policy Exposure}_{f,t} \times \text{Bank Fossil Fuel Exposure}_{b,t}) + \lambda l_{t,i} + \gamma F_{f,t} + \delta B_{b,t} + \varepsilon_{f,b,t,i}$$

Syndicated bank loan spreads, Climate Policy Exposure, and Bank Fossil Fuel Exposure 2007-2018

	(1)	(2)	(3)	(4)
Bank fossil fuel exposure	3.268*	2.751	0.020	-0.966
	(1.865)	(1.293)	(0.016)	(-0.772)
Firm climate policy exposure (CCPI)	2.657***	2.766**	3.514***	3.525***
	(3.015)	(2.580)	(3.184)	(3.343)
Bank fossil fuel exposure × Firm climate policy exposure (CCPI)	-0.159***	-0.152***	-0.179**	-0.137*
	(-4.120)	(-3.366)	(-2.420)	(-1.865)
Firm-level controls	No	Yes	No	Yes
Bank-level controls	No	No	Yes	Yes
Loan-level controls	Yes	Yes	Yes	Yes
Bank	Yes	Yes	Yes	Yes
Firm	Yes	Yes	Yes	Yes
Bank's country*Year FE	Yes	Yes	Yes	Yes
Firm's country*year FE	Yes	Yes	Yes	Yes
Loan type FE	Yes	Yes	Yes	Yes
Loan purpose FE	Yes	Yes	Yes	Yes
Cluster	Bank&Firm	Bank&Firm	Bank&Firm	Bank&Firm
Observations	11952	9093	8388	6462
R ²	0.744	0.764	0.749	0.766
R ² _{adj.}	0.668	0.684	0.671	0.684

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

⇒ Heterogeneity in the pricing of climate policy exposure that can be attributed in parts to banks with high existing investments in fossil fuel.

Bond to bank substitution along Climate Policy Exposure

$$\text{Bond-over-Total Debt}_{f,t} = a + \beta_1 \text{Fossil fuel dummy}_{f,t} + \beta_2 (\text{Fossil fuel dummy}_{f,t} \times \text{Climate Policy Exposure}_{f,t}) + \gamma X_{f,t} + \lambda Z_t + e_{f,t,i}$$

- Bond-over-Total Debt: Ratio of the total amount raised through bonds in a given firm-year to the total amount of funds borrowed in a year.
- Sample limited to firms who get debt financing in every observation
⇒ Disentangles credit supply from demand
- X: Include firm- and debt-level controls for risk characteristics
- Fixed effects at firm level: Observations of the dependent variable for absolute non-switchers and firms that only appear once have no predictive power.
- Control for the cyclicity of bank credit:
 - Firm Country*year FE
 - Z: Bank non-performing loans, Bank stock index

Bond to bank substitution along Climate Policy Exposure

	Bond-over-total debt				Binary bond-over-total debt
	(1)	(2)	(3)	(4)	(5)
Fossil fuel	0.078*** (3.060)	0.112 (0.842)	0.134 (1.057)	-0.020 (-0.171)	-0.006 (-0.043)
Fossil fuel*Climate Policy Exposure (CCPI)	-0.003*** (-4.522)	-0.008*** (-5.470)	-0.007*** (-5.600)	-0.007*** (-5.839)	-0.008*** (-5.342)
Average maturity	0.013*** (3.896)		0.014 (1.608)	0.013*** (3.463)	0.017*** (3.920)
Average amount issued	0.081*** (21.900)		-0.030*** (-4.190)	0.083*** (17.601)	0.072*** (13.307)
Firm size	-0.015*** (-2.969)	0.060*** (4.096)	0.057*** (3.951)	0.019 (1.469)	0.030* (1.919)
Market-to-book	0.007 (1.087)	0.026*** (2.706)	0.022** (2.270)	0.009 (1.094)	0.001 (0.090)
Asset tangibility	0.001*** (4.573)	0.000** (2.027)	0.000* (1.758)	0.001** (2.427)	0.001** (2.414)
Leverage	0.002*** (5.269)	-0.000 (-0.128)	-0.000 (-0.112)	0.001 (1.258)	0.001* (1.740)
Non-performing loans			0.008** (2.058)		
Constant	-1.159*** (-22.016)	-0.209 (-1.477)	0.319* (1.754)	-1.507*** (-9.971)	-1.438*** (-8.019)
Firm's Country* Year FE	Yes	Yes	No	Yes	Yes
Firm's Country FE	No	No	Yes	No	No
Year FE	No	No	Yes	No	No
Firm FE	No	Yes	Yes	Yes	Yes
Cluster	Firm	Firm	Firm	Firm	Firm
Observations	13869	9092	8747	13453	10314
R ²	0.274	0.493	0.504	0.553	0.613
R ² _{adj.}	0.251	0.328	0.363	0.427	0.468

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

1 std. dev. ↑ of climate policy exposure ➡ ↓ amount of finance raised from bonds relatively to the total combined amount of debt raised from banks and the bond market by approx. 5.25% - 7.5%.

Conclusion

- Market discipline, on its own, seems to be more effective in driving bondholders, rather than banks, to price the negative externalities associated with the risk of stranded assets.
- Non-pricing of climate policy exposure in bank loans can be attributed at least in parts to banks with high existing investments in fossil fuel.
- Recognize debt heterogeneity when looking at how to reduce the financing of carbon-intensive activities.

So that carbon cannot continue to lurk in the shadow ...

APPENDIX

Summary statistics

Bond-over-total debt ratio 2007-2018:

	Whole sample		Fossil fuel sector		Difference	
	mean	sd	mean	sd	b	t
Bond-over-total debt ratio	0.42	0.46	0.40	0.43	0.02	(1.62)
Binary bond-over-total debt ratio	0.38	0.49	0.38	0.48	0.01	(0.60)
Average maturity	6.52	10.44	5.87	3.17	0.70***	(5.77)
Average amount issued	19.36	2.43	20.37	1.42	-1.09***	(-25.60)
Observations	18,245		1,397		18,245	
					Observations:	
Climate policy exposure (CCPI)			43.30	7.67	612	
Climate policy exposure (HHI trend)			-0.67	0.93	636	

Summary statistics

Corporate bonds 2007-2018:

	Whole sample		Fossil fuel sector		Difference	
	mean	sd	mean	sd	b	t
Bond spread	193.20	193.54	377.13	243.30	-198.32***	(-21.57)
Amount issued	19.82	0.88	20.10	0.65	-0.30***	(-11.69)
Maturity	11.25	25.59	10.19	7.18	1.14**	(3.00)
Secured	0.10	0.30	0.06	0.24	0.04***	(4.11)
Exchange-listed	0.66	0.47	0.71	0.46	-0.05**	(-2.80)
Firm Size	10.85	2.51	9.17	1.74	1.81***	(25.65)
Market-to-book	1.61	0.94	1.47	0.78	0.14***	(4.45)
Asset tangibility	83.68	59.33	140.22	50.64	-60.86***	(-29.40)
Leverage	33.59	16.13	29.53	17.74	4.38***	(6.35)
Observations	10,072		731		10,072	

Bank fossil fuel exposure 2007-2018:

		N	sd	mean	p25	p50	p75
2007-2018	Bank Fossil fuel Legacy Share	23'035	5.688	4.282	3.629	4.785	6.770
	↳ Lending to fossil fuel firms Firms	1648	8.053	6.068	4.596	6.667	10.078