Carbon pricing and credit reallocation

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Banks have been subject to concurrent policy shocks over the past years

1. Increasingly stringent climate policies affect banks, including through their credit exposures to firms

2. Introduction of negative interest rates by the ECB caused some banks to adjust their lending and risk-taking behavior

3. How do these shocks interact? Evidence crucial to
   - ▷ understand the role of monetary policy in the transition to a low-carbon economy
   - ▷ quantify the climate-related risks associated with bank lending

This paper

What is the role of climate policy for the transmission of monetary policy to bank credit supply?

1. Construct new dataset generating a unique coverage of lending activities, loan characteristics and emissions
2. Estimate effect of bank's interest rate shock exposure on
   - ▷ credit volumes
   - ▷ collateral shares
   - ▷ default probabilities

   differentially across ETS and non-ETS firms

Findings in a nutshell

Following an exogenous bank-level liquidity shock, banks

- increase lending to ETS firms
- decrease the default probabilities and collateral shares associated with the same loans

$\rightarrow$ Higher credit to ETS-firms provided by banks that are more affected by the NIRP also appears to be safer

$\rightarrow$ ETS firms may be more profitable than non-ETS firms, due to their investment in innovation technology

EU ETS

- Launched in 2005, covers 30 countries across Europe (EU27 plus Iceland, Liechtenstein & Norway)
- For each tonne of carbon emitted, firms must submit one permit, either from their own stock or purchased at auctions
- Important reforms were implemented for phase 3 (= our focus), increasing policy stringency:
  - Unionwide cap for stationary installations started to decrease on a yearly basis
  - MSR postponed the auctioning of a total of 900 million allowances in the early years of phase 3
  - New system of permit allocation based on product-specific benchmarks

Negative Interest Rate Policy (NIRP)

- ECB cut interest rate on overnight deposits held by Eurosystem banks to negative territory on June 5th 2014
- Aimed at expanding bank lending, to avoid negative interest rates on excess holdings of reserves
- NIRP affected banks with higher deposit-to-assets ratios more strongly (Heider et al., 2019):
  - Retail (= individual) investors can withdraw their funds and hold cash with a zero return instead
  - NIRP is more binding for banks with higher deposits-to-assets ratios

$\rightarrow$ exploit NIRP (esp: bank's deposits-to-assets ratio) as an exogenous bank-level liquidity shock

Data

1. Confidential credit registry, contains the universe of large credit relationships between German banks and firms
   - Banks report all loans to individual borrowers exceeding 1.5 million at quarter-end
   - Includes information on the outstanding loan amount, and loan characteristics, such as risk attributes and collateral value
2. Firm and bank balance sheet information from internal data sets: JANIS & BISTA
3. Use reported name in the EU-TL and a string-matching algorithm to identify which firms are ETS participants

- Eight quarters around NIRP introduction (Q1/13 - Q1/15)
- Germany: Wide EU ETS coverage, strong relationships between banks and firms ("Hausbanken")

Descriptive statistics (full sample)

	N	Mean	St.Dev.	33th pct	55th pct	66th pct
Panel A: Bank-firm-quarter						
Credit (thsd €)	411,431	3,996	16,791	895	1,661	2,522
ln(Credit)	411,431	7.01	1.92	6.8	7.42	7.83
RWA	396,052	2294.18	5327.82	400	1009	1811
PD	157,607	0.06	0.21	0	0	0.01
Collateral / Credit	408,923	0.37	0.44	0	0.14	0.53
Panel B: Firm						
Number of banks	32,142	1.54	3.2	1	1	1
Total Assets (MM €)	10,649	86.79	618.73	7.65	14.09	26.42
Profit / Sales	10,570	0.64	4.99	0.41	0.5	0.59
Sales / Assets	10,649	1.81	2.17	1.15	1.56	1.99
Age	10,628	33.62	36.15	15	22	32
Equity / Assets	10,649	0.31	0.22	0.18	0.29	0.39
Panel C: Bank						
Deposits / Assets	1,405	0.68	0.15	0.68	0.72	0.74

Empirical Strategy: Ideal experiment

Target estimate: Role of climate policy – namely, the EU ETS – in the transmission of monetary policy to bank credit supply:

$$ln(credit_{bft}) = \alpha + \beta_1 Post_t + \beta_2 ETS_f + \beta_3 Post_t \times ETS_f + \epsilon_{bft}$$

Identification challenges:

1. Monetary policy changes affect bank liquidity and firm loan demand simultaneously $\rightarrow$ triple differences
2. By policy design, ETS-firms differ along several important dimensions from non-ETS firms $\rightarrow$ matching

Empirical Strategy: Triple differences

1. **Static/average effect**

$$ln(credit_{bft}) = \beta Post_t \times ETS_f \times D/A_b + \alpha_{bt} + \alpha_{ft} + \alpha_{bf} + \epsilon_{fbt}$$

2. **Event study design**

$$ln(credit_{bft}) = \sum_{j=Q1/2012}^{Q1/2016} \alpha_j \times D_j \times D/A_b \times ETS_f + \alpha_{bt} + \alpha_{ft} + \alpha_{bf} + \epsilon_{bft}$$

Empirical Strategy: Matching

- Plant-level inclusion criterions imply that ETS and non-ETS firms can be comparable (Calel and Dechezlepretre, 2016)
- Use information on firm balance sheet characteristics prior to the introduction of negative policy rates in June 2014
- Choose variables relevant for determining loan eligibility at firm-level, exact match on NACE2 sector

Matching proceeds in 2 steps:

1. Use coarsened exact matching (Iacus, 2012) to discard firms that are poor candidates for matching
2. Each EU ETS firm is then matched to its nearest neighbour, using the GenMatch algorithm (Sekhon, 2022)

ETS and non-ETS firms differ in their balance sheet characteristics

	ETS Mean	Non-ETS Mean	Simple Diff	Two-sided t-test p-value
Credit (thsd €)	6,050	2,420	3,630	0.00
Collateral / Credit	0.43	0.29	0.14	0.00
PD	3.09	6.09	-3.00	0.00
Total Assets (MM €)	543.80	67.09	476.71	0.00
Profit / Sales	0.44	0.65	-0.21	0.39
Sales / Assets	1.46	1.82	-0.36	0.00
Age	49	33	16	0.00
Number of banks	5.71	1.45	4.26	0.00

Post-matching descriptive statistics and equivalence tests

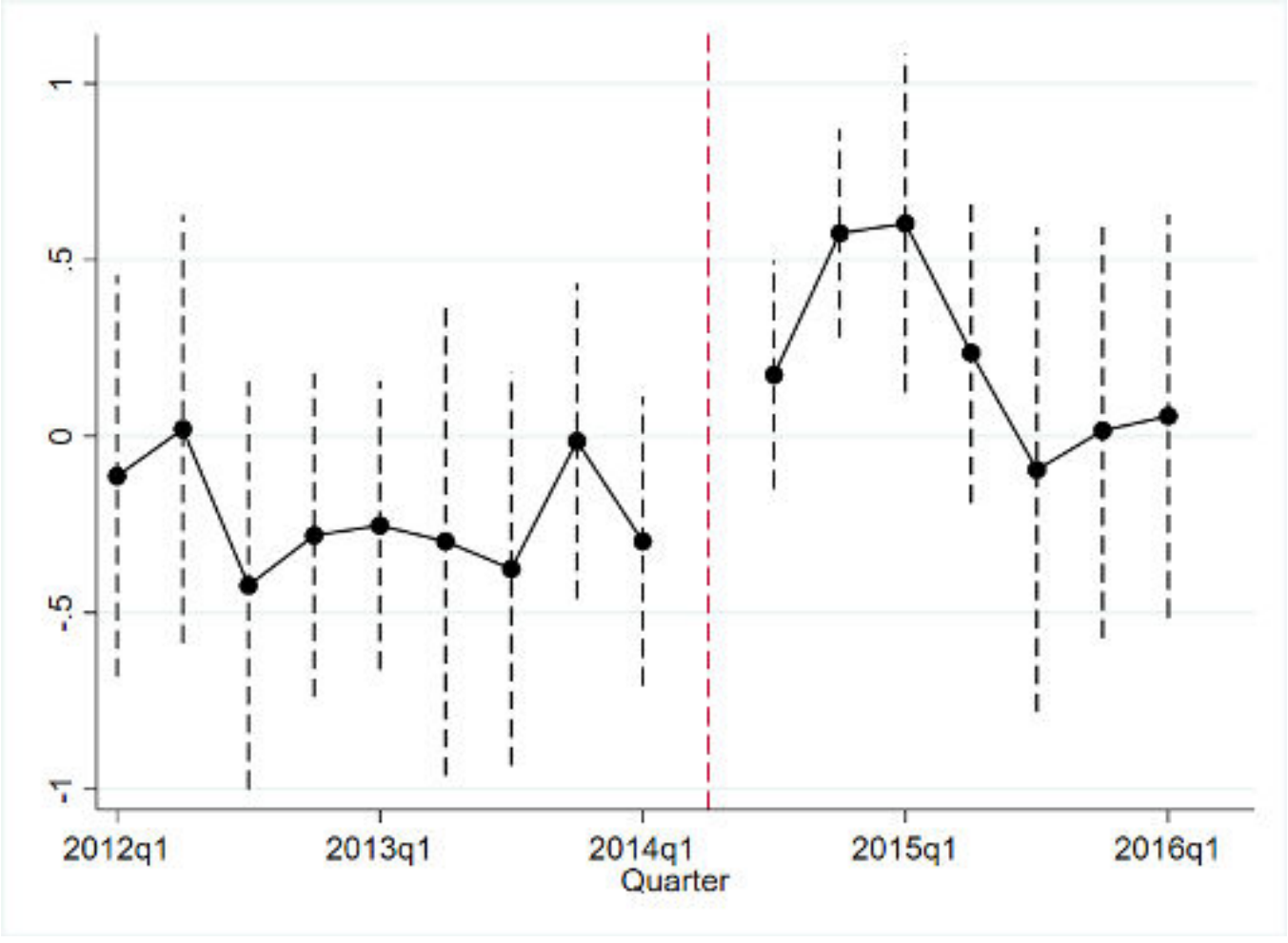
	Non-ETS Mean	ETS Mean	Simple Diff	Two-sided t-test p-value
Credit (thsd €)	5,766	6,364	598	0.37
ln(Credit)	7.15	7.13	-0.02	0.91
PD	5.35	3.17	-2.18	0.07
Total Assets (MM €)	275.57	434.13	158.56	0.01
Sales / Assets	1.42	1.50	0.08	0.35
Profit / Sales	.42	.46	0.03	0.21
Age	50.86	49.55	-1.32	0.72
Number of banks	3.23	3.94	0.71	0.09

Effect of bank's interest rate shock exposure on credit allocated to ETS firms (static)

	(1)	(2)	(3)	(4)
Post	-0.015			
	(0.059)			
Post x ETS	-0.226	-0.226		
	(0.236)	(0.236)		
Post x D/A	-0.100	-0.098	-0.055	
	(0.116)	(0.116)	(0.104)	
ETS x D/A	-0.120*	-0.120*	-0.128**	
	(0.070)	(0.070)	(0.059)	
ETS x D/A x Post	0.260**	0.259**	0.216**	0.420**
	(0.125)	(0.125)	(0.112)	(0.168)
N	27,010	27,010	26,449	22,114
Bank	Yes	Yes	Yes	
Firm	Yes	Yes	Yes	
Quarter		Yes	Yes	
Bank-Firm			Yes	Yes
Bank-Quarter				Yes
Firm-Quarter				Yes

Full sample results

Effect of bank's interest rate shock exposure on credit allocated to ETS firms (event study)



Effect of bank's interest rate shock exposure on collateral shares and default probabilities

	(1)	(2)	(3)	(4)	(5)	(6)
	Collateral share			Probability of default (PD)		
ETS x D/A	-0.074			-0.012		
	(0.058)			(0.020)		
ETS x Post	0.013	0.025*		0.019**	0.015*	
	(0.012)	(0.013)		(0.008)	(0.008)	
Post x D/A	0.049	0.062**		-0.011	-0.007	
	(0.039)	(0.029)		(0.016)	(0.017)	
ETS x D/A x Post	-0.019	-0.051*	-0.073*	-0.054**	-0.042	-0.051*
	(0.027)	(0.027)	(0.038)	(0.025)	(0.026)	(0.027)
N	26,917	26,355	22,024	13,873	13,670	11,051
Bank	Yes	Yes		Yes	Yes	
Firm	Yes	Yes		Yes	Yes	
Time	Yes	Yes		Yes	Yes	
Bank-Firm		Yes	Yes		Yes	Yes
Bank-Date			Yes			Yes
Firm-Date			Yes			Yes

Summary and discussion

- **How do monetary policy shocks interact with climate policy?**
  - Evidence crucial to understand role of monetary policy in the transition to a low/zero-carbon future

- **Banks more strongly affected by the NIRP policy adjust lending differentally across ETS and non-ETS firms**
  - Lending volumes to ETS firms increase
  - Banks decrease the share of collateral and estimated probabilities of default (PDs) for credit exposures to ETS firms

- **Banks may prefer lending to ETS firms since they increase investment and innovation**
  - Findings consistent with Porter hypothesis (= firms benefit from env. regulation by increasing efficency and green innovation)

Next steps

1. **Abatement activity:** Did firms invest in emissions reduction technology?
2. **Innovation activity:** Do ETS firms with larger credit volumes innovate more?
3. **ETS stringency:** Do firms with permit shortages demand more credit?
4. **Model** to predict bank lending activity across ETS and non-ETS firms

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Full sample results

	(1)	(2)	(3)	(4)
Post	-0.074***			
	(0.013)			
ETS x D/A	-1.522***	-1.521***		
	(0.322)	(0.322)		
Post x D/A	-0.013	-0.014	0.026	
	(0.023)	(0.023)	(0.023)	
ETS x Post	-0.046	-0.047	-0.049	
	(0.044)	(0.044)	(0.031)	
ETS x Post x D/A	0.149**	0.152**	0.199***	0.105*
	(0.068)	(0.068)	(0.046)	(0.062)
Bank	Yes	Yes	Yes	
Firm	Yes	Yes	Yes	
Time		Yes	Yes	
Bank-Firm			Yes	Yes
Bank-Date				Yes
Firm-Date				Yes
N	411,431	411,431	405,375	215,998

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