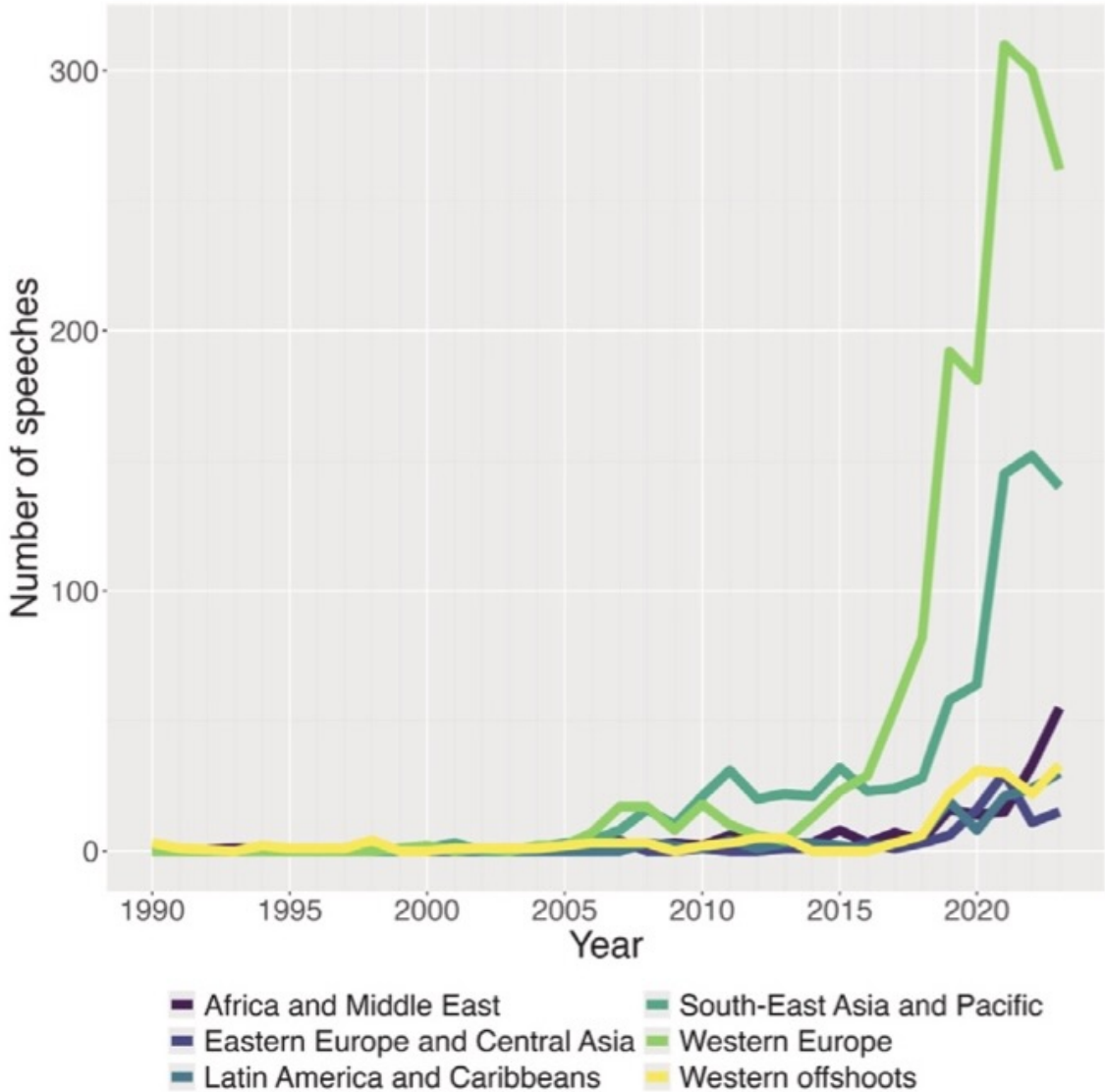
Firms' Carbon Emissions and Monetary Policy

Olena Havrylchyk & Pedram Pourabbasvafa
University of Paris 1 Panthéon-Sorbonne

Climate speeches by central banks



Context and Motivation

- Corporate bond purchases by CBs are skewed toward sectors with high carbon emissions (Matikainen, Campiglio, and Zenghelis, 2017; Papoutsi, Piazzesi, and Schneider 2021).
- Adherence to the principle of market neutrality is likely to perpetuate preexisting market failures and lead to the misallocation of resources (Schnabel, 2021).
- The ECB, the BoE, and Riksbank have pledged to decarbonize their corporate bond purchases / holdings.

Research Question

- **Does monetary policy have a carbon bias ?**
- We define carbon bias in monetary policy transmission as the phenomenon whereby firms with higher carbon emissions intensity exhibit greater sensitivity to monetary policy shocks. This definition is unconditional: we do not control for firm- or industry-level characteristics.
- 1671 firms in the U.S. and 696 firms in the euro area (2005 -2022):
- Two methodologies:
  - Event study to measure an impact on stock prices on the announcement day
  - Jorda's (2005) local projections to measure an impact on investment during the 12 quarter period

Preview of results

- In simple regression, we find evidence of carbon bias in the transmission of MP in the US, but not in the euro area
- Three explanations:
  - Two confounders
    - Industry: Fossil fuel energy firms are much more reactive to monetary policy shocks
    - Carbon-intensive industries have more tangible capital, which strengthens monetary policy transmission
  - Limited evidence of transition risk

Literature

- Heterogeneity in MP's transmission depending on firms' size (Gertler and Gilchrist, 1994), age (Cloyne et al. 2018), Tobin's Q (Ehrmann and Franzscher, 2004), financial constraints (Ozdagli, 2017; Chava and Hsu, 2020; Maio, 2014), bank dependence (Ippolito et al. 2018), leverage (Jeenas, 2019), default risk (Ottonello and Winberry, 2020), asset intangibility (Dottling and Ratnovski, 2022), type and maturity of debt issued (Gürkaynak et al., 2022)
- Use of monetary tools to support the transition to a low-carbon economy (ECB, 2021; Macaire and Naef, 2021; Schoenmaker, 2021; Krogstrup and Oman, 2019; McKibbin et al. 2021; Hansen, 2022).
- Carbon emissions and transmission of monetary policy (Dottling and Lam, 2023; and Bauer et al., 2025).

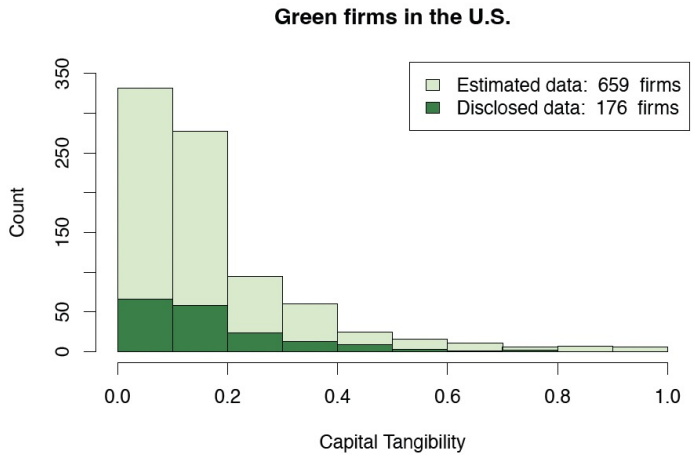
Theoretical foundations

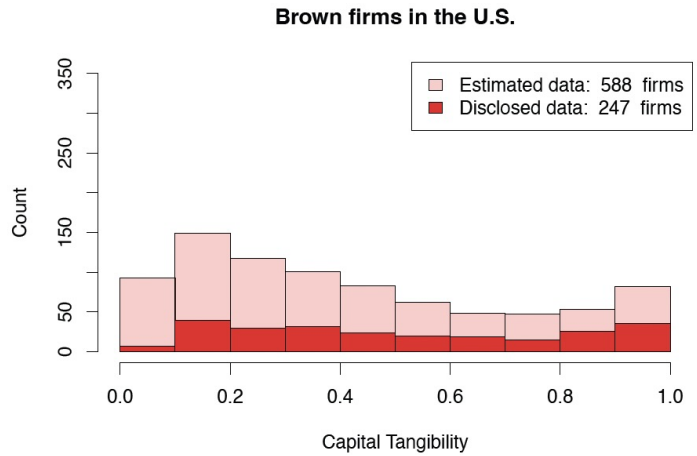
Three possible mechanisms for the carbon bias:

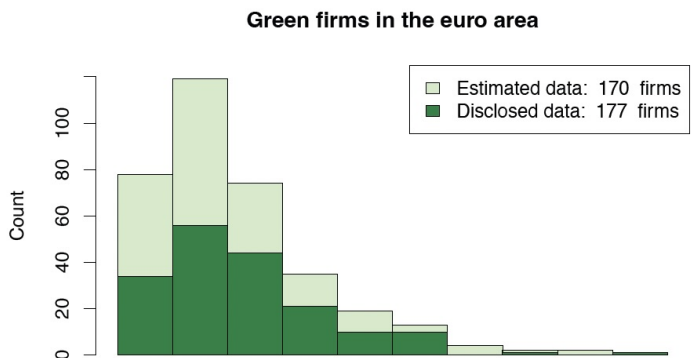
- Brown and green firms belong to different industries (gas, oil, coal = 75% of GHG emissions and 90% of all carbon emissions). We know that different industries react differently to MP shocks (Dedola and Lippi, 2005; Peersman and Smets, 2002).
- Brown firms have more tangible assets, which strengthens MP's impact (Dottling and Ratnovski, 2022).
- Emissions intensity might reflect transition risk, i.e. these firms need more investment for transition (Aswani et al., 2023; Bauer et al., 2025; Bolton and Kacperczyk, 2021; Bolton and Kacperczyk, 2022; Döttling and Lam, 2024)

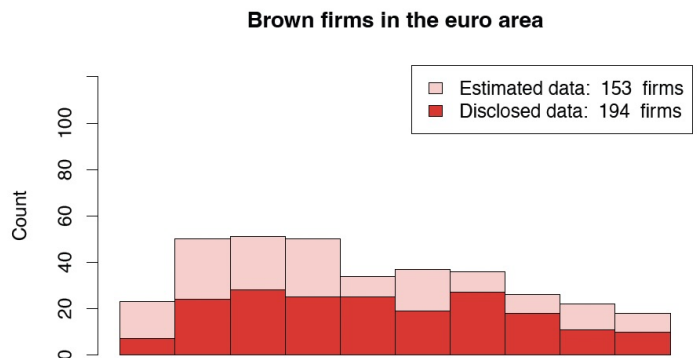
Brown firms have more tangible assets

- Correlation between carbon intensity and capital tangibility is 74% in the U.S. and 64% in the Euro area
- Distribution of tangibility ratio









Model Specification without Controls

To measure carbon bias, we estimate :

$$AR_{i,t} = \beta_1 \cdot (MP_t \times \text{ Carbon}_i) + \alpha_i + \gamma_t + \varepsilon_{i,t}$$

- $AR_{i,t}$: abnormal return of firm i at time t
- MP_t: monetary policy shock (target and path factors)
- Carbon_i: log of Scope 1+2 emissions intensity of firm i
- α_i: firm fixed effects
- γ_t: event fixed effects

Model Specification with Controls

To understand mechanisms (e.g. confounding factors), we include controls:

$$AR_{i,t} = \beta_1 \cdot (MP_t \times \text{Carbon}_i) + \beta_2 \cdot (MP_t \times X'_{i,t}) + \alpha_i + \gamma_t + \psi_{SIC,t} + \varepsilon_{i,t}$$

- $AR_{i,t}$: abnormal return of firm i at time t
- MP_t: monetary policy shock (target and path factors)
- Carbon_i: log of Scope 1+2 emissions intensity of firm i
- $X_{i,t}$: controls (**capital tangibility**, log assets, log age, leverage, Tobin's q, cash holding, cash flow, dividend payment dummy and emission disclosure ratio)
- α_i: firm fixed effects
- γ_t: event fixed effects
- $\psi_{SIC,t}$: **4-digit industry-time fixed effects**

Data & Variable Definitions

- 1671 firms in the U.S. and 696 firms in the Euro area (2005 -2022):
- **Carbon emission intensity** = log((Scope 1 + Scope 2 emissions of GHG) / firm's revenue)
- **Capital tangibility** = tangible capital /(tangible + intangible capital)

  We use Peters and Taylor (2017) methodology to estimate intangible capital in the U.S. and the Euro area.
- **2-factor monetary policy shocks (target and path)**: Gurkaynak et al. (2005) for the U.S. and Altavilla et al. (2019) for the euro area.

Monetary policy shocks for robustness tests

Panel A: Fed Monetary Policy Shocks

	N	Mean	Median	SD	1st Q	3rd Q	Min	Max	MP-GSS-Path	MP-BRW	MP-JK
MP-GSS-Target	142	0.0001	0.0022	0.0306	-0.0025	0.0068	-0.1887	0.1222	0.06	0.25	0.66
MP-GSS-Path	142	0.0010	0.0024	0.0488	-0.0180	0.0200	-0.1465	0.1877		0.42	0.78
MP-BRW	142	-0.0038	-0.0055	0.0555	-0.0327	0.0275	-0.2087	0.2091			0.47
MP-JK	142	-0.0048	0.0000	0.0528	-0.0179	0.0137	-0.2463	0.1049			

Panel B: European Central Bank Monetary Policy Shocks

	N	Mean	Median	SD	1st Q	3rd Q	Min	Max	MP-FG	MP-JK	MP-K
MP-Target	183	-0.1293	-0.2966	2.2324	-0.5414	0.1175	-13.747	11.323	0.05	0.60	0.15
MP-FG	181	-0.0300	-0.1150	3.7266	-1.3282	1.0721	-25.726	14.366		0.43	0.75
MP-JK	184	0.0012	-0.0005	0.0416	-0.0088	0.0102	-0.1614	0.2002			0.73
MP-K	184	0.0005	-0.0033	0.0416	-0.0202	0.0141	-0.2580	0.2611			

- GSS Target/Path: Gurkaynak et al. (2005)
- BRW: Bu, Rogers, and Wu (2021)
- JK: Jaroci´nski and Karadi (2018)
- Target/FG: Altavilla et al. (2019)
- K: Kerssenfischer (2022)

Stock return reactions to monetary policy shocks

Panel A: The US

	(1) Base	(2) + Tangibility	(3) + Size	(4) + Age	(5) + Leverage	(6) + Tobin's q	(7) All	(8) + Industry	(9) All + Industry
MP-Target × Log Scope 1+2 Intensity	-1.980**	-1.141**	-1.969**	-2.038**	-2.012**	-1.701**	-0.993**	-0.817	-0.367
	(0.976)	(0.473)	(0.977)	(0.980)	(0.948)	(0.844)	(0.450)	(0.540)	(0.427)
MP-Path × Log Scope 1+2 Intensity	-1.012***	-0.768***	-1.032***	-0.947***	-1.009***	-0.777***	-0.586**	0.214	0.295
	(0.347)	(0.236)	(0.357)	(0.319)	(0.344)	(0.262)	(0.247)	(0.353)	(0.369)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Event FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Industry × Event FE	No	No	No	No	No	No	No	Yes	Yes
Obs.	90,874	90,874	90,874	90,874	90,874	90,874	86,574	90,874	86,574
R^2	0.065	0.067	0.065	0.065	0.066	0.066	0.075	0.079	0.087

Panel B: Eurozone

	(1) Base	(2) + Tangibility	(3) + Size	(4) + Age	(5) + Leverage	(6) + Tobin's q	(7) All	(8) + Industry	(9) All + Industry
MP-Target × Log Scope 1+2 Intensity	-0.001	-0.001	-0.001	-0.0004	0.00002	0.004	0.003	0.005	0.003
	(0.005)	(0.006)	(0.005)	(0.005)	(0.006)	(0.006)	(0.008)	(0.009)	(0.009)
MP-Path × Log Scope 1+2 Intensity	0.009**	0.007*	0.009**	0.009**	0.009**	0.005	0.003	0.003	0.003
	(0.004)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)	(0.002)	(0.002)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Event FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Industry × Event FE	No	No	No	No	No	No	No	Yes	Yes
Obs.	41,235	41,235	41,235	41,235	41,235	41,235	39,120	41,235	39,120
R^2	0.045	0.047	0.046	0.046	0.046	0.047	0.051	0.054	0.058

Economic significance of results: column 1 for the US

- One SD increase in emissions intensity is associated with a 3.6 (4.1) bp larger reaction to the average target (path) factor shock
- To compare, the market reaction to average MP shocks is 9.6 bp and 12.9 bp for the target and path factor
- Thus, the carbon bias is equivalent to 37% and 31% of the stock market reaction to the average target factor and path factor shocks

Robustness test

The results for the US are very robust, while results for eurozone are insignificant in robustness tests.

- Scope 1 vs Scope 2
- Data quality: full sample or only disclosed data
- Monetary policy: Jarociński and Karadi (2020) and Bu et al. (2021) for the U.S. and Jarociński and Karadi (2020) and Kerssenfischer (2022) for the euro area.

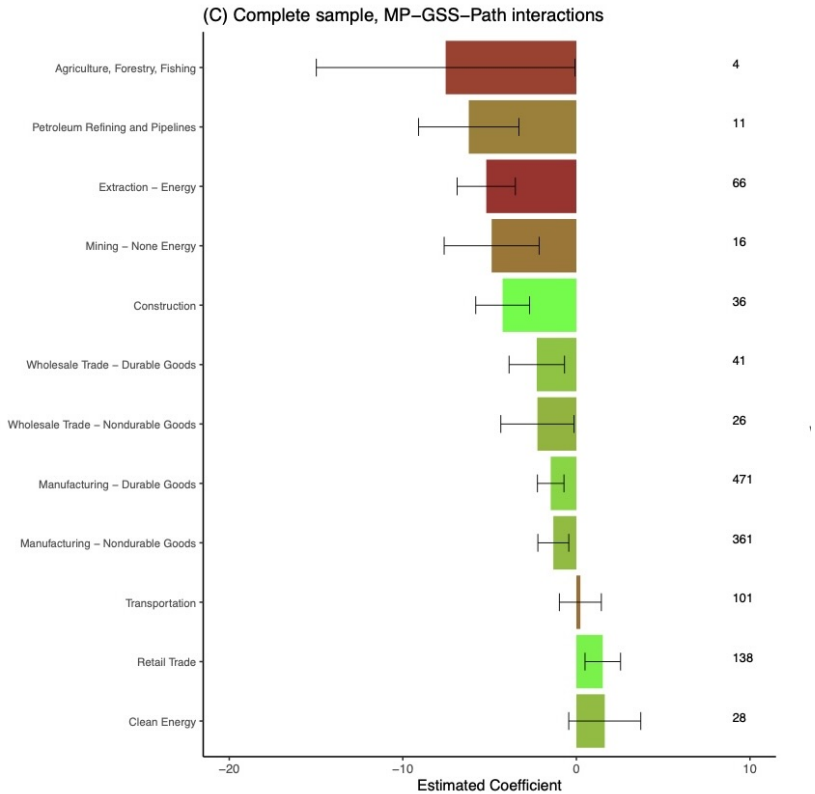
Mechanisms

- **Capital tangibility acts as a confounding factor, particularly in the U.S.**
  - We find evidence of credit channel as this finding holds only for more credit-constrained firms (in line with Dottling and Ratnovski, 2022).
  - We do not find evidence of this channel for the euro zone.
- **Industry*time fixed effects act as confounding factors in the U.S., but not in euro area**
  - Which industries?
- If regression includes all controls, we do not find any carbon bias. Hence, no evidence of **transition risk**.
  - If we split the sample below and above the median carbon emissions, there is limited evidence of transition risk for the largest firms.

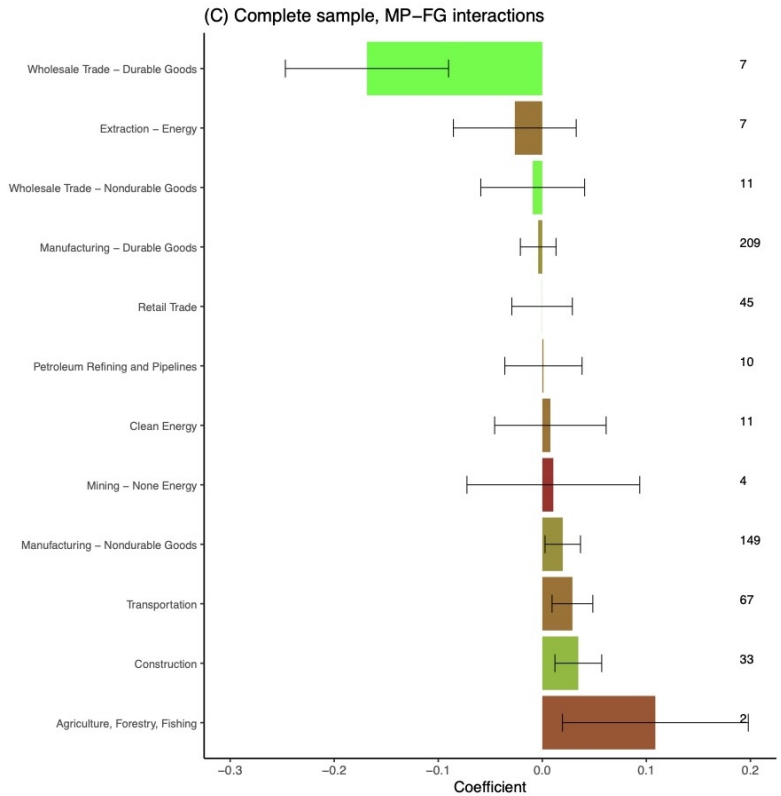
Credit channel for tangibility

	Dependent variable:					
	Stock returns on FOMC meeting day					
Panel A: Split by age						
	Below median			Above median		
	(1)	(2)	(3)	(4)	(5)	(6)
Log scope 1+2 intensity	0.010		0.008	0.057		0.055
	(0.054)		(0.055)	(0.041)		(0.043)
MP-Target : Log scope 1+2 intensity	−3.455**		−2.791*	−0.248		0.537
	(1.559)		(1.633)	(1.042)		(0.754)
MP-Path : Log scope 1+2 intensity	0.131		0.204	−0.092		0.150
	(0.564)		(0.662)	(0.300)		(0.285)
MP-Target : Capital tangibility		−15.638**	−12.509*		−14.786	−15.320
		(6.397)	(6.868)		(11.555)	(11.291)
MP-Path : Capital tangibility		−0.997	−1.294		−4.615**	−4.856***
		(2.665)	(3.195)		(1.928)	(1.781)
Industry.Event FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Observations	31,989	31,989	31,989	32,795	32,795	32,795
Adjusted R^2	0.357	0.357	0.357	0.456	0.456	0.456
Panel B: Split by age and size						
	Below median			Above median		
	(1)	(2)	(3)	(4)	(5)	(6)
Log scope 1+2 intensity	−0.087		−0.094	0.066*		0.066*
	(0.116)		(0.118)	(0.037)		(0.036)
MP-Target : Log scope 1+2 intensity	−5.320*		−4.192	−0.899		−0.347
	(3.075)		(2.948)	(0.728)		(0.600)
MP-Path : Log scope 1+2 intensity	−0.044		0.108	−0.086		0.015
	(1.100)		(1.298)	(0.274)		(0.269)
MP-Target : Capital tangibility		−28.558**	−26.079**		−10.568	−9.992
		(11.466)	(11.267)		(9.361)	(9.422)
MP-Path : Capital tangibility		−3.638	−3.658		−1.725	−1.821
		(5.351)	(5.946)		(1.429)	(1.395)
Industry.Event FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Observations	20,143	20,143	20,143	44,641	44,641	44,641
Adjusted R^2	0.301	0.301	0.301	0.468	0.468	0.468

Industries' reaction to monetary shocks (Path) and emissions intensity: complete sample



The U.S.

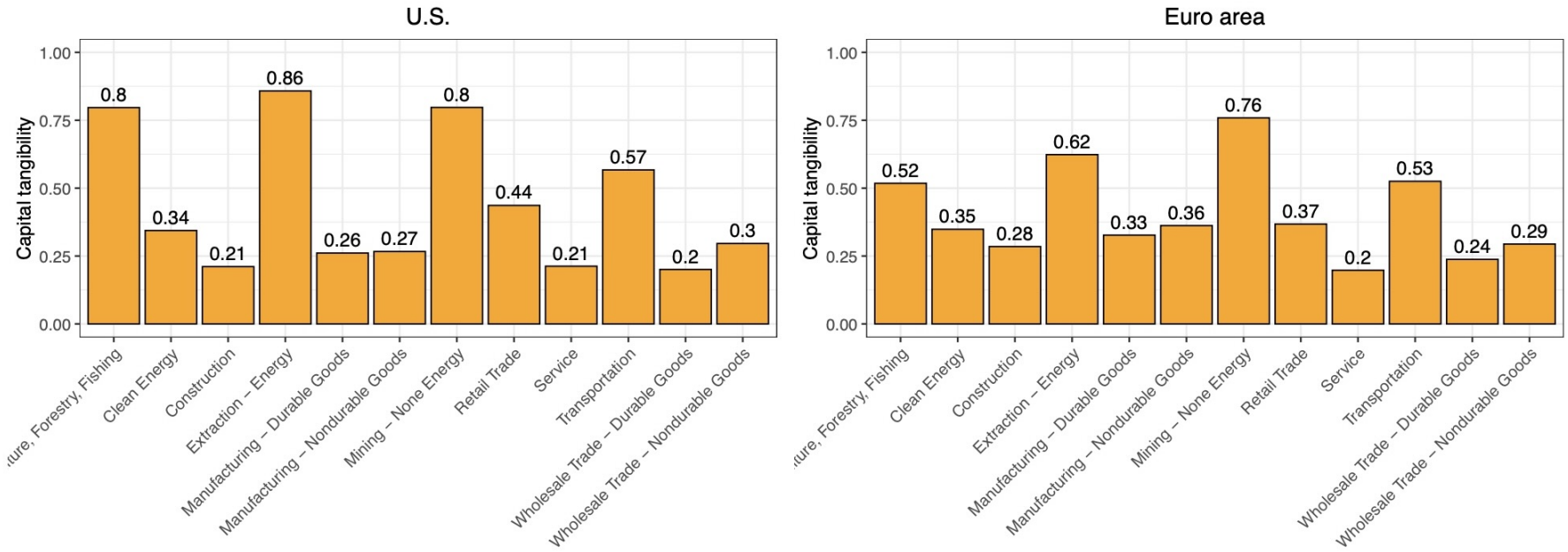


Euro area

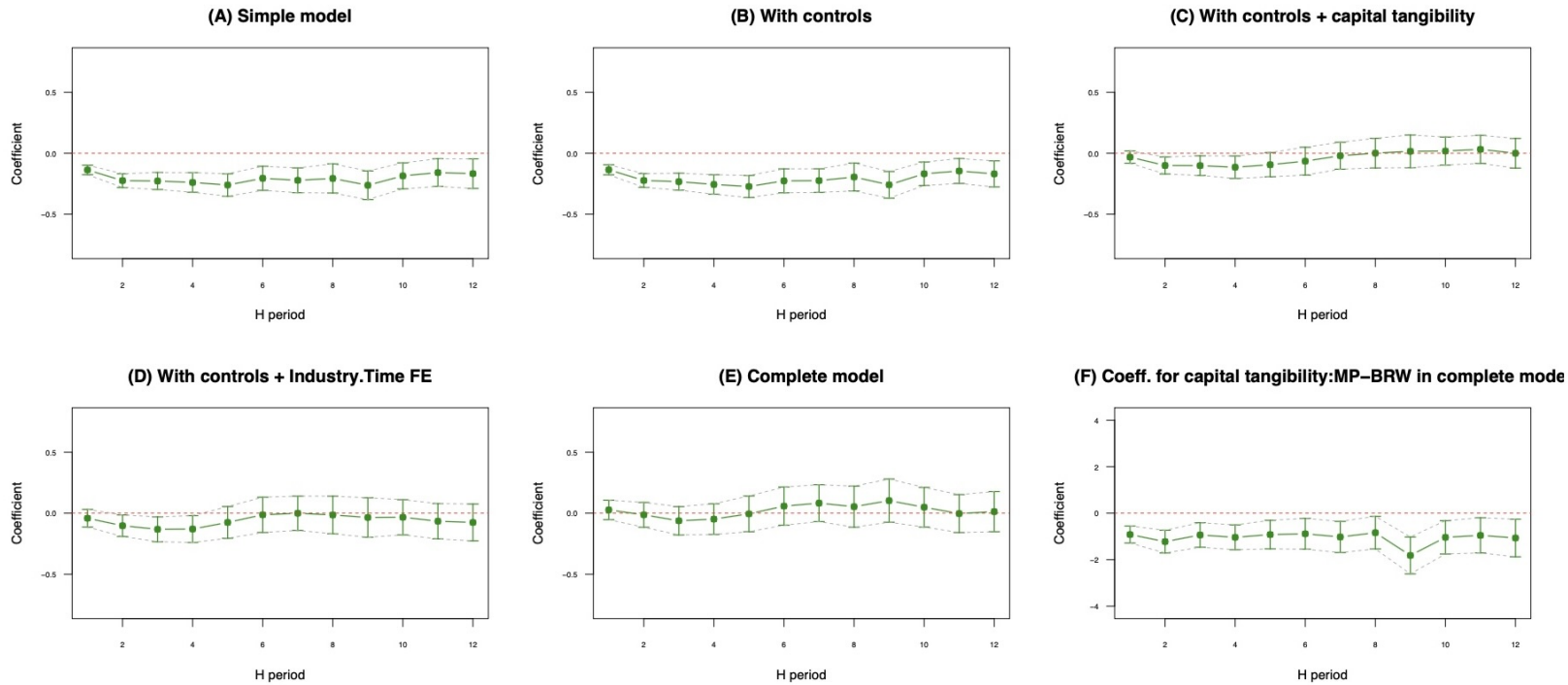
Energy and mining are more reactive to MP shocks

- During the study period, the U.S. emerged as the only country in the world to exploit and produce shale gas and oil on a large scale (Hu et al., 2019).
- U.S. sample includes 66 energy extraction firms, the euro area - 7 firms.
- Shale revolution has generated positive spillover effects on other sectors of the economy (Feyrer et al., 2017).

Capital tangibility in different industries



Impact of MP shocks on investment



The U.S.

Comparing our results to Dottling and Lam (2023) and Bauer et al. (2025)

- Dottling and Lam (2023) find evidence of transition risk, which they measure by absolute carbon emissions. We find similar results for large firms if we use absolute emissions.
- Bauer et al. (2025): methodology similar to ours, but includes utilities (always excluded in the literature!), 2-SIC (we use 4-SIC), log intensity is not in log.

Bridging to results by Bauer et al. (2025)

	Dependent variable:				
	Stock returns				
Panel A: Complete sample	(1)	(2)	(3)	(4)	(5)
1Y-OIS : Log scope 1+2 intensity	−0.76	0.30	−0.64	−1.06**	−0.59
	(0.64)	(0.96)	(0.63)	(0.53)	(0.54)
Industry.time FE	No	4-SIC	2-SIC	2-SIC	No
Utility Financial Industries				Yes	Yes
Observations	40,486	40,486	40,486	54,685	54,685
Adjusted R^2	0.34	0.38	0.37	0.39	0.35
Panel B: Disclosed sample	(1)	(2)	(3)	(4)	(5)
1Y-OIS : Log scope 1+2 intensity	−1.22	0.43	−1.90**	−2.09***	−0.93
	(0.74)	(1.00)	(0.76)	(0.78)	(0.71)
Industry.time FE	No	4-SIC	2-SIC	2-SIC	No
Utility Financial Industries				Yes	Yes
Observations	19,181	19,181	19,181	26,713	26,713
Adjusted R^2	0.41	0.50	0.46	0.49	0.42

Conclusions

- We document carbon bias in the transmission of the monetary policy in the U.S., but not in the euro area.
- The difference is mainly explained by the presence of fossil fuel energy firms in the U.S.
- Capital tangibility also explains part of the bias through a credit channel. Carbon intensity is highly correlated with capital tangibility, which has been shown to strengthen MP transmission.
- We find some evidence of transition risk for large carbon emitters.