Green Transmission: Monetary Policy in the Age of ESG

Alba Patozi

Bank of England

EEA - ESEM Barcelona
29 August 2023

Disclaimer: The views expressed in this presentation are mine, and not necessarily those of the Bank of England or any of its Committes.

Motivation

How sensitive are green firms to monetary policy?

- Policy discussions:
  1. Green firms $\rightarrow$ private **green investment** $\rightarrow$ Net-Zero
  2. Green investments susceptible to Δ in the **cost of credit**
  3. **Higher interest rates** *may* threaten decarbonization efforts

- However, in the **current** high-interest rate environment:

*"...leading climate economists polled last year see only a **mild or very mild impact of rising borrowing costs on the transition to net-zero emissions by 2050**. So far, there is also **no evidence of funding shortages of green investment** projects."*
(Schnabel, International Symposium on CB Independence 2023)

Introduction

- Research Questions:
  - Are *green firms* more (or less) responsive to monetary policy shocks?
  - If so, what explains their sensitivity (or lack thereof) to monetary policy shocks?

- Key Results:
  1. Green firms less sensitive to MP
  2. Result not driven by firm-level characteristics
  3. Evidence of an investors' preference channel

Literature

- Firm Heterogeneity and Monetary Policy Transmission
  - **Seminal papers:** Bernanke et al. (1999), Gertler & Gilchrist (1994), Ottonello & Winberry (2020), Cloyne et al. (2018), Jeenas (2019), Bahaj et al. (2018), Kalemli-Ozcan et al. (2018)
  - **High-frequency strand:** Anderson & Cesa-Bianchi (2020), Gurkaynak et al. (2019), Lakdawala & Moreland (2021), Ozdagli (2018), Ippolito et al. (2018)
  - **This paper:** heterogeneity in firm-level greenness
- Risks from Climate Change and Asset Prices
  - Barnett et al. (2020), Engle et al. (2020), Hong et al. (2019), Krueger et al. (2020), Painter (2020), Alok et al. (2020), Pastor et al. (2021), Correa et al. (2021)
  - **This paper:** sustainable investing and MP transmission

Outline

- Data
- Monetary Policy and Firm Environmental Performance
- Differences in Financial Characteristics
- Preferences for Sustainable Investing

Data

- **Environmental Scores:** MSCI ESG IVA Ratings
- **Monetary Policy Surprises:** Bu, Rogers & Wu (2021)
- **Firm-level Data:** Compustat, CRSP, I/B/E/S, IHS Markit
- **Investor Data:** Thomson Reuters 13F Institutional Ownership, CRSP Mutual Funds Holdings
- **Climate Change Concerns:** FEMA, YCOS, MCCC
- The final dataset:
  - Covers 102 FOMC announcements
  - Spans the 2008 - 2021 period
  - Has information on 2,014 US publicly listed firms

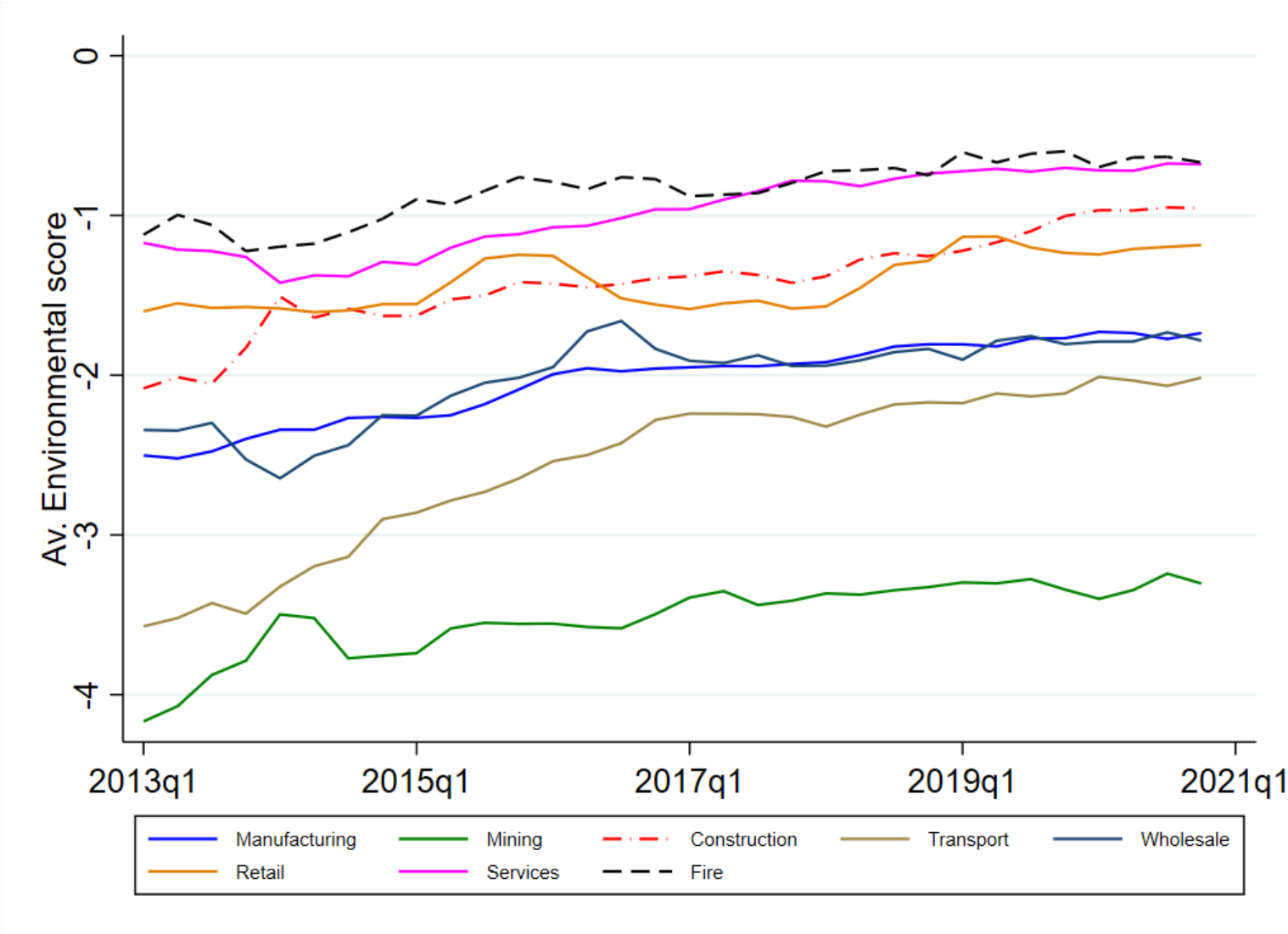
The 'E' in ESG

What constitutes a 'green' firm?

- The 'E' in ESG measures a company's resilience to long-term environmental risks
- 'E' is a weighted av. score across 13 environmental issues

Environment Pillar			
Climate Change	**Natural Capital**	**Pollution & Waste**	**Env. Opportunities**
Carbon Emissions	Water Stress	Toxic Emissions & Waste	Clean Tech
Product Carbon Footprint	Biodiversity & Land Use	Packing Material & Waste	Green Building
Financial Environment Impact	Raw Material Sourcing	Electronic Waste	Renewable Energy
Climate Change Vulnerability			

Environmental Performance



Monetary Policy Surprises

- Monetary policy surprises identified using high-frequency techniques
- Post GFC period: mostly unconventional monetary policy
- Bu, Rogers & Wu (2021) MP surprises consider interest rates at different maturities

	Mean	Median	Std. dev.	Min	Max	Observations
MP surprise	-0.005	-0.007	0.051	-0.189	0.186	102
Contractionary MP surprise	0.037	0.027	0.037	0.000	0.186	43
Expansionary MP surprise	-0.036	-0.029	0.034	-0.189	-0.001	59

Notes: Summary statistics of monetary policy surprises for the period 31/01/2008 to 31/12/2020. Monetary policy surprises are collected from Bu, Rogers & Wu (2021) and expressed in percentage points. Time series

Monetary Policy and Firm Environmental Performance

Empirical Methodology

- Panel event-study based on high-frequency data:

$$\Delta p_{i,t} = \alpha_i + \alpha_{s,t} + \beta(\varepsilon_t^m \times g_{i,t-1}) + \delta g_{i,t-1} + \Gamma' Z_{i,t-1} + e_{i,t}$$

where:

- $\Delta p_{i,t}$ difference in (log) stock price of firm i at date $t+1$ relative to date $t-1$
- ε_t^m BRW monetary policy surprise at FOMC date t
- $g_{i,t-1}$ environmental performance score of firm i in year $t-1$
- $Z_{i,t}$ vector of firm-level controls that include size, profitability, book leverage market-to-book ratio, cash holdings, short term liabilities, retained earnings dividends per share and distance to default
- α_i firm fixed effects
- $\alpha_{s,t}$ sector-time fixed effects
- $e_{i,t}$ errors clustered at the FOMC event level

Baseline Result: Stock Price Semi-Elasticities

	(1) $\Delta p_{i,t}$	(2) $\Delta p_{i,t}$	(3) $\Delta p_{i,t}$	(4) $\Delta p_{i,t}$
MP shock (ε_t^m)	-16.22***	-16.31***		
	(3.999)	(4.013)		
MP shock × Env. score ($\varepsilon_t^m \times g_{i,t-1}$)		3.091***	3.500***	2.975***
		(1.069)	(0.946)	(0.867)
Env. score ($g_{i,t-1}$)		-0.0427	-0.0123	0.0109
		(0.0637)	(0.0457)	(0.0370)
Firm FE	Yes	Yes	Yes	Yes
Sector_time FE	No	No	No	Yes
Controls	Yes	Yes	Yes	Yes
R-squared	0.0666	0.0676	0.299	0.328
Observations	75931	75931	75931	75687

Notes: The numbers in parenthesis are standard errors, which are clustered at the event-level. The asterisks denote statistical significance (*** for p $<$ 0.01, ** for p $<$ 0.05, * for p $<$ 0.1).

Robustness: Ex-ante | MP Shocks | Env. Scores | Additional Results | Ex-post

Additional Evidence: Quintiles | Fama-French | CDS spreads | E, S or G?

Differences in Firm Fundamentals

Financial Characteristics: Green vs. Brown

	Green	Brown	Difference	Sensitivity to MP	Source
Env. performance	-0.291	-4.089	3.798***		
Size	8.074	8.170	-0.096***	less	Gertler & Gilchrist (1994), Bernanke et al. (1996)
Leverage	0.454	0.485	-0.031*	ambiguous	Ottonello & Winberry (2020), Anderson & Cesa-Bianchi
Short term finance	0.029	0.030	-0.001	less	
Long debt share	0.871	0.888	-0.017***	more	Lakdawala & Moreland (2021)
Profitability	0.028	0.027	0.002**	ambiguous	
Retained earnings to assets	-0.028	0.055	-0.083***	ambiguous	
Dividends per share	0.134	0.227	-0.093***	less	Cloyne et al. (2020)
Liquidity	0.171	0.073	0.098***	less	Jeenas (2019), Kashyap et al. (1994)
Market to book ratio	2.175	1.316	0.859***	more	
Age (since CRSP incorp)	25.262	33.397	-8.135***	less	Cloyne et al. (2018), Bahaj et al. (2018)
D2default	9.067	7.161	1.905***	more	Ottonell & Winberry (2020)
Transparency	49.251	28.766	20.486***	less	
Observations	11388	11368			

Notes: Green (Brown) firms are classified according to the top (bottom) quintiles of the environmental score distribution. Sample spans from 2007Q1 to 2020Q4.

Robustness to Financial Characteristics

Additional Interaction	Effect (MP shock × Env. score)
None (Baseline)	2.975***
MP shock × Leverage	2.972***
MP shock × Size	2.864***
MP shock × Age	3.152***
MP shock × D2default	2.567***
MP shock × Liquidity	2.980***
MP shock × Profitablity	2.877***
MP shock × Short-term debt	2.977***
MP shock × Transparency	3.051***
MP shock × Dividends	3.002***
MP shock × Market-to-Book	2.797***
MP shock × All Variables	2.692***

Notes: The numbers in parenthesis are standard errors, which are clustered at the event-level. The asterisks denote statistical significance (*** for $p < 0.01$, ** for $p < 0.05$, * for $p < 0.1$). Regression Table

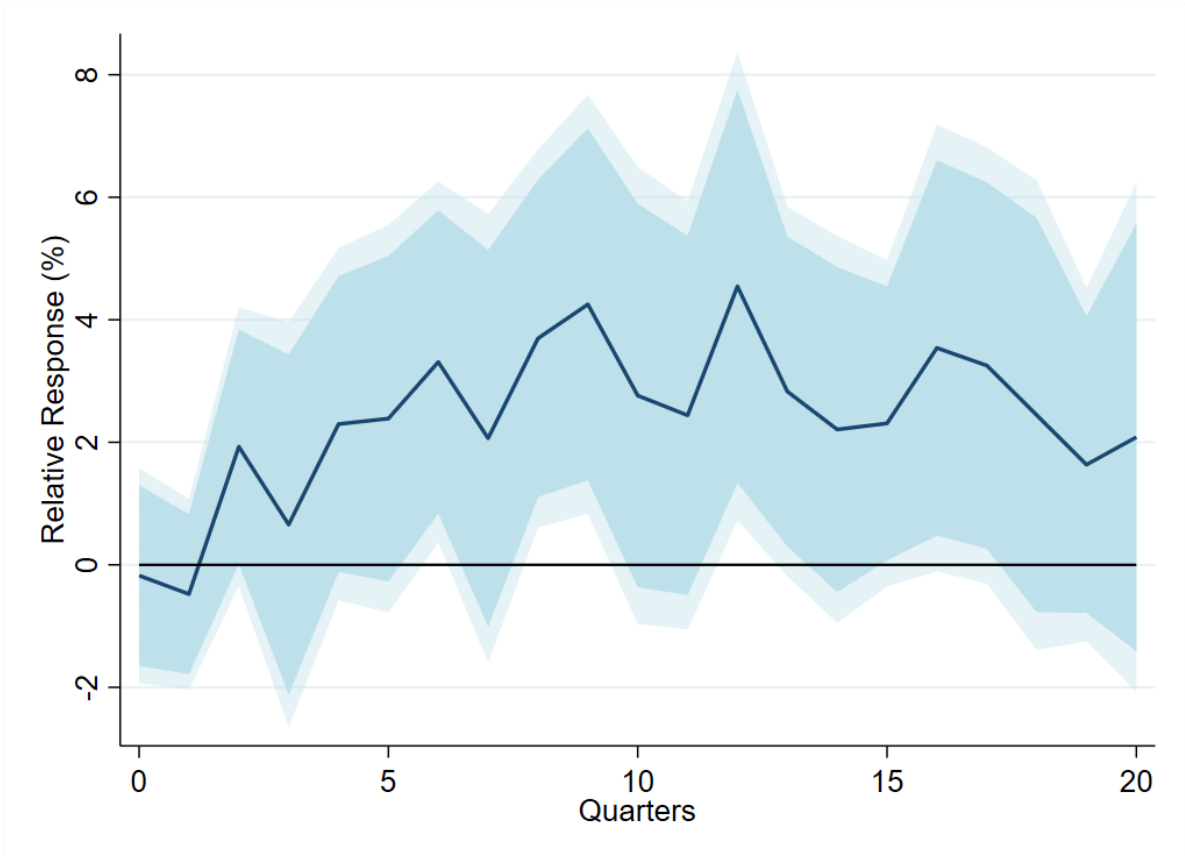
Real Effects of Monetary Policy

- In spirit of Ottonello & Winberry (2020) and given potential dynamic effects $\Longrightarrow$ extend to multiple horizons à la Jorda (2005)

$$\Delta_h logk_{i,t} = \alpha_i^h + \alpha_{s,t}^h + \beta^h(\varepsilon_t^m \times g_{i,t-1}) + \delta^h g_{i,t-1} + \Gamma'^h Z_{i,t-1} + e_{i,t,h}$$

- $\Delta_h logk_{i,t}$ cumulative % change in investment of firm i between quarter $t-1$ and $t+h$
- ε_t^m aggregated BRW monetary policy surprises at quarter t
- $g_{i,t-1}$ environmental performance score of firm i in year $t-1$
- $Z_{i,t}$ vector of firm-level (lagged) controls that include size, real sales growth leverage and distance to default
- α_i firm fixed effects
- $\alpha_{s,t}$ sector$\times$ time fixed effects
- $e_{i,t}$ errors clustered at the time level

Relative Response of Green Firms' Investment to MP shocks



Notes: In line with local projection methods, each horizon is estimated separately. The dependent variable is $\Delta logk_{i,t+h}$, over the horizons considered. The independent variable is $\varepsilon_t^m \times g_{i,t-1}$. The light blue shaded areas denote the 95% and 90% confidence intervals around point estimates constructed with standard errors clustered at the time level. Average Response

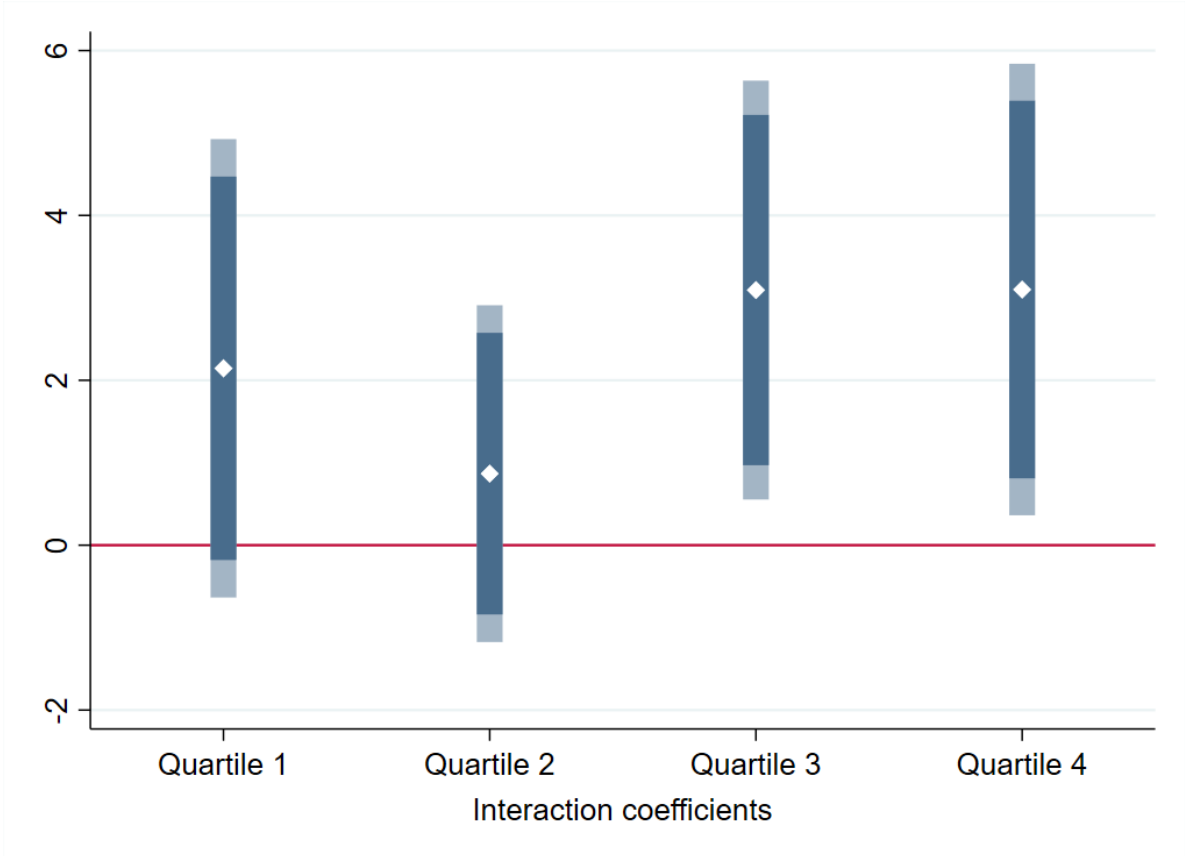
Preferences for Sustainable Investing

Results from a stylized theoretical framework

- Mechanism:
  1. Sustainable preferences $\rightarrow$ imperfect subst. between green and brown assets
  2. Contractionary MP $\rightarrow$ Firm NPV $\downarrow$ $\rightarrow$ Asset Prices $\downarrow$
  3. With sustainable preferences $\rightarrow$ $|\frac{\partial ln(P_{Green})}{\partial r}| < |\frac{\partial ln(P_{Brown})}{\partial r}|$
- Testable Prediction I: *The differential response of green asset prices with respect to monetary policy is more pronounced with* ***stronger preferences*** *for sustainable investing*
- Testable Prediction II: *When investors exhibit a preference for green investing, a contractionary monetary policy shock leads to an increase in the portfolio weight of green securities*

Empirical Evidence I: ESG Mandates

- CRSP Mutual Funds Holdings Data



Notes: This graph plots the beta coefficients from the following specification: $\Delta p_{i,t} = \alpha_i + \alpha_{st} + \beta(\varepsilon_t^m \times g_{i,t-1}) + \delta g_{i,t-1} + \Gamma' Z_{i,t-1} + e_{i,t}$, for four different quartiles based on the fraction of firm i held by index funds with ESG mandates.

Additional Evidence: Climate Change Beliefs | Mutual Fund Flows | Inst. Investors

Result II: Empirical Counterpart

- Merge Thomson Reuters 13F Institutional Ownership dataset with stock-level environmental performance scores
- Compute a green portfolio weight for each institutional investor j (based on median Env. performance):

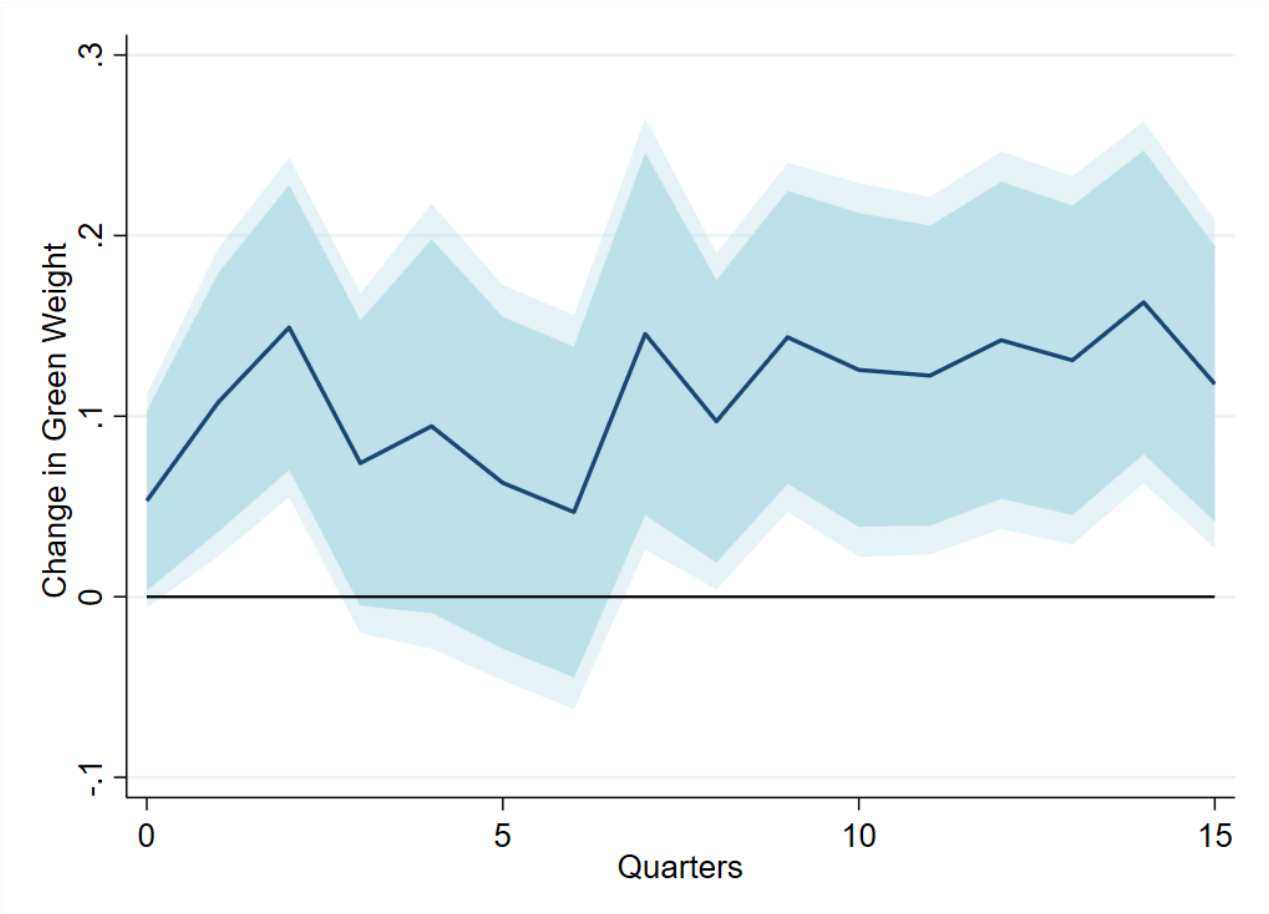
$$w_{j,t}^{G} \equiv \frac{\sum_i q_{j,i,t}^{G} s_{j,i,t}^{G}}{\sum_i q_{j,i,t}^{G} s_{j,i,t}^{G} + \sum_i q_{j,i,t}^{B} s_{j,i,t}^{B}}$$ Green Weight

- Look at response of green weight following an MP shock:

$$\Delta_h w_{j,t}^{G} = \alpha_j^h + \beta^h \epsilon_t^m + \delta t + e_{j,t+h}$$

- $\Delta_h w_{j,t}^{G}$ cumulative change in the green portfolio weight of institutional investor j between quarter $t-1$ and $t+h$
- ε_t^m aggregated BRW monetary policy surprises at quarter t
- t linear time trend
- α_j institutional investor fixed effects
- $e_{i,t}$ errors clustered at the time level

Empirical Evidence II: Green Weight



Notes: The light blue shaded areas denote the 95% and 90% confidence intervals around point estimates constructed with standard errors clustered at the time level. Back

Conclusion

1. This paper estimates the sensitivity of green firms to MP, by:
   - **combining** a firm-level dataset with ESG indicators and monetary policy shocks
   - **using** an identification strategy that exploits high-frequency market-based data
2. Green firms are less sensitive to monetary policy than their brown counterparts
   - Evidence from stock prices, CDS spreads and investment
   - Result not driven by firm-level financial characteristics
   - Evidence of an investors' preference channel
3. **Implication:** Dampened role for monetary policy during the Net-Zero transition

Appendix

E, S or G?

	(1) $\Delta p_{i,t}$	(2) $\Delta p_{i,t}$	(3) $\Delta p_{i,t}$	(4) $\Delta p_{i,t}$
MP shock $\times$ Env. score $(\varepsilon_t^m \times g_{i,t-1})$	2.975***	3.240***	3.073***	3.407***
	(0.867)	(0.812)	(0.872)	(0.832)
MP shock $\times$ Soc. score $(\varepsilon_t^m \times g_{i,t-1})$		0.679		0.753
		(0.564)		(0.608)
MP shock $\times$ Gov. score $(\varepsilon_t^m \times g_{i,t-1})$			0.270	0.384
			(0.684)	(0.716)
Firm FE	Yes	Yes	Yes	Yes
Sector_time FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
R-squared	0.328	0.328	0.328	0.328
Observations	75687	75687	75679	75679

Notes: The numbers in parenthesis are standard errors, which are clustered at the event-level. The asterisks denote statistical significance (*** for p $<$ 0.01, ** for p $<$ 0.05, * for p $<$ 0.1).

Back

Empirical Evidence III: Fund Flows

- Panel regressions based on mutual fund monthly flow data:

$$Flows_{m,t+1} = \alpha_c + \alpha_{s,t} + \beta(\varepsilon_t^m \times ESG_{m,t-1}) + \delta ESG_{m,t-1} + \Gamma' Z_{m,t-1} + e_{m,t}$$

	Equity			Index (equity)			Bond		
	(1) All	(2) Inst.	(3) Retail	(4) All	(5) Inst.	(6) Retail	(7) All	(8) Inst.	(9) Retail
MP shock × ESG Mandate	0.0185	0.0559*	-0.0252	0.0756**	0.122**	-0.0424	0.103	0.152	0.106
	(0.0190)	(0.0288)	(0.0251)	(0.0372)	(0.0489)	(0.0633)	(0.234)	(0.533)	(0.242)
ESG mandate	0.00624***	0.00455**	0.00720***	0.00739*	0.00557	0.00406	0.0197	0.0400*	0.00243
	(0.00158)	(0.00216)	(0.00235)	(0.00381)	(0.00404)	(0.00905)	(0.0137)	(0.0218)	(0.0170)
Mgmt Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lipper_time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.0803	0.0844	0.103	0.161	0.162	0.248	0.140	0.181	0.192
Observations	997769	513026	482799	133769	104312	28413	31954	10817	20948

Notes: The numbers in parenthesis are standard errors, clustered at the mututal fund level. The asterisks denote statistical significance (*** for p < 0.01, ** for p < 0.05, * for p < 0.1). Back

Stock Price Responses are Long-Lasting

	(1) $\Delta_0 p_{i,t}$	(2) $\Delta_1 p_{i,t}$	(3) $\Delta_2 p_{i,t}$	(4) $\Delta_3 p_{i,t}$	(5) $\Delta_4 p_{i,t}$	(6) $\Delta_5 p_{i,t}$	(7) $\Delta_6 p_{i,t}$	(8) $\Delta_7 p_{i,t}$	(9) $\Delta_8 p_{i,t}$	(10) $\Delta_9 p_{i,t}$	(11) $\Delta_{10} p_{i,t}$
MP shock $\times$ Env. score ($\varepsilon_t^m \times g_{i,t-1}$)	1.926***	2.975***	1.993**	1.603	1.474	1.641	1.940*	2.029	2.244*	1.968	1.857
	(0.581)	(0.867)	(0.891)	(1.070)	(1.052)	(1.049)	(1.124)	(1.410)	(1.278)	(1.327)	(1.309)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector_time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.303	0.328	0.299	0.320	0.282	0.265	0.262	0.269	0.269	0.248	0.271
Observations	75769	75687	75666	75031	75282	75618	75593	73036	75576	75554	75535

Notes: The numbers in parenthesis are standard errors, which are clustered at the event-level. The asterisks denote statistical significance (*** for $p < 0.01$, ** for $p < 0.05$, * for $p < 0.1$).

Back

Robustness: Falsification Test

	(1) $\tau-1$	(2) $\tau-2$	(3) $\tau-3$	(4) $\tau-4$	(5) $\tau-5$	(6) $\tau-6$	(7) $\tau-7$	(8) $\tau-8$	(9) $\tau-9$	(10) $\tau-10$
MP shock $\times$ Env. score ($\varepsilon_t^m \times g_{i,t-1}$)	1.521**	0.716	-0.640	-1.533**	-0.226	0.473	0.446	0.161	-0.784	-0.981
	(0.707)	(0.777)	(0.637)	(0.711)	(0.663)	(0.567)	(0.695)	(0.642)	(0.863)	(0.760)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector_time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.248	0.327	0.243	0.206	0.295	0.316	0.265	0.282	0.271	0.313
Observations	75358	75663	75334	75648	75638	74617	75618	73528	75615	71264

Notes: The numbers in parenthesis are standard errors, which are clustered at the event-level. The asterisks denote statistical significance (*** for $p < 0.01$, ** for $p < 0.05$, * for $p < 0.1$).

Back

Robustness: Alternative Environmental Scores

Dep. variable: $\Delta p_{i,t}$	(1) MSCI Baseline	(2) MSCI Raw Score	(3) MSCI Emissions	(4) SUS Env. Policy	(5) SUS Env. Mgmt.	(6) SUS Renew. Energy
MP shock $\times$ Env. score ($\varepsilon_t^m \times g_{i,t-1}$)	2.975***	2.726***	2.960***	0.832*	1.092**	1.692***
	(0.867)	(0.779)	(1.026)	(0.440)	(0.548)	(0.620)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Sector_time FE	Yes	No	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.328	0.299	0.319	0.337	0.337	0.365
Observations	75687	75931	64844	61602	61602	32220

Notes: The numbers in parenthesis are standard errors, which are clustered at the event-level. The asterisks denote statistical significance (*** for $p < 0.01$, ** for $p < 0.05$, * for $p < 0.1$).

Back

Robustness: Alternative MP surprises

	(1) Baseline	(2) Kuttner	(3) GSS	(4) JK	(5) Swanson	(6) RSW	(7) IV
MP shock × Env. score ($\varepsilon_t^m \times g_{i,t-1}$)	2.975***	4.522**	1.094**	3.649	1.071**	3.115**	3.633***
	(0.867)	(2.233)	(0.440)	(2.364)	(0.506)	(1.344)	(1.230)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector_time FE	No	No	No	No	No	No	No
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.328	0.328	0.283	0.328	0.278	0.301	
Observations	75687	75687	58161	75687	62646	49165	75687

Standard errors in parentheses

* $p < .10$, ** $p < .05$, *** $p < .01$

Notes: The numbers in parenthesis are standard errors, which are clustered at the event-level. The asterisks denote statistical significance (*** for p $<$ 0.01, ** for p $<$ 0.05, * for p $<$ 0.1).

Back

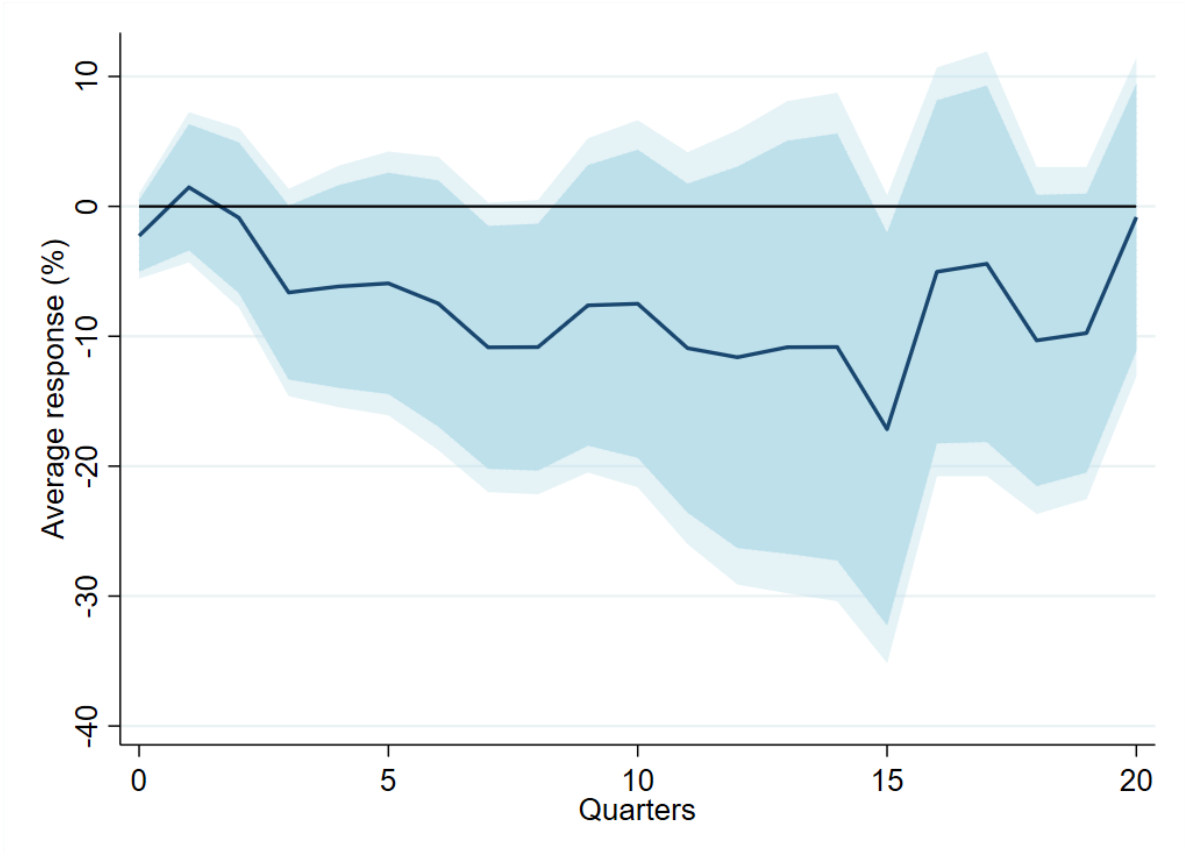
Additional Results: Sample Selection

	(1) Baseline	(2) Contractionary	(3) Expansionary	(4) Post- GFC	(5) ZLB	(6) Post ZLB
MP shock $\times$ Env. score $(\varepsilon_t^m \times g_{i,t-1})$	2.975***	2.778*	- 4.615*	2.566***	1.555**	4.846**
	(0.867)	(1.539)	(2.375)	(0.899)	(0.681)	(1.855)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Sector_time FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.328	0.401	0.262	0.326	0.365	0.324
Observations	75687	36036	39471	72670	28954	43741

Notes: The numbers in parenthesis are standard errors, which are clustered at the event-level. The asterisks denote statistical significance (*** for $p < 0.01$, ** for $p < 0.05$, * for $p < 0.1$).

Back

Average Investment Response



Notes: In line with local projection methods, each horizon is estimated separately. The dependent variable is $\Delta_h logk_{i,t}$, over the horizons considered. The independent variable is ε_t^m. The light blue shaded areas denote the 95% and 90% confidence intervals around point estimates constructed with standard errors clustered at the time level. Back

Robustness: Portfolios

Dep. variable: $\Delta p_{i,t}$	(1) Quintile 1	(2) Quintile 2	(3) Quintile 3	(4) Quintile 4	(5) Quintile 5	(6) Green-minus-Brown
MP shock (ε_t^m)	-15.43***	-14.63***	-11.28***	-9.193***	-6.367*	9.067***
	(3.419)	(3.816)	(3.624)	(3.429)	(3.253)	(2.050)
mktrf	0.672***	0.794***	0.906***	0.834***	0.819***	0.147
	(0.191)	(0.190)	(0.194)	(0.214)	(0.182)	(0.106)
smb	0.947**	0.926**	0.710*	0.575	0.489	-0.459**
	(0.450)	(0.450)	(0.394)	(0.413)	(0.340)	(0.176)
hml	0.373	0.184	0.00867	0.124	-0.0767	-0.450***
	(0.463)	(0.492)	(0.463)	(0.465)	(0.435)	(0.127)
rmw	0.541	0.686	0.821	0.546	0.627	0.0860
	(0.556)	(0.543)	(0.538)	(0.583)	(0.482)	(0.280)
cma	0.928	1.095	1.009	0.378	0.226	-0.702*
	(0.661)	(0.767)	(0.722)	(0.720)	(0.608)	(0.373)
R-squared	0.517	0.492	0.473	0.438	0.404	0.443
Observations	102	102	102	102	102	102

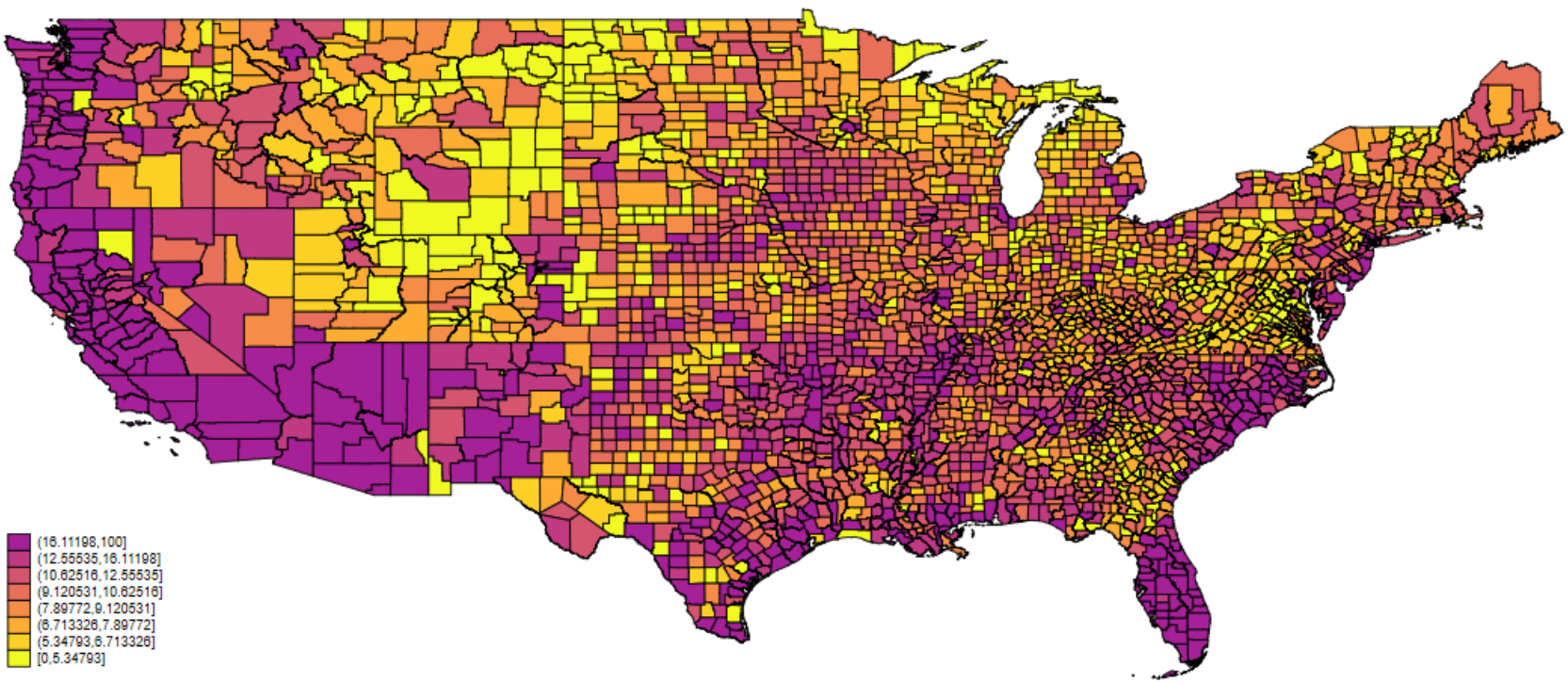
Notes: The numbers in parenthesis are standard errors, which are clustered at the event-level. The asterisks denote statistical significance (*** for $p < 0.01$, ** for $p < 0.05$, * for $p < 0.1$).

Back

National Risk Index

Composite measure of natural hazard risk from FEMA

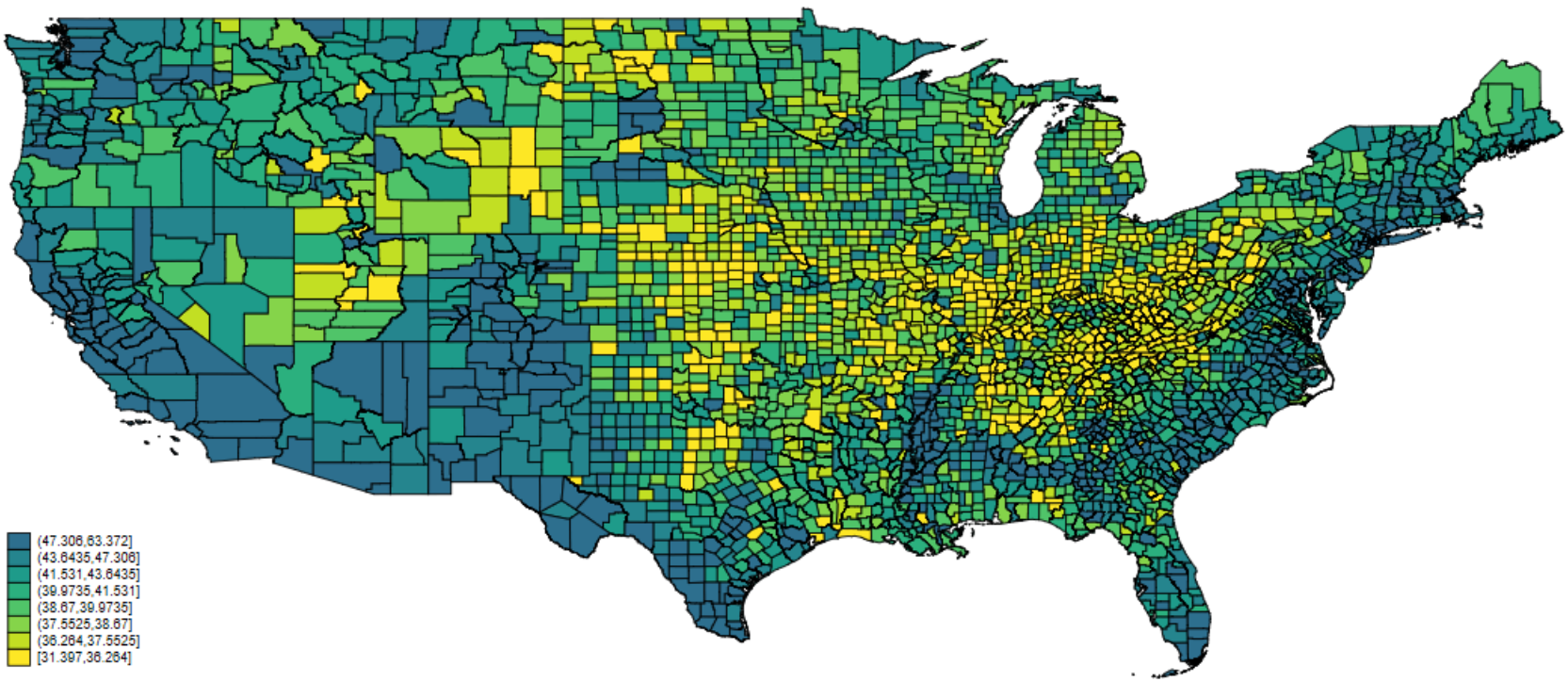
- $s_{i,t}$: how exposed to natural disaster risk are the counties where firm i's investors (mutual funds) are located at?
- combines natural disaster exposure (frequency + historic loss) with social vulnerability and community resilience data



Notes: Map of the National Risk Index at the county level. Back

Yale Climate Change Survey

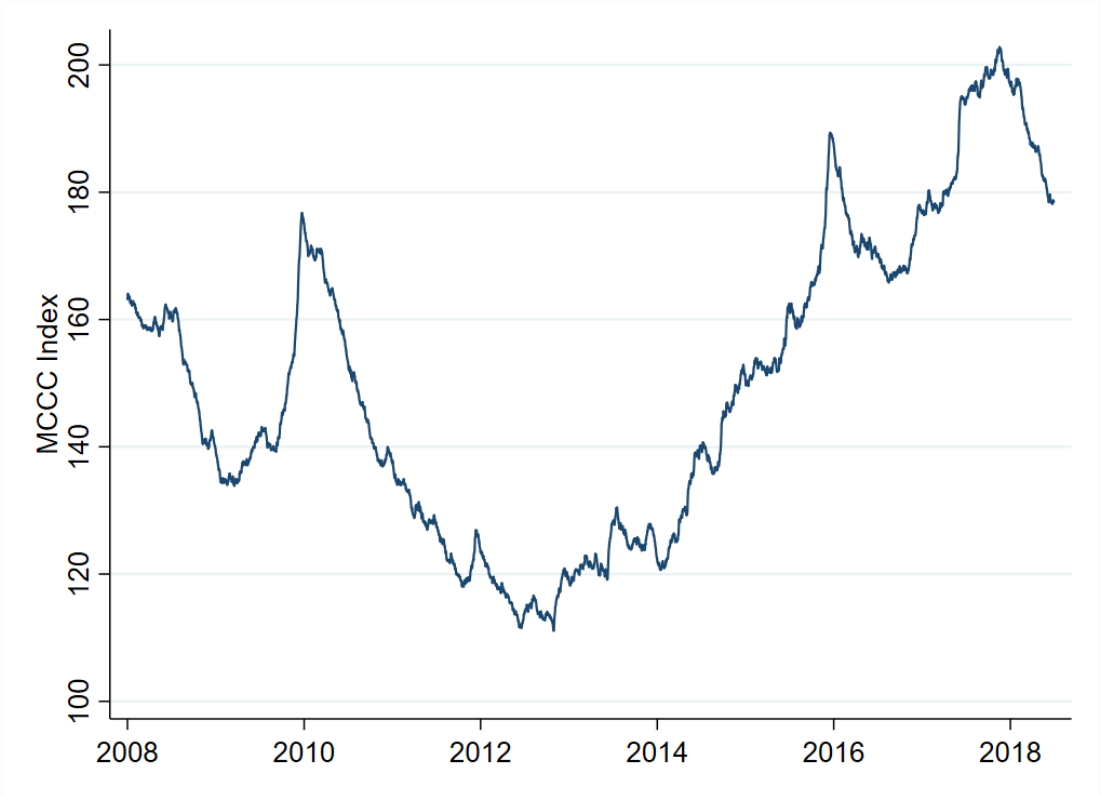
- $s_{i,t}$: climate change beliefs of the counties where firm i's investors (mutual funds) are headquartered at
- 'personal' measures the degree to which the respondents of the Yale Public Opinion Survey believe to be 'personally' affected by climate change



Notes: Map of Climate Change Beliefs at the county level. Back

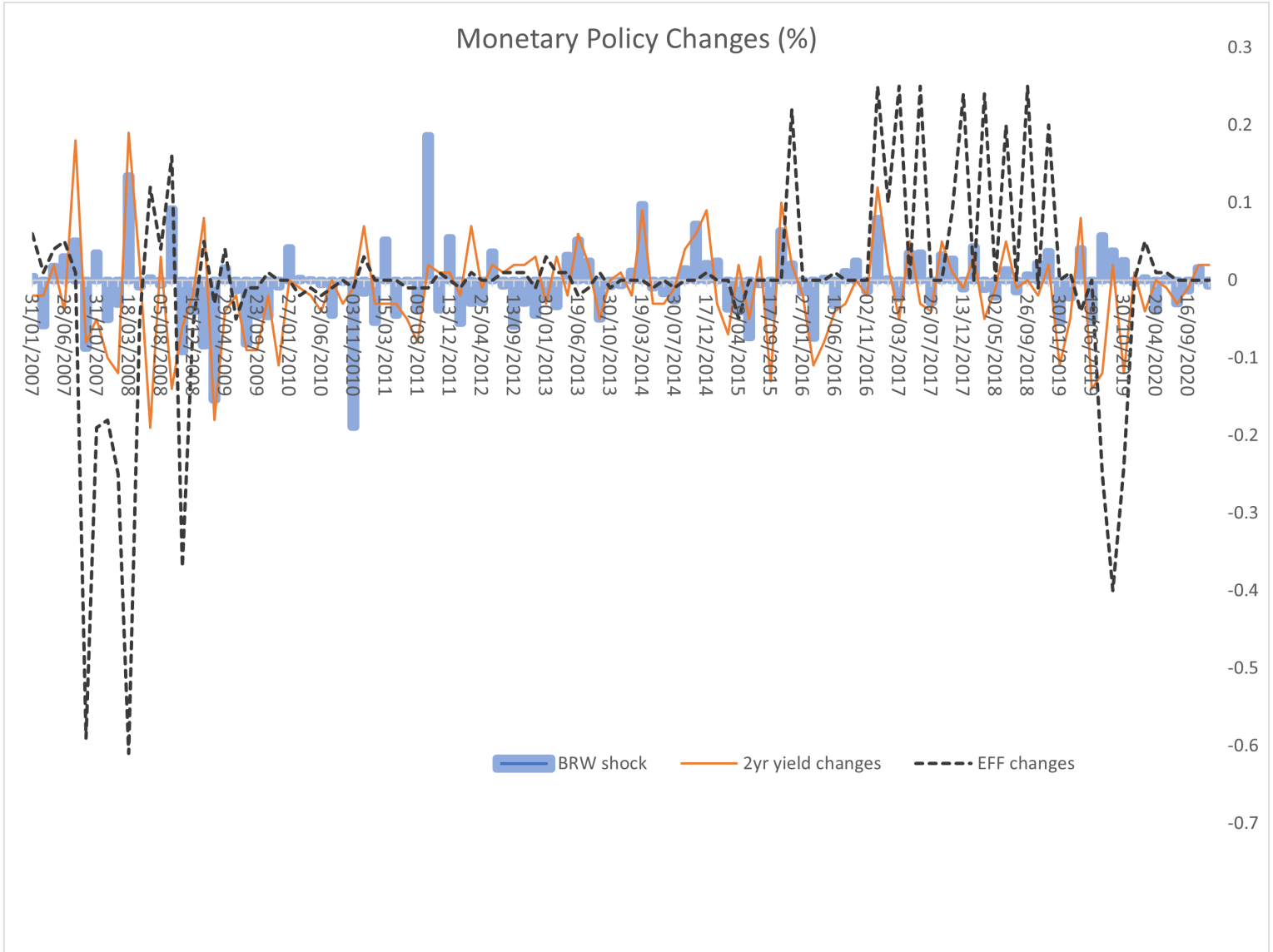
Media Climate Change Concerns Index

- s_t: how high are climate change concerns at time t?
- a daily index of news about climate change (of a negative sentiment) published by major US newspapers and newswires



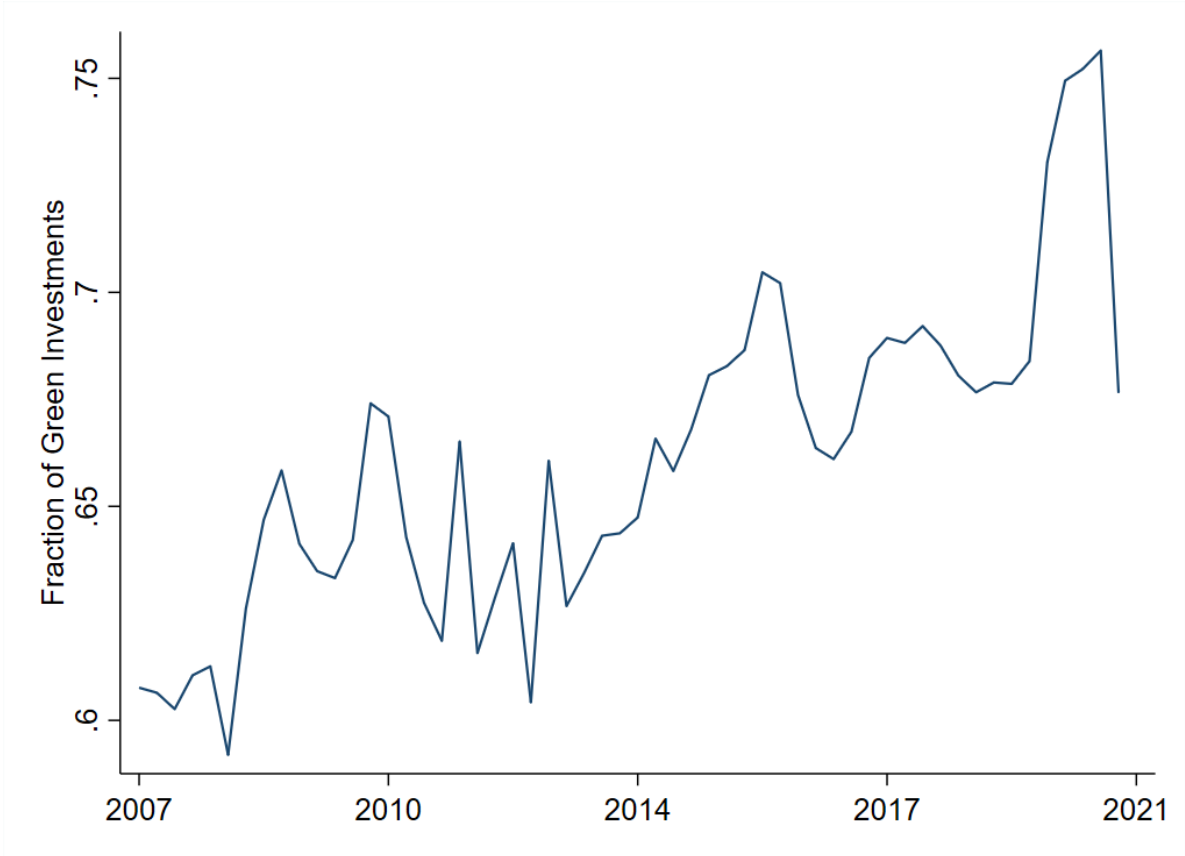
Notes: Time series of the Cumulative Media Climate Change Concerns Index by Ardia et al. (2020), constructed using a distributed lag model. Back

Monetary Policy surprises vis-a-vis interest rates changes



Back

Green portfolio weight



Notes: Cross-sectional average of institutional investors' fraction of green security holdings over time, constructed using institutional ownership data from Thomson Reuters 13F database. Back

Linear marginal response: CDS spreads

	(1) ΔCDS	(2) ΔCDS	(3) ΔCDS	(4) ΔCDS
MP shock (ε_t^m)	21.47**	21.42**		
	(9.350)	(9.342)		
MP shock × Env. score ($\varepsilon_t^m \times g_{i,t-1}$)		-7.894***	-7.909***	-6.109**
		(2.793)	(2.789)	(2.459)
Env. score ($i, t-1$)		0.0918	0.244	0.140
		(0.214)	(0.171)	(0.167)
Firm FE	Yes	Yes	Yes	Yes
Sector_time FE	No	No	No	Yes
Controls	Yes	Yes	Yes	Yes
R-squared	0.0335	0.0346	0.133	0.165
Observations	19610	19610	19610	19422

Standard errors in parentheses

* $p < .10$, ** $p < .05$, *** $p < .01$

Notes: The numbers in parenthesis are standard errors, which are clustered at the event-level. The asterisks denote statistical significance (*** for p < 0.01, ** for p < 0.05, * for p < 0.1). Back

Transparency

- Kim et al. (2014): Socially responsible firms commit to a higher standard of transparency and provide more financial disclosure
- Data on firms' earnings forecasts from financial analysts from I/B/E/S
- Construct transparency proxy following Casella et al. (2022)

$$\text{transparency}_{i,t} \equiv \frac{1}{std.\ dev.(EPS_{i,t})}$$

where $std.\ dev.(EPS_{i,t})$ is the standard deviation of analysts' forecasts on firm i's earnings per share in the last 30 calendar days before the earnings announcement. Back

Evidence from CDS Spreads

- CDS spreads: proxy for firms' external financing costs
- Data extracted from IHS Markit

$$\Delta cds_{i,t} = \alpha_i + \beta_1 (g^{high}_{i,t-1} \times \epsilon^m_t) + \beta_2 (g^{low}_{i,t-1} \times \epsilon^m_t) + \delta_1 g^{high}_{i,t-1} + \Gamma' Z_{i,t-1} + e_{i,t}$$

	(1) ΔCDS	(2) ΔCDS	(3) $\Delta prob^{default}$	(4) $\Delta prob^{default}$
MP shock (ε^m_t)	21.47**		1.692**	
	(9.350)		(0.734)	
MP shock × Green ($\varepsilon^m_t \times g^{high}_{i,t-1}$)		16.21*		1.403*
		(8.716)		(0.721)
MP shock × Brown ($\varepsilon^m_t \times g^{low}_{i,t-1}$)		26.62**		1.982**
		(10.39)		(0.766)
Firm FE	Yes	Yes	Yes	Yes
Sector_time FE	No	No	No	No
Controls	Yes	Yes	Yes	Yes
R-squared	0.0335	0.0340	0.0393	0.0398
Observations	19610	19610	18352	18352

Notes: The numbers in parenthesis are standard errors, which are clustered at the event-level. The asterisks denote statistical significance (*** for p < 0.01, ** for p < 0.05, * for p < 0.1). Back

Model Environment

- Time is discrete and there are only two periods
- No uncertainty
  - Three riskless assets: (i) bonds, (ii) green securities, (iii) brown securities
  - Period two returns: $(1 + r)$, π_G, π_B for bonds, green securities and brown securities, respectively
- Endowment: y in period one and zero in period two
- Household/investor exhibits a preference for sustainable investing:

$$\max_{c_t, b_1, s_G s_B} E_1\Big(\sum_{t=1}^{2} \beta^{t-1}\big(u(c_t) + f(s_{G,1})\big), \quad \text{subject to,}$$

$$c_1 + b_1 + q_{G,1}s_{G,1} + q_{B,1}s_{B,1} \leq y \quad \text{in period one}$$

$$c_2 \leq (1 + r)b_1 + \pi_G s_{G,1} + \pi_B s_{B,1} \quad \text{in period two}$$

No-Arbitrage Conditions

- Internal solution from utility max problem:

$$q_{B,1} = \frac{\pi_B}{1+r}; \quad q_{G,1} = \frac{\pi_G}{1+r} + \frac{(1+\beta)f'(s_{G,1})}{u'(c_1)}$$

- Assuming $u(c_t) = log(c_t)$ and $f(s_{G,1}) = \alpha s_{G,1}$ where $\alpha > 0$, and solving for equilibrium prices:

$$q^*_{B,1} = \frac{\pi_B}{1+r}, \quad q^*_{G,1} = \frac{\pi_G}{1+r} + \frac{\alpha}{1+\alpha}y$$

- Taking logs and differentiating with respect to r (theoretical analogue to the empirical results):

$$\frac{dln(q^*_{B,1})}{dr} = \underbrace{-\frac{1}{1+r}}_{\text{Pecuniary Effect}}, \frac{dln(q^*_{G,1})}{dr} = -\frac{1}{1+r} \underbrace{+\frac{\frac{\alpha}{1+\alpha}y}{\frac{\pi_G}{1+r} + \frac{\alpha}{1+\alpha}y}\frac{1}{1+r}}_{\text{Green Preferences Effect}}$$

Result 2: Empirical Counterpart

- Augment baseline specification with a triple interaction term:

$$\Delta p_{i,t} = \alpha_i + \alpha_t + \beta(\varepsilon_t^m \times g_{i,t-1}) + \delta g_{i,t-1} + \gamma(\varepsilon_t^m \times g_{i,t-1} \times s_{i,t-1}) + \Gamma' Z_{i,t-1} + e_{i,t}$$

where:

- $p_{i,t}$ difference in (log) stock price of firm i at date $t+1$ relative to date $t-1$
- ε_t^m BRW monetary policy surprise at FOMC date t
- $g_{i,t-1}$ environmental performance score of firm i in year $t-1$
- $s_{i,t-1}$ proxy for investors' preferences for sustainable investing
- $Z_{i,t-1}$ vector of firm-level controls that include size, profitability, book leverage market-to-book ratio, cash holdings, short term liabilities, retained earnings dividends per share & distance to default, $pi \times g_{i,t-1}$, $p_i \times \epsilon_t^m$
- α_i firm fixed effects
- α_t time fixed effects
- $e_{i,t}$ errors clustered at the FOMC event level

s_i variable: National Risk Index | Climate Change Survey | Media Climate Change Concerns

Baseline Result: Quintiles (Firm-Level)

Dep. variable: $\Delta p_{i,t}$	(1) Quintile 1	(2) Quintile 2	(3) Quintile 3	(4) Quintile 4	(5) Quintile 5
MP shock (ε_t^m)	-21.21***	-19.44***	-16.25***	-13.98***	-11.17***
	(4.409)	(4.598)	(4.097)	(3.851)	(3.707)
Firm FE	Yes	Yes	Yes	Yes	Yes
Sector_time FE	No	No	No	No	No
Controls	Yes	Yes	Yes	Yes	Yes
R-squared	0.0851	0.100	0.0929	0.0952	0.0698
Observations	14766	15433	15325	15161	15187

Notes: The numbers in parenthesis are standard errors, which are clustered at the event-level. The asterisks denote statistical significance (*** for $p < 0.01$, ** for $p < 0.05$, * for $p < 0.1$).

Back

Panel Event Study: Double Sorting

- Augment the previous specification with an additional term:

$$\Delta p_{i,t} = \alpha_i + \alpha_{st} + \beta(\varepsilon_t^m \times g_{i,t-1}) + \delta g_{i,t-1} + \gamma(\varepsilon_t^m \times c_{i,t-1}) + \Gamma' Z_{i,t-1} + e_{i,t}$$

where:

- $p_{i,t}$ difference in (log) stock price of firm i at date $t+1$ relative to date $t-1$
- ε_t^m BRW monetary policy surprise at FOMC date t
- $g_{i,t-1}$ environmental performance score of firm i in year $t-1$
- $c_{i,t-1}$ financial characteristic of firm i in quarter $t-1$
- $Z_{i,t-1}$ vector of firm-level controls that include size, profitability, book leverage market-to-book ratio, cash holdings, short term liabilities, retained earnings dividends per share and distance to default
- α_i firm fixed effects
- α_{st} sector$\times$ time fixed effects
- $e_{i,t}$ errors clustered at the FOMC event level

Robustness: Financial Characteristics

	(1) $\Delta p_{i,t}$	(2) $\Delta p_{i,t}$	(3) $\Delta p_{i,t}$	(4) $\Delta p_{i,t}$	(5) $\Delta p_{i,t}$	(6) $\Delta p_{i,t}$	(7) $\Delta p_{i,t}$	(8) $\Delta p_{i,t}$	(9) $\Delta p_{i,t}$	(10) $\Delta p_{i,t}$	(11) $\Delta p_{i,t}$	(12) $\Delta p_{i,t}$
MP shock × Env. score ($\varepsilon_t^m \times g_{i,t-1}$)	2.975***	2.972***	2.864***	3.152***	2.567***	2.980***	2.877***	2.977***	3.051***	3.002***	2.797***	2.692***
	(0.867)	(0.868)	(0.861)	(0.872)	(0.806)	(0.819)	(0.851)	(0.866)	(0.935)	(0.868)	(0.746)	(0.771)
MP shock × Leverage ($\varepsilon_t^m \times c_{i,t-1}$)		-2.670										0.735
		(5.035)										(4.819)
MP shock × Size ($\varepsilon_t^m \times c_{i,t-1}$)			1.433									0.705
			(0.894)									(0.736)
MP shock × Age ($\varepsilon_t^m \times c_{i,t-1}$)				1.698***								1.009**
				(0.603)								(0.419)
MP shock × D2default ($\varepsilon_t^m \times c_{i,t-1}$)					3.593***							3.185***
					(1.208)							(0.913)
MP shock × Liquidity ($\varepsilon_t^m \times c_{i,t-1}$)						-0.0356						0.159
						(0.783)						(0.553)
MP shock × Profitablity ($\varepsilon_t^m \times c_{i,t-1}$)							3.774**					1.112
							(1.796)					(1.604)
MP shock × Short-term debt ($\varepsilon_t^m \times c_{i,t-1}$)								0.980				1.717**
								(0.630)				(0.662)
MP shock × Transparency ($\varepsilon_t^m \times c_{i,t-1}$)									1.880***			1.315**
									(0.561)			(0.506)
MP shock × Dividends ($\varepsilon_t^m \times c_{i,t-1}$)										1.789		-0.168
										(1.150)		(0.664)
MP shock × Market-to-Book ($\varepsilon_t^m \times c_{i,t-1}$)											1.667	0.0121
											(1.872)	(1.687)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry_time FE	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.328	0.328	0.328	0.329	0.329	0.328	0.328	0.328	0.333	0.328	0.328	0.335
Observations	75687	75687	75687	75687	75687	75687	75687	75687	69746	75687	75687	69746

Notes: The numbers in parenthesis are standard errors, which are clustered at the event-level. The asterisks denote statistical significance (*** for $p < 0.01$, ** for $p < 0.05$, * for $p < 0.1$).

Back

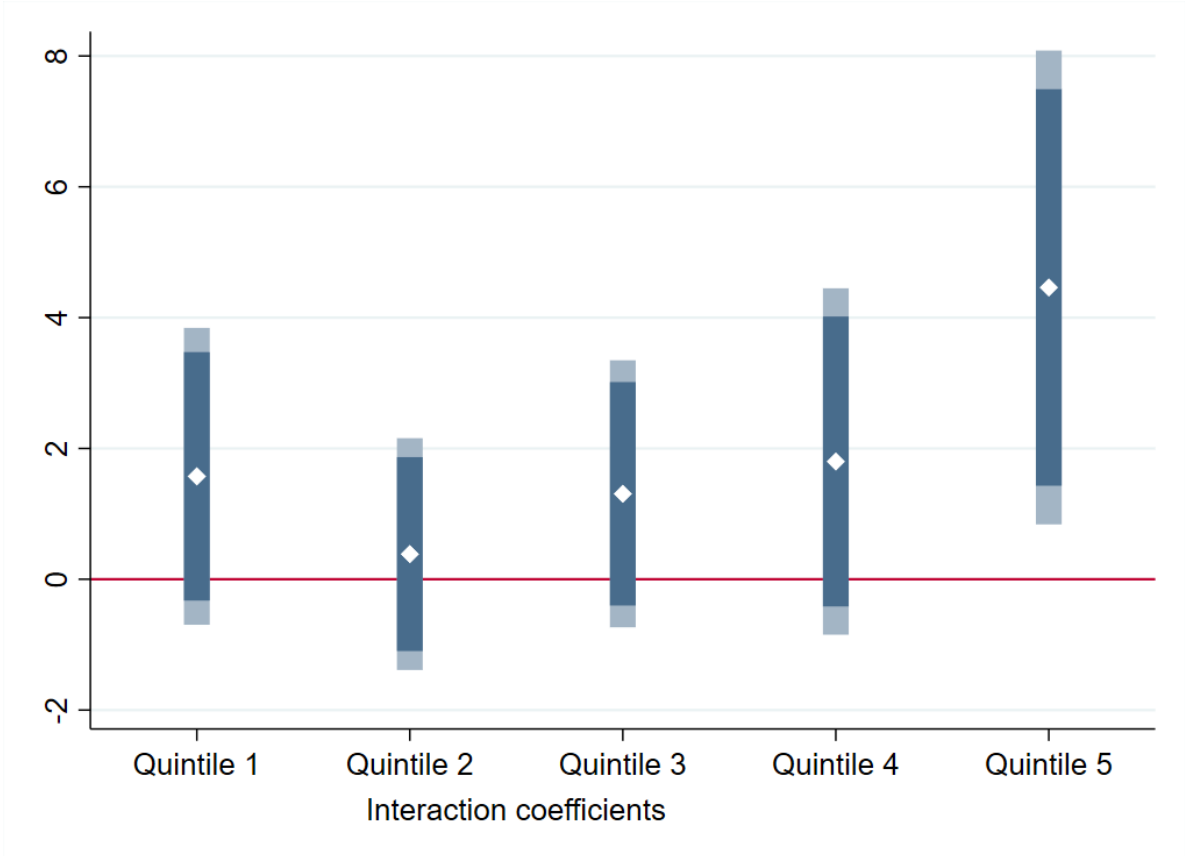
Climate Change Beliefs as a Proxy for Preferences

	(1) $\Delta p_{i,t}$	(2) $\Delta p_{i,t}$	(3) $\Delta p_{i,t}$	(4) $\Delta p_{i,t}$	(5) $\Delta p_{i,t}$	(6) $\Delta p_{i,t}$	(7) $\Delta p_{i,t}$
MP shock × Env. score ($\varepsilon_t^m \times g_{i,t-1}$)	2.975***	2.817***	2.672***	2.806***	2.691***	2.861***	3.538***
	(0.867)	(0.853)	(0.850)	(0.847)	(0.853)	(0.868)	(0.924)
MP shock × Env. score × NRI		1.548**					
		(0.704)					
MP shock × Env. score × Happening			1.172*				
			(0.613)				
MP shock × Env. score × Worried				1.676**			
				(0.748)			
MP shock × Env. score × Personal					1.492**		
					(0.658)		
MP shock × Env. score × CO_2 Limits						1.753**	
						(0.744)	
MP shock × Env. score × MCCC							1.890**
							(0.778)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector_time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.328	0.333	0.333	0.333	0.333	0.333	0.288
Observations	75687	68880	68880	68880	68880	68880	53658

Notes: The numbers in parenthesis are standard errors, which are clustered at the event-level. The asterisks denote statistical significance (*** for $p < 0.01$, ** for $p < 0.05$, * for $p < 0.1$). Back

Empirical Evidence I: Institutional Investors

- 13F Institutional Stock Ownership



Notes: This graph plots the beta coefficients from the following specification: $\Delta p_{i,t} = \alpha_i + \alpha_{st} + \beta(\varepsilon_t^m \times g_{i,t-1}) + \delta g_{i,t-1} + \Gamma' Z_{i,t-1} + e_{i,t}$ for the five different quintiles of the Investor-based greenness distribution. Quintile 1 refers to securities that are held by investors with 'brown' preferences. Back