

Carbon Stock Devaluation

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Carbon Divestment

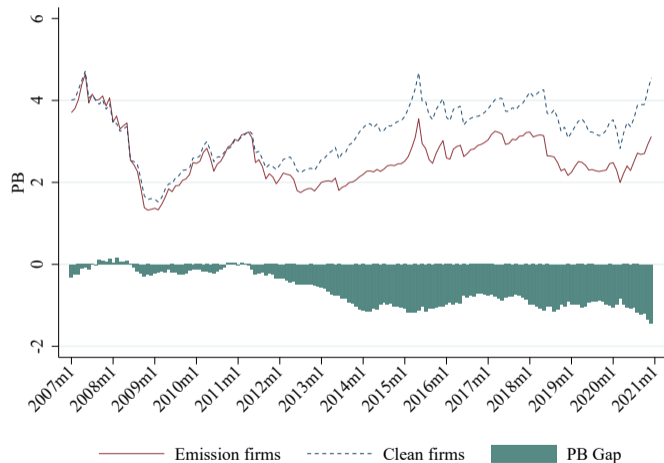
- A shift in capital allocation from high-emission to low-emission firms
 - Over **3,800 organizations** (with a collective assets under management of **US\$121 trillion**) have become signatories of the Principles for Responsible Investment (PRI)
- Most are institutional investors, including sovereign wealth funds, university endowments, faith-based organizations, and pension funds

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- Most are institutional investors, including sovereign wealth funds, university endowments, faith-based organizations, and pension funds
- Investment funds apply negative screens and exclude climate-unfriendly firms

Carbon Stock Devaluation

- $EMC\ PB\ Gap = Value\text{-weighted\ average\ } P/B\ \text{ratio of high-emission firms minus Value-weighted average } P/B\ \text{ratio of low-emission firms for 26 equity markets}$



- EMC PB gap is close to zero before 2011 but negative and growing in magnitude afterward

Divestment and Devaluation

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 - Heightened climate risk increases physical and regulatory concerns for high-emission firms, reducing their future cashflow

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- Theoretical predictions by Pastor, Stambaugh, and Taylor (2021)
 - Positive shock to the ESG factor (Strong investor ESG preferences) →
A large valuation gap between green and brown firms →
Incentivizes firms to become greener

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A large valuation gap between green and brown firms →
Incentivizes firms to become greener
- We empirically show
 - A large valuation gap between green and brown firms ---→
Brown firms became greener by reducing emissions and increasing green innovation

Data

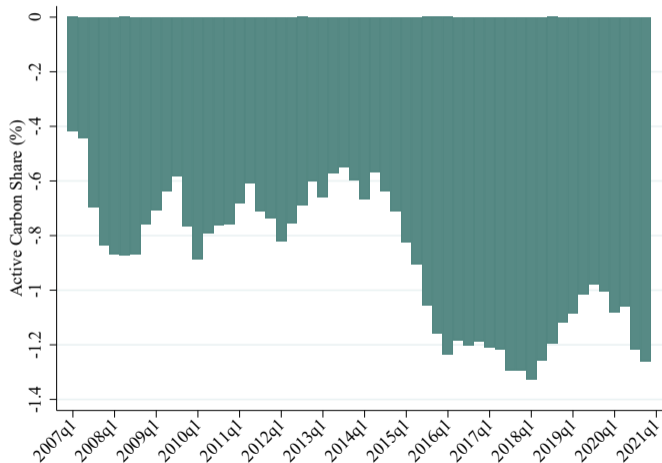
- FactSet quarterly holdings: equity portfolios of financial institutions and blockholders around the world
 - 3 groups: institutions, blockholders excluding institutions, and retail investors
 - Retail ownership = 100% - institutional ownership - blockholders' (excluding institutions) ownership
- FactSet Fundamentals: stock and firm information
- Orbis IP: firm-level patent data
 - Provides global patent applications filed to regional, national, and international patent offices
 - Includes patents filed by both public and private firms
 - We classify “green” patents based on the International Patent Classification (IPC), following Cohen, Gurun, and Nguyen (2020)

Data

- Trucost: firm-level emission data
 - Provides an estimation of companies' CO₂ emission (in tons) on an annual basis
 - Scope 1 emissions are direct emissions from owned or controlled sources
 - Scope 2 emissions are indirect emissions from the generation of purchased energy
 - Scope 3 emissions are all indirect emissions that occur in the value chain of the reporting company, including both upstream and downstream emissions
- Center for Research on the Epidemiology of Disasters' EM-DAT database: disaster type, date, location, and impact
 - We use the measure developed by Baker, Bloom, and Terry (2020): the number of major natural disasters in a country in a quarter

Active Carbon Share of Institutions and Retail Investors

- *Active Carbon Share* = carbon share gap between institutions and retail investors, and the market.



- Decrease over the years, in particular around 2015
- Blockholders (excluding institutions) are buying high-emission firms

Natural Disasters

Natural Shocks = Number of major natural disasters in a country in a quarter (>100 deaths or damages > 0.1% of GDP)

	(1)	(2)	(3)	(4)
	Log SVI		Log News	
Natural Shocks	0.206*** (0.031)	0.063** (0.025)	0.395*** (0.054)	0.041* (0.022)
Year-Quarter FE	Yes	Yes	Yes	Yes
Country FE		Yes		Yes
Obs.	1800	1800	1014	1014
Adj. R^2	0.20	0.77	0.08	0.90

Upon one natural shock,

- *SVI* ↑ by 6.3%
- *News* ↑ by 4.1%

Natural Disasters and Price Gap

	(1)	(2)	(3)
	Log PB		
Natural Shocks	0.013 (0.012)		
Emission×Natural Shocks	-0.016*** (0.003)	-0.010*** (0.003)	-0.018*** (0.003)
Controls	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Year-Quarter FE	Yes		
Country×Year-Quarter FE		Yes	Yes
Emission×Year-Quarter FE			Yes
Obs.	1192213	1192213	1192213
Adj. R^2	0.674	0.696	0.697

Upon one natural shock,

- PB ↓ by 1.8%

Natural Disasters and Divestment

	(1)	(2)	(3)	(4)	(5)
	Inst. and Retail Ownership(%)			Inst. Ownership(%)	Retail Ownership(%)
Natural Shocks	-0.106 (0.161)				
Emission×Natural Shocks	-0.536*** (0.119)	-0.548*** (0.115)	-0.436*** (0.144)	-0.380*** (0.124)	-0.168*** (0.051)
Controls	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Year-Quarter FE	Yes				
Country×Year-Quarter FE		Yes	Yes	Yes	Yes
Emission×Year-Quarter FE			Yes		
Obs.	1229379	1229379	1229379	1229379	1229379
Adj. R^2	0.613	0.622	0.622	0.694	0.851

- Upon one natural shock, institutions and retail investors reduce their ownership of emission firms by 0.38% and 0.17% relative to that of clean firms in the same country.

Firms' Actions: Carbon Emissions

$EMC\ PB\ Gap = Average\ Emission - Minus - Clean\ PB\ Gap$ in the country in the past year

	(1)	(2)	(3)
	S1int	S2int	S3int
Emission \times EMC PB Gap	8.636** (3.729)	0.938 (0.964)	4.276*** (0.767)
IO(%)	0.030 (0.086)	0.009 (0.014)	0.021 (0.015)
Emission \times IO(%)	0.288 (0.294)	-0.009 (0.026)	-0.072** (0.032)
Emission \times ESG Disclosure	-104.168*** (29.734)	0.152 (2.849)	-2.874 (3.364)
Controls	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Country \times Year FE	Yes	Yes	Yes
Obs.	74122	74122	74120
Adj. R^2	0.851	0.841	0.957

One standard deviation \downarrow of EMC PB Gap

- Scopes 1, 2, and 3 emission intensities \downarrow of 5.3%, 2.2%, and 2.4% (relative to the mean values), compared with low-emission firms.

Firms' Actions: Green Patents

Dep. Var.: Green Ratio (%)	(1)	(2)	(3)
Emission	1.123*** (0.183)		
EMC PB Gap	-0.144* (0.072)		
Emission×EMC PB Gap	-0.297** (0.141)	-0.312** (0.142)	-0.310** (0.140)
IO(%)			0.008** (0.003)
Emission×IO(%)			-0.006 (0.005)
Emission×ESG Disclosure			0.326 (0.779)
Controls	Yes	Yes	Yes
Year-Quarter FE	Yes		
Firm FE		Yes	Yes
Country×Year-Quarter FE		Yes	Yes
Obs.	122571	120666	120666
Adj. R^2	0.008	0.313	0.313

$Green_Ratio = \# \text{ Green Patents} / \# \text{ All Patents}$ of a firm in a quarter

One standard deviation ↓ of EMC PB Gap

- $Green\ Ratio$ ↑ of 12% (relative to the mean values), compared with low-emission firms.

Operation Downsizing and Financing

Given the higher cost of equity capital, do high-emission firms adjust their operations?

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Log Sales	Log Total Assets	CapEx(%)	Log Scope1	Log Scope2	Log Scope3	Total Patent
Emission×EMC PB Gap	0.024*** (0.005)	0.041*** (0.004)	0.159*** (0.042)	0.033** (0.014)	0.025** (0.012)	0.044*** (0.008)	3.985* (2.051)
IO(%)	0.004*** (0.000)	0.005*** (0.000)	0.011*** (0.002)	-0.000 (0.001)	-0.000 (0.000)	-0.000 (0.000)	-0.010 (0.025)
Emission×IO(%)	0.000 (0.001)	-0.001 (0.001)	0.001 (0.003)	0.001 (0.001)	0.000 (0.001)	0.000 (0.000)	-0.049 (0.053)
Emission×ESG Disclosure	-0.012 (0.019)	0.003 (0.015)	-0.761*** (0.121)	0.076 (0.072)	-0.042 (0.072)	-0.113*** (0.039)	-0.356 (3.080)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country×Year/-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	280605	281234	276041	74122	74122	74120	275968
Adj. R ²	0.945	0.961	0.442	0.945	0.926	0.970	0.760

Operation Downsizing and Financing

Given the higher cost of equity capital, how do high-emission firms finance their green investments?

	(1)	(2)	(3)	(4)	(5)
	Payout Ratio(%)	Repur. Ratio(%)	Stock Sales Rate(%)	ST Debt(%)	LT Debt(%)
Emission×EMC PB Gap	0.051 (0.121)	-0.109*** (0.033)	0.191*** (0.069)	0.005 (0.024)	-0.020 (0.039)
IO(%)	0.017*** (0.006)	0.012*** (0.004)	-0.006* (0.004)	0.003** (0.001)	0.005** (0.002)
Emission×IO(%)	-0.010 (0.009)	-0.006 (0.006)	-0.002 (0.005)	-0.001 (0.002)	-0.000 (0.003)
Emission×ESG Disclosure	0.432 (0.374)	-0.099 (0.109)	0.121 (0.198)	-0.131* (0.079)	-0.763*** (0.117)
Controls	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Country×Year FE	Yes	Yes	Yes	Yes	Yes
Obs.	222710	250295	267376	208229	277301
Adj. R^2	0.627	0.246	0.251	0.043	0.122

- High-emission firms reduce their external financing (especially equity financing) in the presence of high price pressure from equity markets.

Private Firms: Placebo Tests

- Endogeneity concerns
 - It is still possible that some omitted variables driving firms' activities

Private Firms: Placebo Tests

- Endogeneity concerns
 - It is still possible that some omitted variables driving firms' activities
- We use a triple difference (diff-in-diff-in-diff) approach
 - We see larger changes in emissions and green innovation among high-emission public firms when the price gap is large
 - We use data on private firms to see the difference between public and private firms, to rule out the potential impact of nationwide events, such as environmental regulations
 - This highlights the role of the capital market

Private Firms: Placebo Tests

We use data on private firms to rule out the potential impact of nationwide events, such as environmental regulations

	(1)	(2)	(3)	(4)	(5)	(6)
	S1int	S2int	S3int	Log Scope1	Log Scope2	Log Scope3
Emission \times EMC Price Gap	14.698 (21.849)	-6.795* (3.761)	2.041 (1.520)	-0.112** (0.049)	-0.055 (0.055)	-0.026 (0.037)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Country \times Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	14609	14609	14609	14609	14609	14609
Adj. R^2	0.796	0.789	0.974	0.962	0.948	0.966

Private Firms: Placebo Tests

We use data on private firms to rule out the potential impact of nationwide events, such as environmental regulations

	(1)	(2)
	Green Ratio (%)	Log Total Assets
Emission \times EMC Price Gap	0.228 (0.279)	0.030 (0.023)
Controls	Yes	
Firm FE	Yes	Yes
Country \times Year-Quarter FE	Yes	Yes
Obs.	137597	137597
Adj. R^2	0.499	0.988

Robustness

- We also estimate a Poisson model on green patents as suggested by Cohn et al (2022)
 - A fixed-effects Poisson model gives consistent and efficient estimate when many firms file zero green patents (Cohn et al (2022));
 - Poisson regressions show that only carbon firms increase green patents relatively when facing price pressures from stock markets.
- We also utilize the natural shocks as IV for estimation
 - First stage: natural shocks \rightarrow depressed prices for carbon firms, not weak IV;
 - Second stage: depressed prices \rightarrow more green patents and less total emissions for carbon firms, relative to their private peers.
- We will add these to next draft!

Conclusion

- Carbon Divestment and Devaluation are larger after natural disasters, when climate awareness is higher
- Depressed prices push high-emission firms to become greener
 - Reduce CO₂ emissions
 - File more “green” patents
 - (These effects are not observed among high-emission private firms)
- This evidence suggests the importance of equity markets, and rule out environmental regulations
- Given higher cost of capital in equity markets, high-emission firms downsize their operations and rely more on internal financing than external financing.