Counterproductive Sustainable Investing:
The Impact Elasticity of Brown and Green Firms

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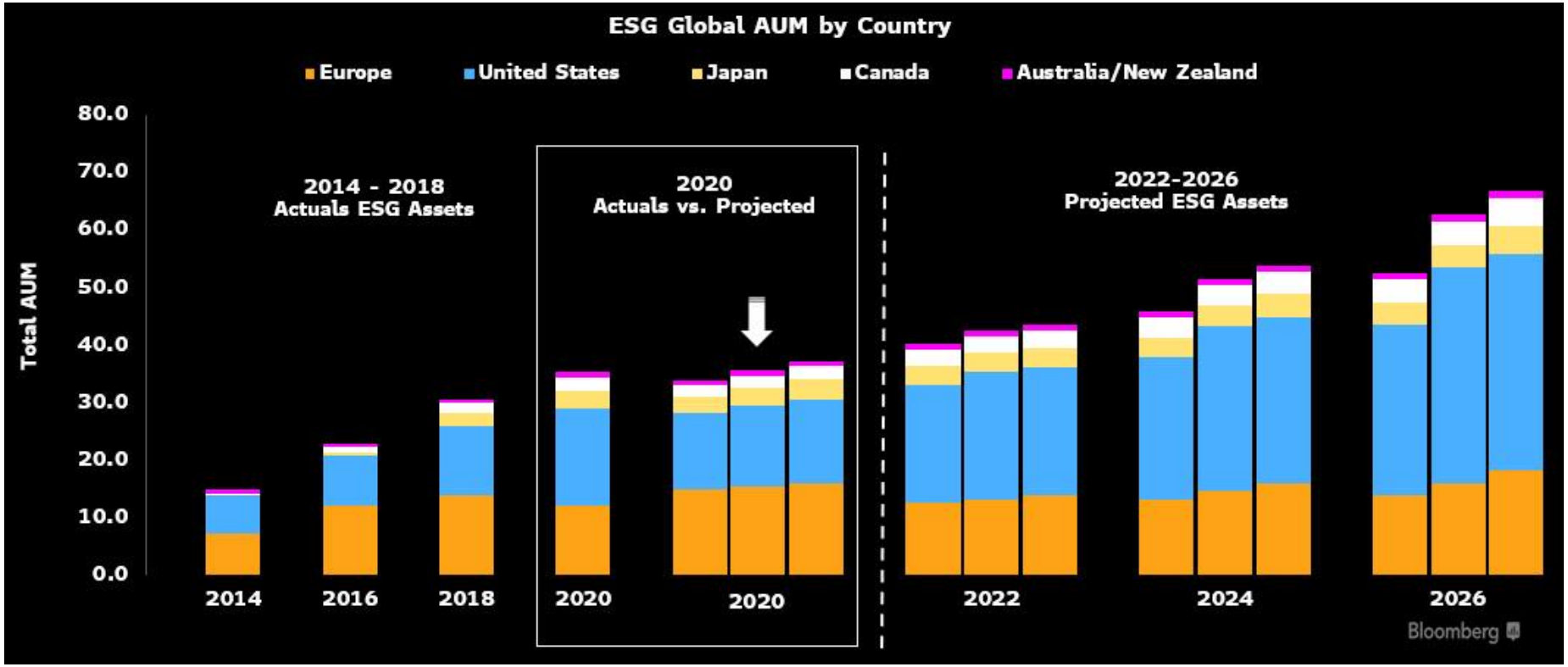
Sustainable investing

Sustainable investing has exploded in popularity

- $35 trillion in global assets in 2020, expected to grow to 1/3 of AUM by 2025 (Bloomberg Insights 2022)



Sustainable investing in practice: The Focus

What is the dominant focus of sustainable investors?

- Reduce firm greenhouse gas emissions intensity to combat global warming

Leaders | Sustainable investing

ESG should be boiled down to one simple measure: emissions

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U.S. SECURITIES AND EXCHANGE COMMISSION MCMXXXIV

Sustainable investing in practice: The Goal

What is the dominant goal for sustainable investors?

- Transition to a green economy
  - Make firms more green
  - Minimize economic disruption in doing so
- Alternatives exist, e.g. degrowth, but transition goal is dominant

"If there is a dominant paradigm for how politicians and economists today think about solving climate change, it is called green growth ... the global economy can both continue growing and defuse the threat of a warming planet through rapid, market-led environmental action and technological innovation."

The New York Times

Sustainable investing in practice: The Strategy

What is the dominant sustainable investing strategy?

- Buy green firms and divest from brown firms
- Not project-specific

Alternative strategies exist

- Engagement or project-specific investments in green R&D, venture and PE
  - 0.04% of Blackrock's $50B
  - 1.2% of Vanguard's $18B in sustainable investments

<u>This paper is about the dominant strategy, focus, and goal</u>

Will sustainable investing achieve its green transition goal?

The mechanism: Sustainable investors hope to make firms more green by changing their cost of capital

- Direct capital toward green firms, lowering their cost of capital
- Direct capital away from brown firms, raising their cost of capital

What will happen if sustainable investing changes the cost of capital under the dominant strategy? Will it achieve the transition goal?

Depends on *Impact Elasticity* $\equiv \frac{\partial \text{ Impact}}{\partial \text{ Cost of capital}}$ of brown and green firms

A typical green firm

- Travelers Insurance
  S&P 500 firm in insurance
- Emissions intensity:
  1 ton per million revenue
- Cut emissions intensity
  by ~40% (2019-21)
- Long term goals
  - Net-zero by 2030

A typical brown firm

- Martin Marietta Materials
  S&P 500 firm in building materials
- Emissions intensity:
  1,000 tons per million revenue
- Cut emissions intensity
  by ~12% (2019-21)
- Long term goals: Modest, discusses that moving to clean production is costly up front

Dominant strategy: Buy  and avoid 

-  cannot get much more green or brown with cost of capital shifts
  - Decrease its cost of capital and invest more in what?
    - 100% reduction in emissions same as  cutting emissions by $\sim 0.1\%$
  - No reason to think  could produce building materials at a lower emissions intensity or that it could meaningfully conduct green R&D

-  could become much more green or brown with cost of capital shifts
  - Cost of capital $\downarrow$: Invest in expensive green tech that pays off in the future
  - Cost of capital $\uparrow$: More short-termist, cut corners or double down on existing brown production to get cash now
    - Reversing recent reduction in emissions $\rightarrow$ increase ~ 30 times  level

This paper

- Green firm impact elasticity ≈ 0
  Brown firm impact elasticity < 0, pollute more per unit output when cost of capital ↑

- If sustainable investing succeeds in changing cost of capital…
  - Counterproductive relative to a goal of transitioning firms to green:
    Brown becomes more brown, green does not become more green

- Brown firms face weak incentives to become more green
  - Sustainable investors reward green firms for large % reductions in emissions
  - Mistake: brown firm emits 261 times more pollution as a green firm

- Investors don't grow green firms that can replace critical brown output
  - Avoid entire brown industries (e.g. agriculture) and hold green (e.g. insurance)

Has sustainable investing changed the cost of capital?

- **Yes, by 1-3%+ :** Chava (2014), van der Beck (2021), Kacperczyk and Pedro (2022), Pastor et al. (2022), Green and Vallee (2022), Gormsen et al. (2022)

- **No, offsetting flows**: Teoh et al. (1999), Berk and van Binsbergen (2021)

Regardless, with $35 trillion invested and growing, important to know what would happen if sustainable investing succeeds in changing the cost of capital

We show best case scenario is one in which the dominant strategy has not yet succeeded

Implications for related literature

Models of firm investment choices in the presence of sustainable investing

- Broccardo et al. (2020), Berk and van Binsbergen (2021), Davies and Van Wesep (2018), Edmans et al. (2022), Pastor et al. (2021), Heinkel et al. (2001), Oehmke and Opp (2022)

- Focuses on incentives to become green to access cheap capital or higher share price

  Our paper: incentives are very weak in practice

- Existing models do not model the direct and heterogeneous effect of cost of capital

  Our paper: impact elasticity, counterproductive instead of merely ineffective

- Output from green and brown firms assumed to be fully substitutable (reasonable *if* sustainable investors industry-adjust their investments)

Measurement and data

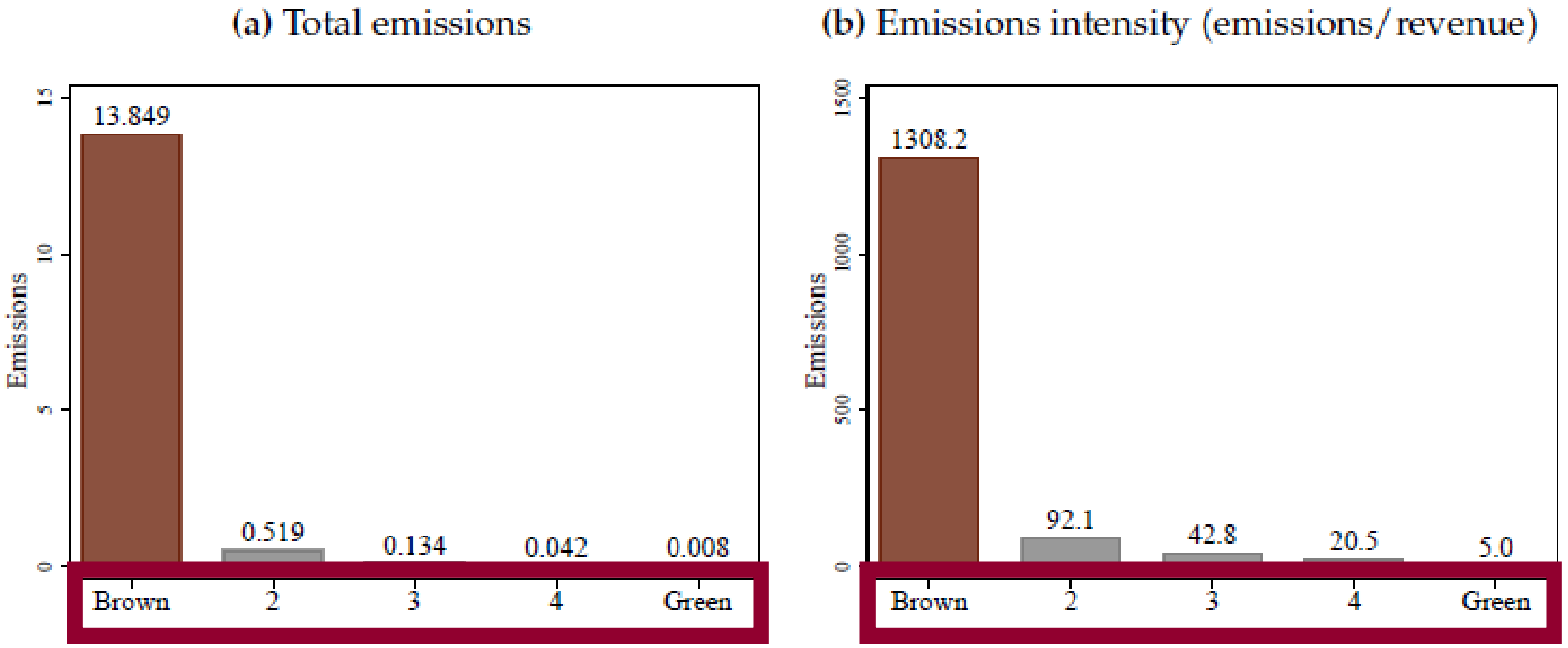
Focus on **emissions intensity** = emissions/revenue

- Standard practitioner target
- Normalizes for firm size
- Recognizes trade-off between emissions and output for a transition goal

- Scope 1 and 2 greenhouse gas emissions for ~3000 firms from Trucost for 2002 to 2020
  - Results robust to using emissions data directly reported by firms
- ESG ratings from MSCI
- Firm and industry data from Compustat and CRSP
- Firm implied cost of capital from Lee, So, and Wang (2021)
- Sustainable investment fund definitions from Cohen, Gurun, and Nguyen (2020)

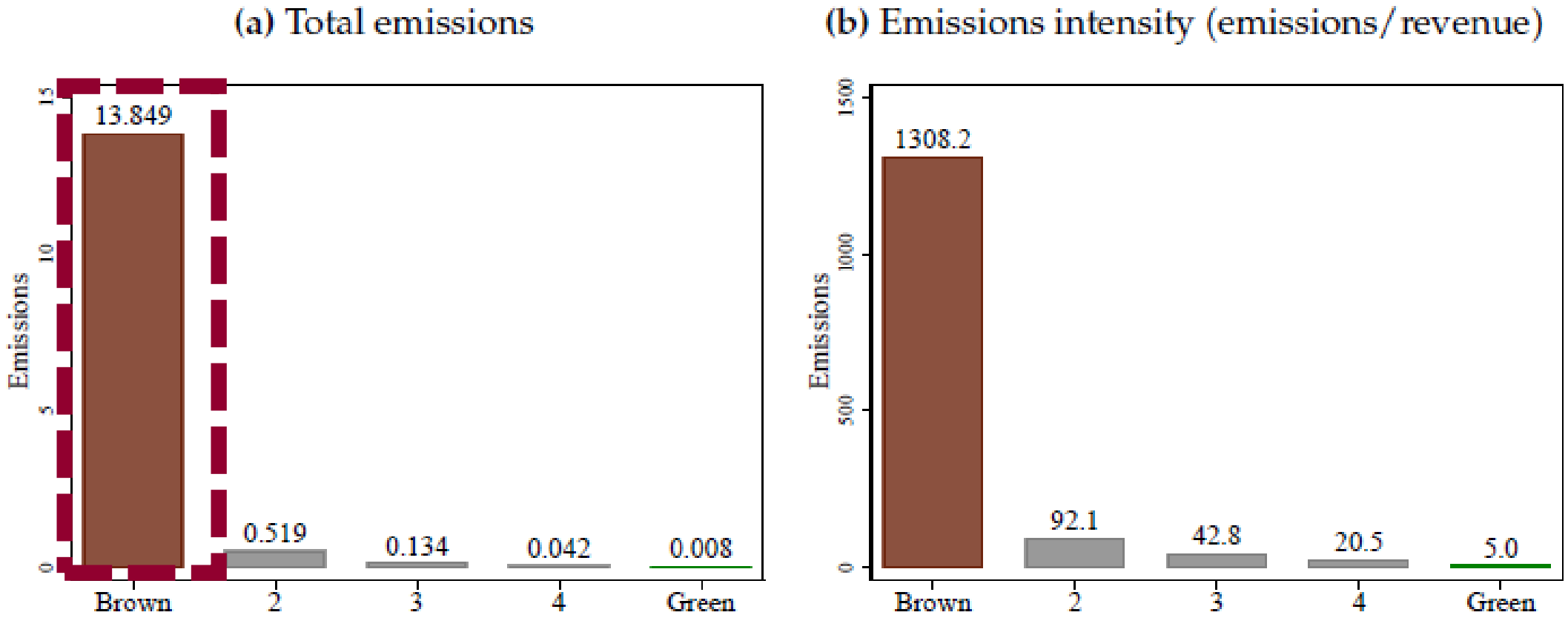
Emissions

Brown: Quintile 1, Neutral: Quintiles 2-4, Green: Quintile 5



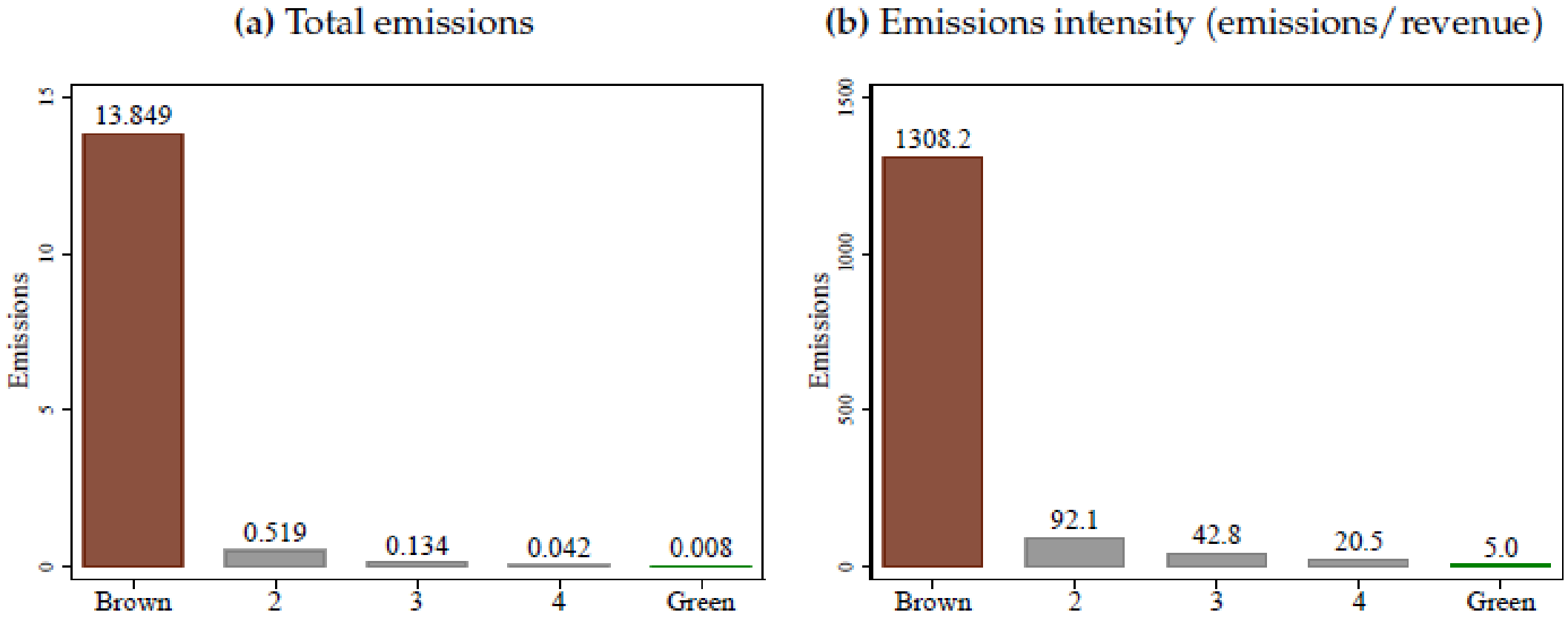
Emissions

Brown firms have ~1,700 times the total emissions of green firms



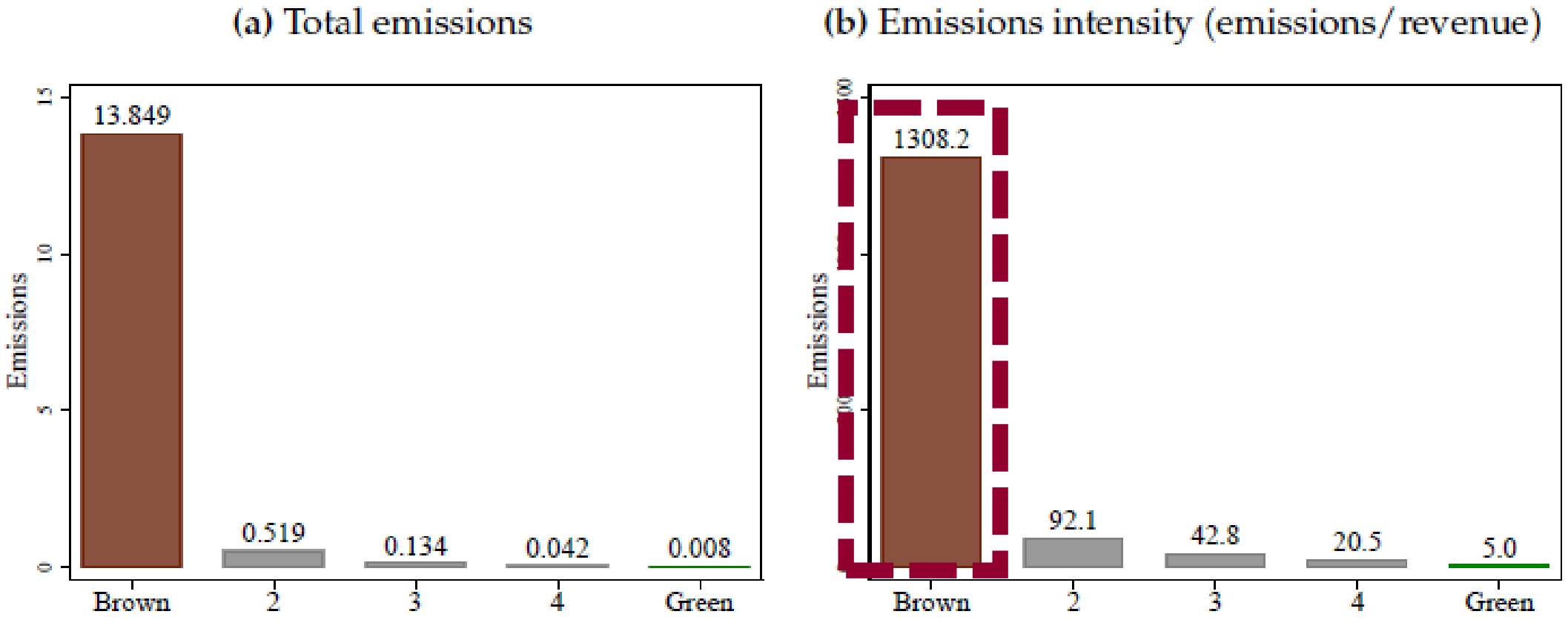
Emissions

Is this just due to differences in firm size?



Emissions

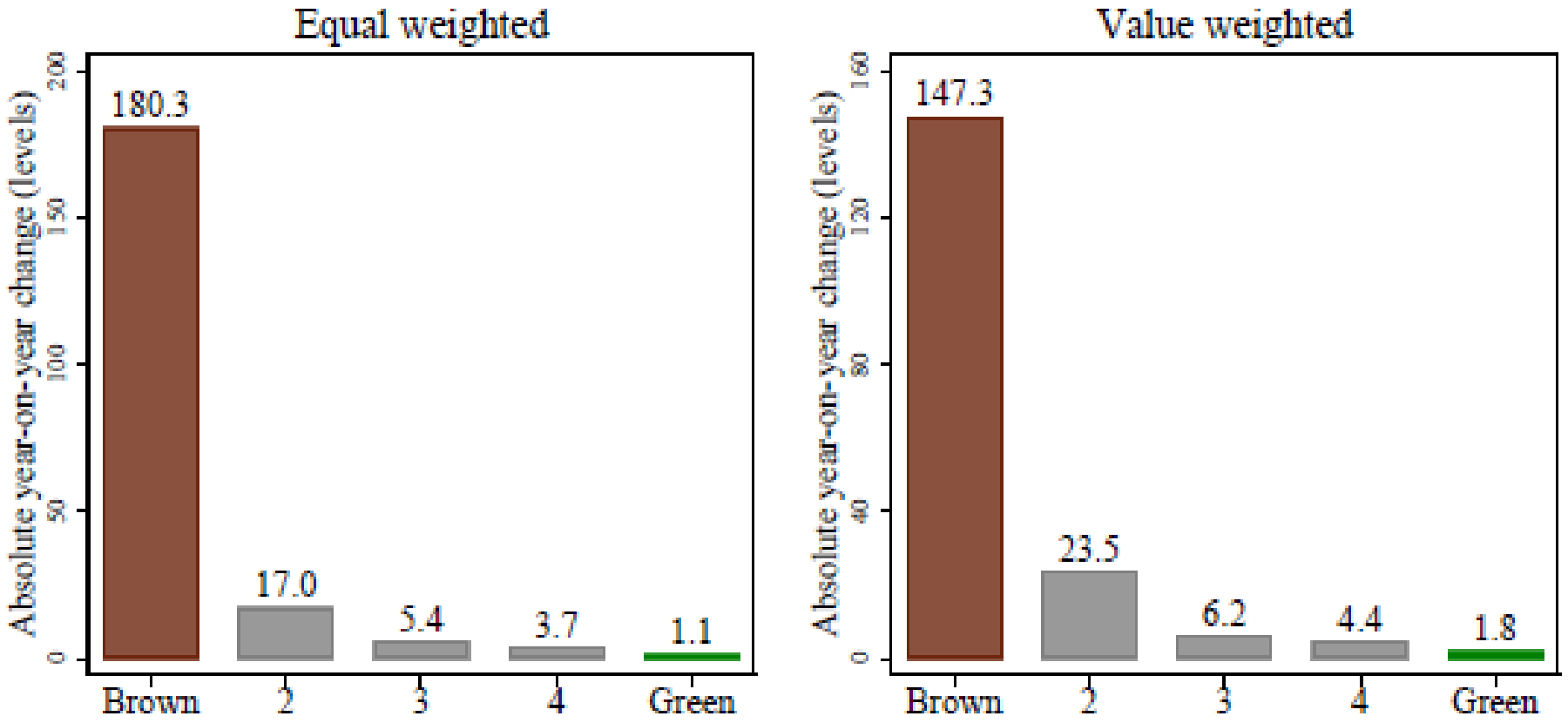
No, brown firms have 261 times the emissions intensity of green firms



Emissions variability

Variability ≡ |annual level change in emissions intensity|

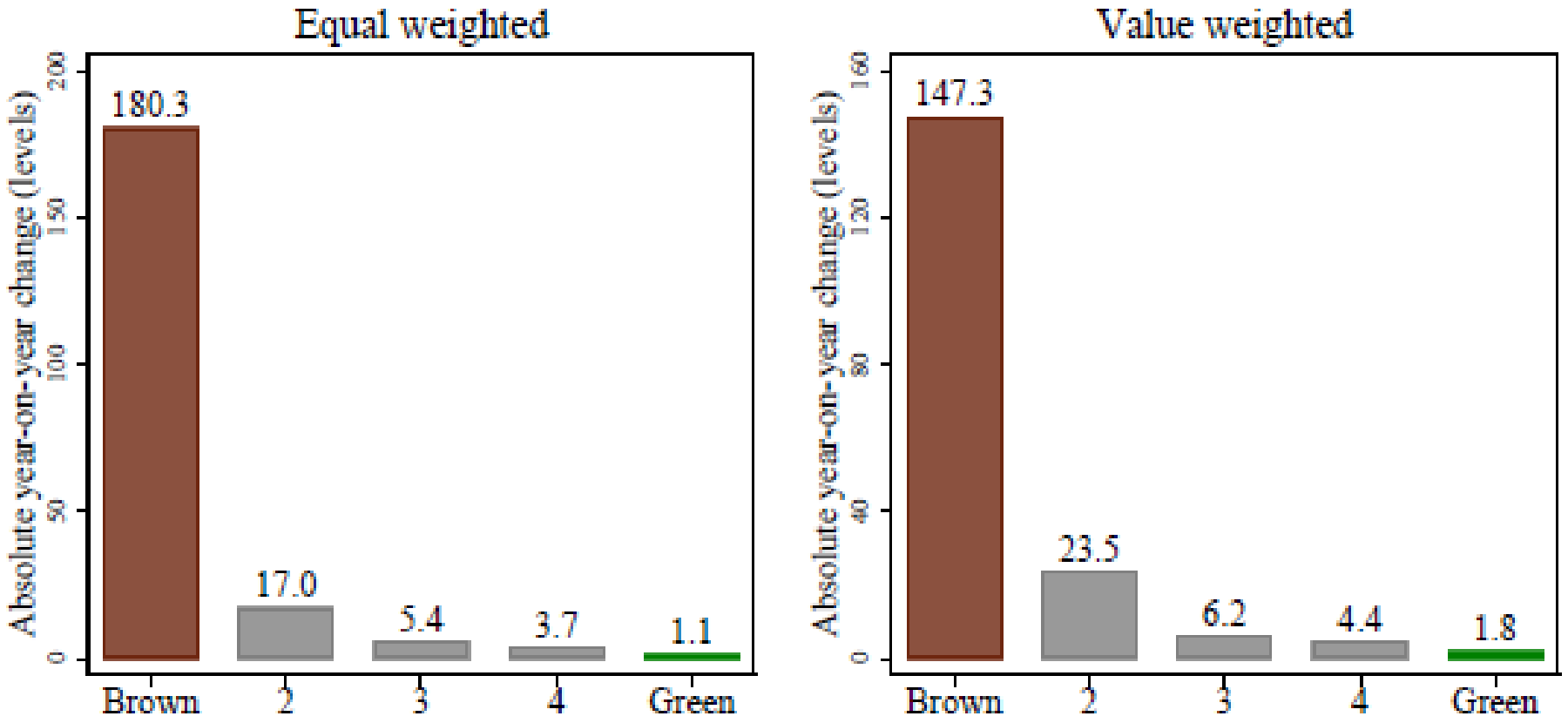
Variability close to zero implies impact elasticity is also close to zero



Emissions variability

Brown variability in emissions ~160 times greater than green

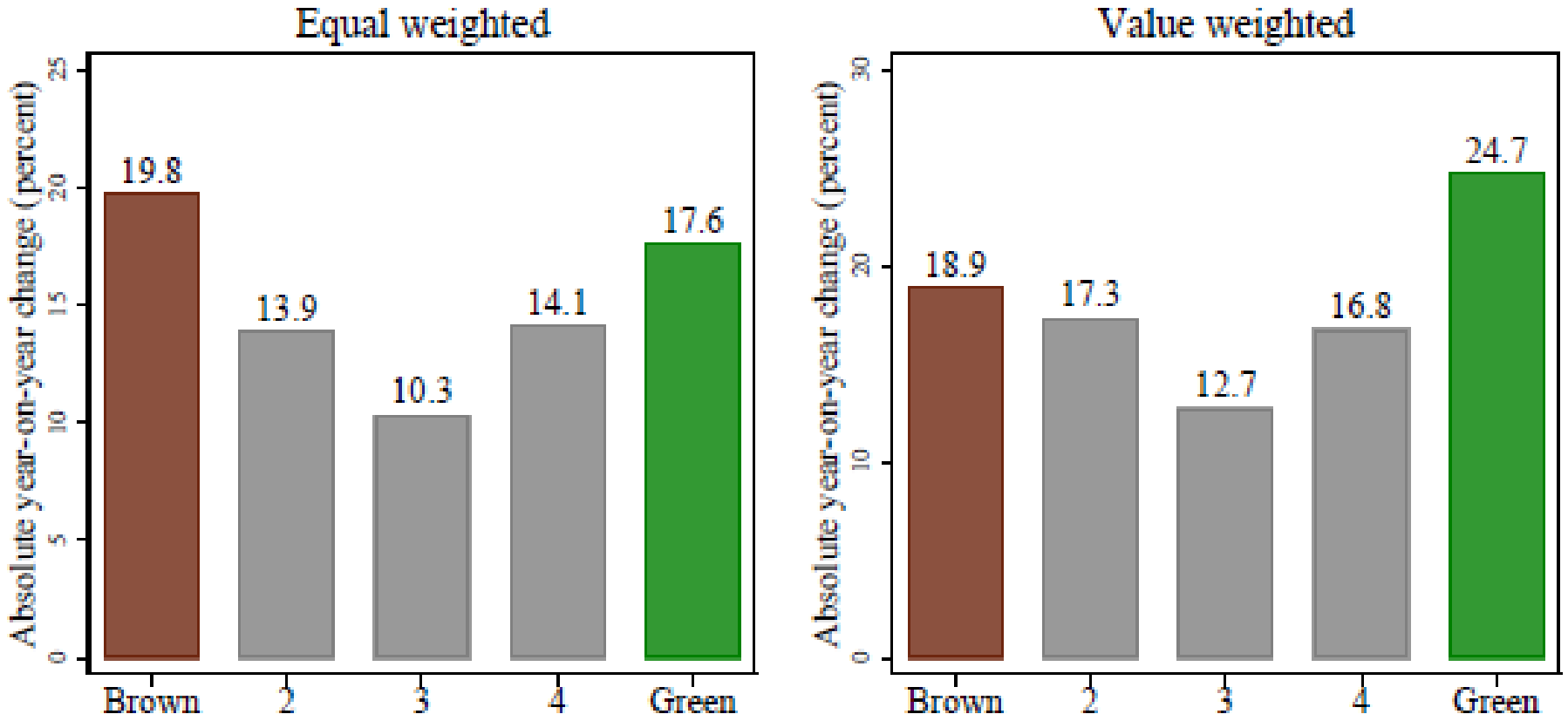
Implies brown firms have greater scope for change



Emissions variability in percentage changes

Green firms experience high ***percentage*** changes in emissions

A 100% reduction in emissions by a green firm is far less economically meaningful than a 1% reduction by a similarly-sized brown firm



Measuring the impact elasticity

$$\textit{Impact Elasticity} \equiv \frac{\partial\ \text{Impact}}{\partial\ \text{Cost of capital}}$$

- Impact measured as emissions intensity
- Examine reactions to a broad class of shocks to firms' cost of capital
- Underlying assumption: if the dominant sustainable investing strategy succeeds alters firm's financing costs, firms would react in a similar fashion as they react to other changes to their cost of capital
- Potential violations of assumption (incentive effects) explored later

Emissions and firm financial performance

	Changes in emissions	
	(1)	(2)
Brown × Annual return	-49.95***	
	(8.150)	
Neutral × Annual return	1.260	
	(0.944)	
Green × Annual return	1.245	
	(1.101)	
Brown × Industry annual return		-72.84***
		(16.96)
Neutral × Industry annual return		-0.315
		(5.014)
Green × Industry annual return		1.445
		(5.487)
p-value: Brown × X = Green × X	0.000	0.000
Type FE	Yes	Yes
Year FE	Yes	Yes
SIC2 FE	Yes	Yes
N	23818	24271
R^2	0.0493	0.0432

Strong past financial performance eases the firm's financial constraints

Lowering its cost of capital

Emissions and firm financial performance

	Changes in emissions (1)	(2)
Brown × Annual return	-49.95***	
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Brown firms become more green after higher returns (and more brown after lower returns)

Green firms are largely unchanged

Implies a large negative impact elasticity for brown firms, and a close-to-zero one for green firms

Emissions and firm financial performance

	Changes in emissions	
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Is this due to reverse causality or omitted variables?

Use industry return (excluding focal firm) instead of firm returns to establish causality

Emissions and firm financial performance

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Year FE	Yes	Yes
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N	23818	24271
R^2	0.0493	0.0432

Similar using industry return

Brown firms become more green after higher industry returns (and more brown after lower returns)

Green firms are largely unchanged

Longer term changes in emissions

	5-year Changes in emissions	
	(1)	(2)
Brown × Annual return	-145.5***	
	(35.30)	
Neutral × Annual return	0.748	
	(5.373)	
Green × Annual return	-3.234	
	(3.183)	
Brown × Industry annual return		-281.4***
		(63.45)
Neutral × Industry annual return		-40.49***
		(14.54)
Green × Industry annual return		-36.90**
		(15.33)
p-value: Brown × X = Green × X	0.000	0.000
Type FE	Yes	Yes
Year FE	Yes	Yes
SIC2 industry FE	Yes	Yes
N	12272	12412
R^2	0.130	0.128

- Stronger effects over longer horizons
  - Consistent with effect of investment choices on emissions taking several years to fully materialize
- Inconsistent with results being driven by short term revenue swings and slow emissions adjustment

Financial distress

- Goal of sustainable investors is often to punish brown firms, reduce their access to capital, and push them toward financial distress
- What happens if green investors succeed?
- Examine firms' emissions behavior when they’re close to financial distress

Emissions and financial distress

	Changes in emissions	
	(1)	(2)
Brown × Low interest coverage	26.15*	
	(14.80)	
Neutral × Low interest coverage	-6.135***	
	(1.189)	
Green × Low interest coverage	-4.218***	
	(1.289)	
Brown × Low Z-score		34.90***
		(12.96)
Neutral × Low Z-score		-5.333***
		(1.273)
Green × Low Z-score		0.508
		(2.117)
p-value: Brown × X = Green × X	0.041	0.009
Type FE	Yes	Yes
Year FE	Yes	Yes
SIC2 FE	Yes	Yes
N	19747	19069
R^2	0.0404	0.0425

Proxy for financial distress using interest coverage or Altman Z-score in the bottom decile within our sample

When pushed to financial distress, brown firms pollute more

Green firm have smaller reactions, sometimes in the opposite direction

Productivity shocks or cost of capital shocks?

Financial performance could capture productivity shocks as well as cost of capital shocks

- Examine measures that isolate the financial channel

1. Implied cost of capital (ICC): internal rate of return that equates the firm's market value to the present value of expected future cash flows
   - ΔICC is the Δcost of capital that is distinct from Δcash flow expectations

2. Firm leverage interacted with industry productivity shocks: Highly-leveraged firms are more likely to face financial constraints following bad shocks

3. Exogenous variation in demand for dividend payments as a shock to the cost of capital (Hartzmark and Solomon 2013, 2019)

Emissions and implied cost of capital

	Changes in emissions			
	(1)	(2)	(3)	(4)
Brown × ΔICC	680.6***			
	(140.8)			
Neutral × ΔICC	-14.36			
	(19.15)			
Green × ΔICC	-18.40			
	(16.90)			
Brown × ΔIndustry ICC		452.8*		
		(240.9)		
Neutral × ΔIndustry ICC		-26.56		
		(62.93)		
Green × ΔIndustry ICC		-44.19		
		(57.17)		
Brown × ΔICC composite			418.3***	
			(107.3)	
Neutral × ΔICC composite			-10.35	
			(18.38)	
Green × ΔICC composite			-22.82	
			(16.78)	
Brown × ΔIndustry ICC composite				402.1***
				(122.8)
Neutral × ΔIndustry ICC composite				19.59
				(23.34)
Green × ΔIndustry ICC composite				38.02*
				(22.98)
p-value: Brown × X = Green × X	0.000	0.042	0.000	0.003
Type FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
SIC2 industry FE	Yes	Yes	Yes	Yes
N	15978	24162	6801	22809
R^2	0.0521	0.0389	0.0639	0.0390

Similar results using the ICC

Interaction between leverage and real productivity shocks

	Changes in emissions	
	(1)	(2)
Brown × Low interest coverage × ΔIndustry ROA	-563.8*	
	(305.7)	
Neutral × Low interest coverage × ΔIndustry ROA	-17.89	
	(46.53)	
Green × Low interest coverage × ΔIndustry ROA	184.4**	
	(87.26)	
Brown × Firm leverage × ΔIndustry ROA		-922.5*
		(504.3)
Neutral × Firm leverage × ΔIndustry ROA		16.26
		(101.9)
Green × Firm leverage × ΔIndustry ROA		335.9***
		(110.5)
p-value: Brown × X × Z = Green × X × Z	0.019	0.014
Type × ΔIndustry ROA	Yes	Yes
Type × Low interest rate	Yes	No
Type × Firm Leverage	No	Yes
Type FE	Yes	Yes
Year FE	Yes	Yes
SIC2 industry FE	Yes	Yes
N	19677	24169
R^2	0.0415	0.0419

Brown firms with low interest coverage or higher leverage increase emissions more following negative industry productivity shocks

Dividend demand shocks to the cost of capital

	Changes in emissions	
	(1)	(2)
Brown × High dividend yield firm × Dividend demand	-89.78***	
	(32.27)	
Neutral × High dividend yield firm × Dividend demand	2.061	
	(3.350)	
Green × High dividend yield firm × Dividend demand	-2.593	
	(2.325)	
Brown × High dividend yield firm × High dividend demand		-58.01***
		(17.35)
Neutral × High dividend yield firm × High dividend demand		-0.368
		(1.852)
Green × High dividend yield firm × High dividend demand		-0.597
		(1.047)
p-value: Brown × X × Z = Green × X × Z	0.007	0.001
Type × Dividend demand	Yes	No
Type × High dividend demand	No	Yes
Type FE	Yes	Yes
Year FE	Yes	Yes
SIC2 industry FE	Yes	Yes
N	16605	16605
R^2	0.0550	0.0553

When aggregate dividend demand is high…

Brown dividend paying firms experience a decrease in their cost of capital

And reduce emissions

Why do brown and green firms have different impact elasticities?

Brown firms can choose between two types of projects

1. Continue/expand brown production, cut corners on abatement (cash now)
2. New green production (higher up-front cost, backloaded cash flows)

↑ cost of capital = ↑ discount rate: Short term cash flows look more attractive, favoring Option 1 → negative impact elasticity

Contradiction: Sustainable investors want brown firms to care more about the future, but raising their discount rates makes brown firms care less about the future

Green firms operate in a line of business (e.g. insurance) where they cannot generate large environmental externalities regardless of which investments are chosen

Additional incentive effects?

Direct effect of changes in cost of capital:

- Brown firms increase emissions (negative impact elasticity)
- Green firms don't change (close-to-zero impact elasticity)

Indirect incentive effects? What if brown firms choose to become more green to access a lower cost of capital or higher share price from sustainable investors in the future?

- Promising in theory!
- In practice, sustainable investors offer very weak incentives
  - Reward green firms for large %, but economically trivial, emissions reductions

Green fund holdings and emissions

	Overweight in green funds			
	(1)	(2)	(3)	(4)
Emissions	-0.00726***	-0.00808***	-0.00697***	-0.00764***
	(0.00237)	(0.00253)	(0.00233)	(0.00248)
$\Delta_{t,t-1}$Emissions (changes in levels)	-0.00196			
	(0.00554)			
$\Delta_{t,t-2}$Emissions (changes in levels)		0.000651		
		(0.00455)		
$\Delta_{t,t-1}$Emissions (changes in percents)			-0.106***	
			(0.0385)	
$\Delta_{t,t-2}$Emissions (changes in percents)				-0.0584**
				(0.0279)
Year FE	Yes	Yes	Yes	Yes
N	24345	21118	24345	21118
R^2	0.0106	0.0113	0.0108	0.0114

Green fund holdings and emissions

Green funds overweight firms with low emissions

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Year FE	Yes	Yes	Yes	Yes
N	24345	21118	24345	21118
R^2	0.0106	0.0113	0.0108	0.0114

Green fund holdings and emissions

Green funds don't respond to changes in emissions levels

	Overweight in green funds			
	(1)	(2)	(3)	(4)
Emissions	-0.00726***	-0.00808***	-0.00697***	-0.0076
	(0.00237)	(0.00253)	(0.00233)	(0.00248)
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Green fund holdings and emissions

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				(0.0279)
Year FE	Yes	Yes	Yes	Yes
N	24345	21118	24345	21118
R^2	0.0106	0.0113	0.0108	0.0114

Environmental score and emissions

Environmental ESG ratings (MSCI) similarly reward firms for low levels of emissions and % reductions in emissions, but not reductions in levels

	Environmental score			
	(1)	(2)	(3)	(4)
Emissions	-0.0190***	-0.0197***	-0.0188***	-0.0196***
	(0.00346)	(0.00361)	(0.00348)	(0.00364)
$\Delta_{t,t-1}$Emissions (changes in levels)	-0.00514			
	(0.00748)			
$\Delta_{t,t-2}$Emissions (changes in levels)		0.00172		
		(0.00756)		
$\Delta_{t,t-1}$Emissions (changes in percents)			-0.130***	
			(0.0347)	
$\Delta_{t,t-2}$Emissions (changes in percents)				-0.0874***
				(0.0256)
Year FE	Yes	Yes	Yes	Yes
N	9887	8568	9887	8568
R^2	0.155	0.167	0.156	0.169

Which firms get rewarded for % reductions?

Sustainable investors reward green firms more than brown firms for the same percentage reduction in emissions

	Overweight in green funds		Environmental score	
	(1)	(2)	(3)	(4)
Emissions	-0.00633**	-0.00608**	-0.0161***	-0.0155***
	(0.00308)	(0.00303)	(0.00444)	(0.00464)
Brown × $\Delta_{t,t-1}$Emissions (changes in percents)	-0.0142		-0.133*	
	(0.0734)		(0.0698)	
Neutral × $\Delta_{t,t-1}$Emissions (changes in percents)	-0.161***		-0.121**	
	(0.0553)		(0.0538)	
Green × $\Delta_{t,t-1}$Emissions (changes in percents)	-0.199***		-0.146**	
	(0.0574)		(0.0589)	
Brown × $\Delta_{t,t-2}$Emissions (changes in percents)		0.00814		-0.0836
		(0.0473)		(0.0526)
Neutral × $\Delta_{t,t-2}$Emissions (changes in percents)		-0.0908**		-0.0673*
		(0.0385)		(0.0364)
Green × $\Delta_{t,t-2}$Emissions (changes in percents)		-0.169**		-0.147***
		(0.0704)		(0.0489)
p-value: Brown × X = Green × X	0.050	0.042	0.890	0.370
Type FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	24345	21118	9887	8568
R^2	0.0110	0.0119	0.159	0.173

Europe's Climate Leaders 2022

Company	Country	Sector	Reduction of core emissions intensity (Scope 1 and 2) YoY 2015-20 [1]	Core emissions intensity (GHGs in tonnes per €mn revenue) [2]	Core emissions in tonnes (CO2 equivalent) [2]	Total reduction of core emissions 2015-20 [3]	Scope 3 emissions reported? [4]	CDP rating [5]	Participation in Science Based Targets initiative (SBTi) [6]
Logitech International	Switzerland	Technology & Electronics	46.8%	0.4	1,889	88.9%	yes	-	Committed
CAP	Italy	Energy & Utilities	45.2%	14.2	3,365	95.1%	yes	-	-
ICA Gruppen	Sweden	Retail & Ecommerce	42.4%	1.5	19,394	92.1%	yes	Not scored (F)	Targets set, well below 2°C
Rosenberger	Germany	Technology & Electronics	42.3%	0.4	554	89.6%	no	-	-
Vaisala	Finland	Technology & Electronics	41.3%	1.1	431	91.7%	yes	B	-
SEGRO	UK	Property	39.5%	7.2	3,489	86.0%	yes	B	Targets set, 1.5°C
Sopra Steria	France	Consulting & Professional Services	39.4%	1.1	4,842	72.9%	yes	A	Targets set, 1.5°C

Focus on % reductions is a proportional thinking error (Kahneman 1981, Shue and Townsend 2021)

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Counterproductive relative to what goal?

1. **Transition to green**
2. **Degrowth (shrink economy or shrink/eliminate brown sectors)**

We show brown firms become more brown in terms of emissions per unit output

- Only counterproductive relative to a transition goal

Dominant sustainable investing strategy not counterproductive to degrowth goal

- Large increase in financing costs will kill firms, deter entry, and reduce absolute emissions

Shrinking brown firms and a green transition

Brown industries produce output that we cannot easily substitute away from

- Hard to substitute from agriculture, energy and building materials (brown) to insurance, health care, and financial services (green)

Transition goal implies sustainable investors should invest in relatively green or improving firms ***within*** a brown industry

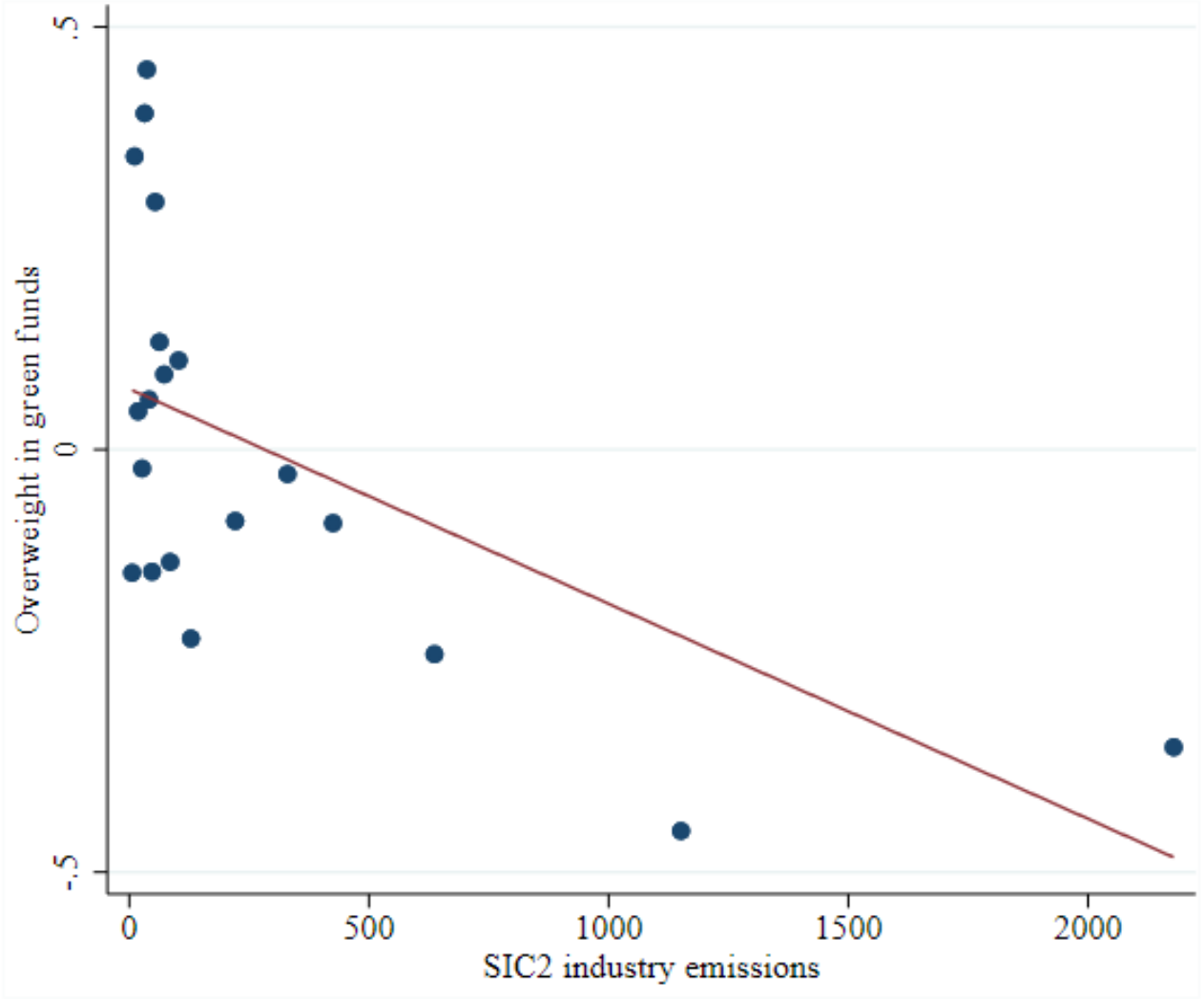
- Without underweighting entire brown industries

Example goal: Decrease emissions intensity and still feed people

- Invest in relatively green or transitioning (in levels, not %s) agriculture firms
- Relatively green agriculture is still brown compared to insurance firms

- Reality: Sustainable investors underweight entire agriculture industry $\sim 80\%$

Green fund allocations by SIC2 industry



S&P 500 firms with the lowest emissions

1. Amerisource Bergen
2. Lincoln National
3. United Health
4. Anthem
5. Metlife
6. Cigna
7. Prudential Financial
8. Humana
9. Hartford Financial Services
10. Travelers

Insurance, healthcare, and financial services companies

Not obvious candidates for

- replacing brown agriculture or any brown products
- creating green R&D

Cohen et al. (2022) shows that brown energy sector firms develop the most promising green energy patents

Improvements to sustainable investing strategy

- Reward firms for improvement using the correct metric
  - Some investors try to do this, but use the wrong (%) metric
  - Coming soon: Index of improvers based on appropriate metric
- Strategy to achieve “impact” can’t ignore brown firms
  - “Impact” investors cannot follow deontological investment principles
- Shrinking brown firms in a green transition requires growing firms to replace output - Much investment will be within industry or product class
- This is a complicated and nuanced problem and a better strategy is likely not as simple and straightforward as the current dominant versions
  - Well meaning investors avoiding this nuance likely accounts for some of the issues with the current strategy

Conclusion

Dominant sustainable investing strategy may be counterproductive

- Green impact elasticity ≈ 0, brown impact elasticity $<< 0$
- Brown firms face very weak incentives to become more green
- Shrinking brown and growing green industries won't lead to smooth transition goal

Not a critique of all sustainable investing strategies

- Dominant strategy seems motivated by an "affect heuristic" (naïve desire to reward good and punish bad firms--Hartzmark and Sussman 2019) or deontological ethics
- Investor flows and engagement should target brown firms (e.g. Engine No. 1)
- Portfolios should overweight (or not underweight) brown industries, and reward the relatively green or transitioning firms within brown industries

What about investors who just want to hedge carbon transition risk?

- Demand higher returns for brown firms → Brown becomes more brown