

Dissecting Green Returns

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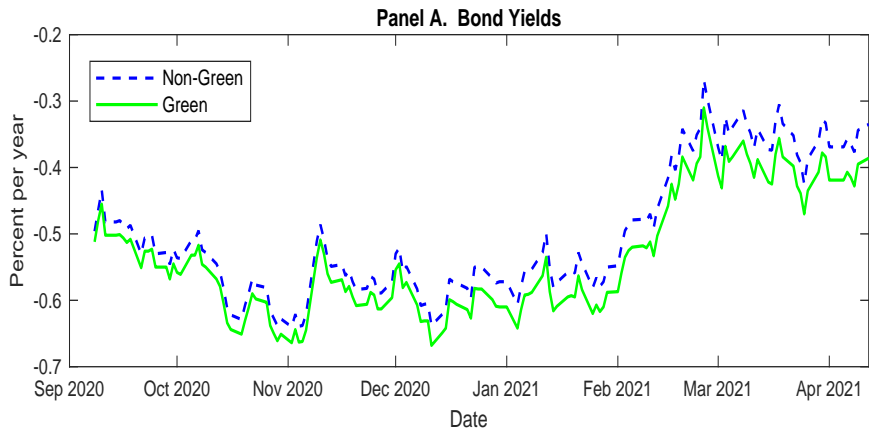
- Asset managers often market ESG/sustainable investments as offering superior risk-adjusted returns
 - Blackrock: *“integrating sustainability can help investors build more resilient portfolios and achieve better long-term, risk-adjusted returns”*
 - State Street: *“ESG is a source of alpha”*
- Many **investors expect high returns from ESG investing**
 - Surveys by BlackRock (2020), BNP Paribas (2019), Schrodgers (2020)
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- **Future performance?**
 - **Expected return \neq Realized return**

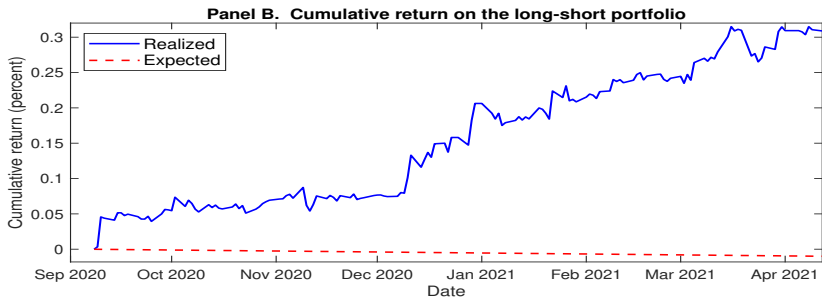
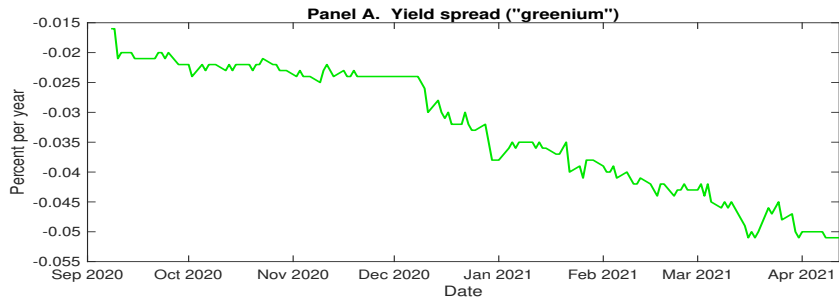
Example: German Twin Bonds

- German government has been issuing **green bonds** since 2020
 - First issue: September 2020 (10-year, zero coupon; 6.5 billion euros)
- Each green bond has a **conventional “twin”**
 - Same issuer, maturity date, coupon rate, coupon payment dates
- Twin bonds offer identical cash flows but different greenness
 - Expected returns?
 - Realized returns?

German Twin Bonds: Yields



German Twin Bonds: Expected vs. Realized Returns



Main Results

- Green stocks outperformed brown in the 2010s
 - Green-minus-brown VW average return: +65 bp per month ($t = 3.23$)
 - Green factor's average return: +58 bp per month ($t = 2.91$)
 - Green factor: Long green, short brown, weight by greenness

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 - The outperformance vanishes if we set climate shocks to zero
 - The factor's **realized return** > **expected return**

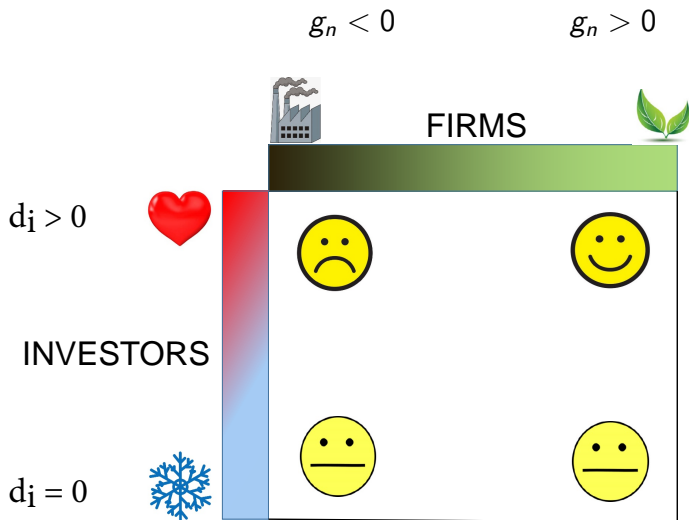
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 - **Value** stocks tend to be **brown**; **growth** stocks tend to be **green**
- The **green factor** reacts to climate-concern shocks with a delay
 - Small stocks seem to **underreact** to climate news

Background: Pástor, Stambaugh, and Taylor (JFE forth.)



Background: PST Model's Implications

- Greener assets have **lower expected returns** (and alphas)
 - Because agents have green tastes & green assets hedge climate risk

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- Greener assets have **higher realized returns** (and alphas) while tastes are shifting unexpectedly toward green assets & products
- **ESG factor** captures shifts in customers' and investors' tastes
 - ESG factor is long green, short brown assets, weighted by ESG scores
 - ESG factor's **expected return is negative**

$$E(\tilde{f}_g) = -\frac{\bar{d}}{a} < 0$$

where \bar{d} is the average taste for green assets, a is risk aversion

- ESG factor and the market price assets in a **two-factor model**
- Here, the **green factor** takes the role of the ESG factor

Measuring Stocks' Greenness

- MSCI ESG Ratings (MSCI: world's largest ESG data provider)
- Firm i 's unadjusted **greenness** in month $t + 1$:

$$G_{i,t} = -(10 - E_score_{i,t}) \times E_weight_{i,t}/100$$

- E_score = “Environmental pillar score” (0–10)
 - Measures a company's resilience to long-term environmental risks
 - Weighted-average score across 13 environmental issues
- E_weight = “Environmental pillar weight” (0–100)
 - Measures the importance of E relative to S and G in this industry

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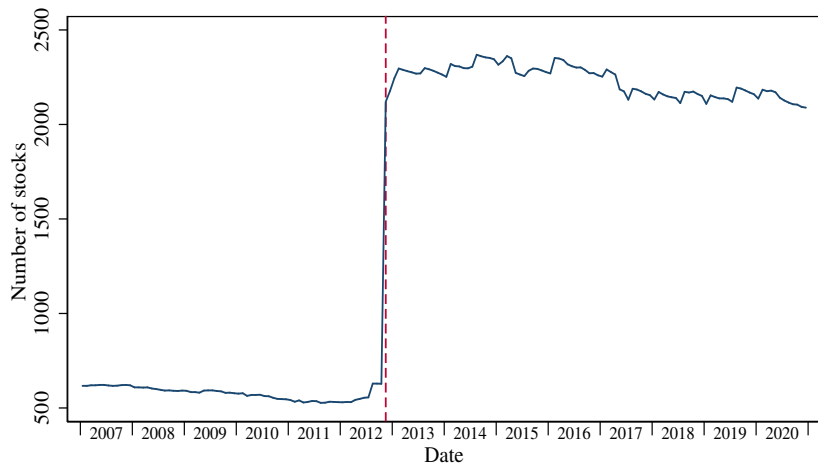
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- Example (2019):
 - Exxon Mobil: $E_score = 4.2$, $E_weight = 48 \Rightarrow G_{i,t} = -2.78$
 - Best Buy: $E_score = 4.1$, $E_weight = 11 \Rightarrow G_{i,t} = -0.65$
- We use firm i 's greenness relative to the market: $g_{i,t} = G_{i,t} - \bar{G}_t$
 - \bar{G}_t is the value-weighted average of $G_{i,t}$ across all firms

Industries Ranked by Environmental Scores (Dec 2019)

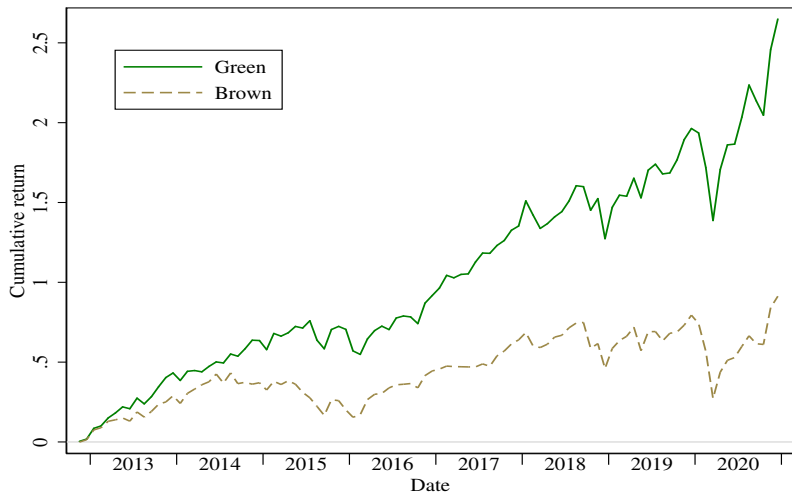
Rank	MSCI Industry	Avg. g	Rank	MSCI Industry	Avg. g
1	Asset Management & Custody Banks	0.870	33	Textiles, Apparel & Luxury Goods	-0.502
2	Professional Services	0.850	34	Auto Components	-0.505
3	Telecommunication Services	0.841	35	Property & Casualty Insurance	-0.506
4	Consumer Finance	0.837	36	Casinos & Gaming	-0.542
5	Health Care Equipment & Supplies	0.835	37	Real Estate Development	-0.548
6	Health Care Providers & Services	0.825	38	Semiconductors	-0.657
7	Life & Health Insurance	0.761	39	Electrical Equipment	-0.750
8	Interactive Media & Services	0.736	40	Construction & Farm Machinery	-0.758
9	Diversified Financials	0.732	41	Tobacco	-0.885
10	Media & Entertainment	0.704	42	Trading Companies & Distributors	-0.987
11	Diversified Consumer Services	0.614	43	Industrial Machinery	-1.040
12	Biotechnology	0.567	44	Containers & Packaging	-1.091
13	Pharmaceuticals	0.489	45	Energy Equipment & Services	-1.159
14	Multi-Line Insurance & Brokerage	0.405	46	Real Estate Management & Services	-1.198
15	Investment Banking & Brokerage	0.387	47	Airlines	-1.214
16	Banks	0.348	48	Hotels & Travel	-1.566
17	Restaurants	0.309	49	Building Products	-1.620
18	Construction & Engineering	0.125	50	Utilities	-1.903
19	Aerospace & Defense	0.097	51	Integrated Oil & Gas	-2.008
20	Commercial Services & Supplies	0.069	52	Food Products	-2.019
21	Air Freight & Logistics	-0.055	53	Beverages	-2.044
22	Household Durables	-0.116	54	Metals and Mining, Precious	-2.193
23	Software & Services	-0.130	55	Oil & Gas Refining, Marketing	-2.522
24	Electronic Equipment, Instruments	-0.170	56	Construction Materials	-2.556
25	Leisure Products	-0.173	57	Specialty Chemicals	-2.818
26	Automobiles	-0.215	58	Marine Transport	-2.828
27	Retail - Food & Staples	-0.251	59	Paper & Forest Products	-2.930
28	Retail - Consumer Discretionary	-0.269	60	Metals and Mining, Non-Precious	-2.947
29	Road & Rail Transport	-0.299	61	Steel	-2.955
30	Household & Personal Products	-0.300	62	Oil & Gas Exploration & Production	-3.010
31	Industrial Conglomerates	-0.364	63	Diversified Chemicals	-3.212
32	Technology Hardware, Storage	-0.391	64	Commodity Chemicals	-3.783

MSCI Coverage



- Sample: November 2012 to December 2020

Returns on Value-Weighted Green and Brown Portfolios



GMB (Green Minus Brown) Portfolio Performance

	(1)	(2)	(3)	(4)	(5)	(6)
Constant	0.648 (3.23)	0.712 (2.91)	0.496 (2.23)	0.472 (2.14)	0.500 (2.25)	0.496 (2.38)
Mkt-Rf		-0.0508 (-0.78)	0.0156 (0.32)	0.0473 (0.87)	0.0106 (0.21)	0.0363 (0.77)
SMB			-0.137 (-1.49)	-0.114 (-1.23)	-0.162 (-1.56)	-0.262 (-2.59)
HML			-0.262 (-3.36)	-0.182 (-1.99)	-0.265 (-3.26)	-0.212 (-2.60)
UMD				0.130 (2.00)		
LIQ					0.0412 (0.60)	
RMW						-0.385 (-2.90)
CMA						-0.0960 (-0.60)
Observations	98	98	98	98	98	98
R^2	0.000	0.011	0.186	0.220	0.189	0.261

Constructing the Green Factor

- PST derive a two-factor asset pricing model:

$$\tilde{r} = \beta \tilde{r}_m + g \tilde{f}_g + \tilde{\epsilon}$$

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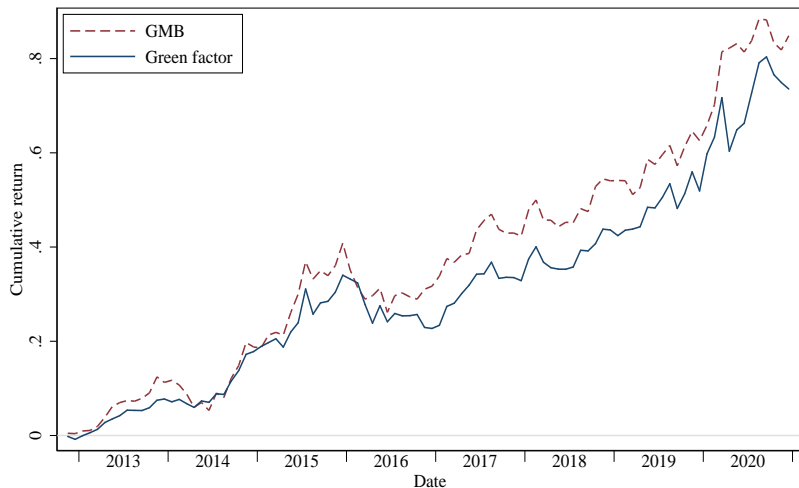
$$\tilde{r} = \beta \tilde{r}_m + g \tilde{f}_g + \tilde{\epsilon}$$

⇒ The realization of \tilde{f}_g in month t is the slope from the cross-sectional regression of $\tilde{r}_{i,t}^e$ on $g_{i,t-1}$, with no intercept:

$$\hat{f}_{gt} = \frac{g'_{t-1} \tilde{r}_t^e}{g'_{t-1} g_{t-1}}$$

- \tilde{r}_t^e : vector of stocks' market-adjusted excess returns, $\tilde{r}_{i,t} - \beta_{i,t-1} \tilde{r}_{mt}$
 - g_{t-1} : vector of stocks' greenness characteristics, $g_{i,t-1}$
- Return on a portfolio of market-adjusted stock positions where
 - Green stocks have positive weights
 - Brown stocks have negative weights
 - Stocks are weighted by their greenness

Green Factor versus GMB



Green-Factor Performance

	(1)	(2)	(3)	(4)	(5)	(6)
Constant	0.584 (2.91)	0.695 (3.38)	0.383 (2.48)	0.338 (2.46)	0.379 (2.42)	0.392 (2.60)
Mkt-RF		-0.0888 (-1.28)	0.0121 (0.17)	0.0701 (1.19)	0.0173 (0.29)	0.0103 (0.17)
SMB			-0.226 (-3.77)	-0.183 (-3.54)	-0.201 (-2.24)	-0.316 (-4.02)
HML			-0.370 (-6.42)	-0.224 (-3.78)	-0.367 (-5.70)	-0.280 (-4.49)
UMD				0.238 (4.57)		
LIQ					-0.0429 (-0.38)	
RMW						-0.243 (-1.62)
CMA						-0.258 (-2.36)
Observations	98	98	98	98	98	98
R^2	0.000	0.034	0.408	0.519	0.411	0.464

Pricing Value and Momentum in the Green-Factor Model

- PST's two-factor model: Market + Green factor

	Value		Momentum	
Constant	-0.709 (-1.93)	-0.151 (-0.50)	0.663 (1.92)	-0.064 (-0.22)
Mkt-RF	0.139 (1.18)	0.068 (0.70)	-0.368 (-3.75)	-0.275 (-3.14)
Green factor		-0.803 (-4.55)		1.047 (6.18)
Observations	98	98	98	98
R^2	0.041	0.345	0.173	0.487

Explaining the Green Factor's Performance

- The **green factor's realized** return is **positive** over this period, but its **expected** return is **negative** in PST's theory: $E(\tilde{f}_g) < 0$
- In PST's model, $\tilde{f}_g > 0$ in periods of unanticipated increases in demands for green firms' products and stocks
 - Or decreases in demands for brown firms' products and stocks
- Can the factor's positive performance in 2012–2020 be explained by increases in **concerns about climate change**?

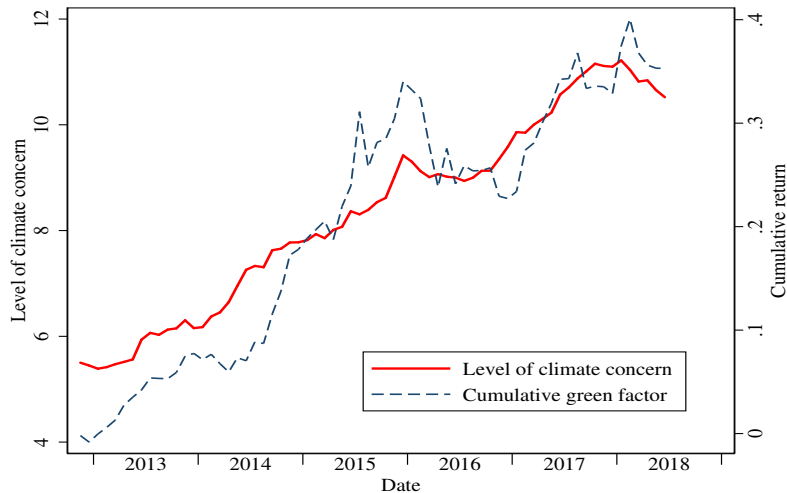
Measuring Climate Concerns

- We use the **Media Climate Change Concerns index (MCCC)** of Ardia, Bluteau, Boudt, and Inghelbrecht (2021)
 - Constructed by aggregating data from eight major U.S. newspapers
 - Captures the number of climate news stories each day as well as their negativity and focus on risk, as measured by textual analysis
- Level of climate concerns at the end of month t :

$$C_t = \sum_{\tau=0}^T \rho^\tau MCCC_{t-\tau}$$

- Assumes memory of climate news decays gradually over time
- ρ measures how long climate news persists in investors' memories
- We set the half-life of news stories to one year $\Rightarrow \rho = 0.94$

Climate Concerns and the Green Factor



Sources of Green-Factor Returns

	(1)
Δ Climate concerns (same month)	0.0119 (0.95)
Δ Climate concerns (prev. month)	0.0440 (2.85)
Constant	0.000246 (0.11)
Observations	68
R^2	0.171

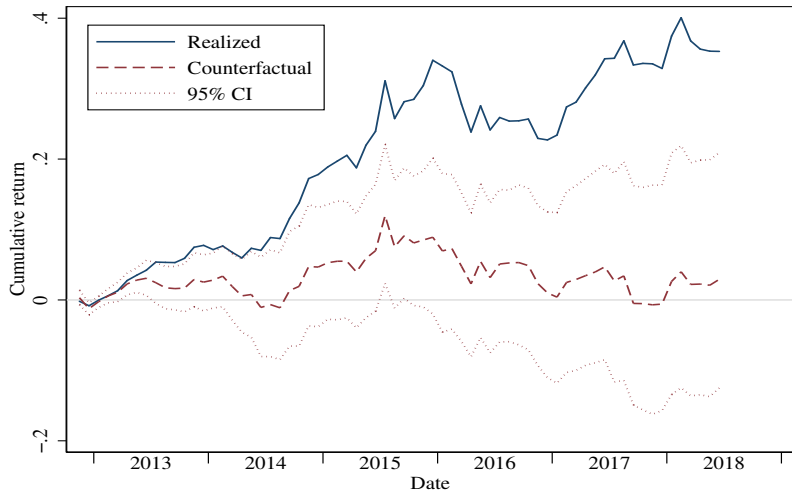
Other Drivers of Green Demand

- Proxies for **customers' demand** for green products
 - Two measures of firms' earnings news, from I/B/E/S and CRSP
 - Proxy 1: Market-adjusted stock return in a three-trading-day window around two types of earnings-related announcements
 - Quarterly earnings announcements
 - Forward guidance regarding future earnings
 - Proxy 2: Change in analysts' forecasts of long-run earnings growth
 - For firm i and quarter t , take the earliest mean analyst forecast in quarter $t + 1$ minus the latest mean forecast in quarter $t - 1$
 - Idea: Capture all news arriving in quarter t
 - Aggregate firm-level earnings measure X_{it} into a green-minus-brown value as $g'_t X_t / (g'_t g_t)$, mimicking the construction of the green factor
- Proxy for **investors' demand** for green assets
 - Capital flows into sustainable mutual funds & ETFs, from Morningstar
 - Scale these "ESG flows" by CRSP's total market capitalization

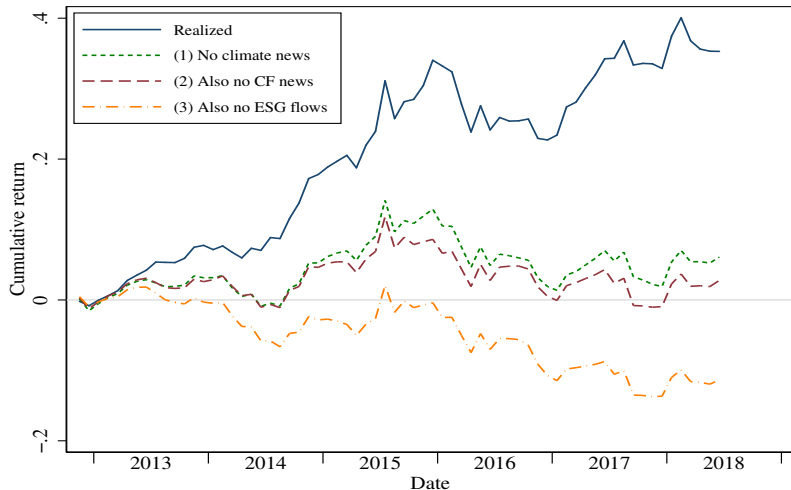
Sources of Green-Factor Returns

	(1)	(2)	(3)
Δ Climate concerns (same month)	0.0119 (0.95)	0.00615 (0.49)	0.00668 (0.54)
Δ Climate concerns (prev. month)	0.0440 (2.85)	0.0394 (2.52)	0.0397 (2.59)
Earnings announcement returns		1.045 (0.98)	0.953 (0.87)
Δ Earnings forecasts		0.426 (0.41)	0.487 (0.42)
ESG flows			0.0804 (0.46)
ESG assets			-0.00295 (-0.59)
Observations	68	68	68
R^2	0.171	0.190	0.181

Counterfactual Green-Factor Returns



Components of Green-Factor Returns



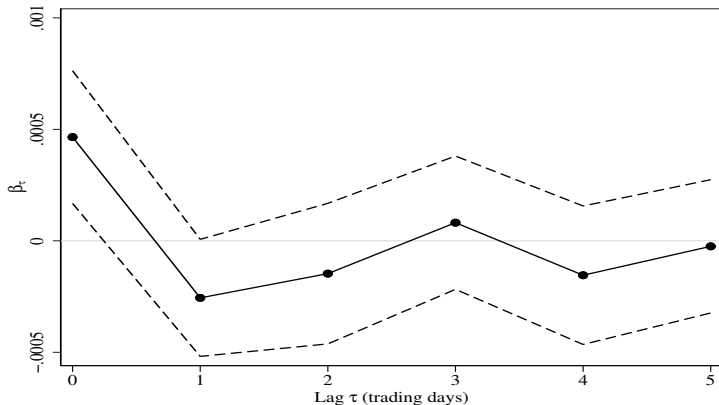
Greenness and Individual Stock Returns

	(1)	(2)	(3)	(4)	(5)
$g_{i,t-1}$	0.00213 (2.24)	-0.0000103 (-0.01)	-0.000267 (-0.27)	-0.00309 (-0.84)	-0.00416 (-0.85)
$g_{i,t-1} \times \Delta C_t$		0.00769 (1.15)	0.00802 (1.36)	0.00830 (1.31)	0.00806 (1.15)
$g_{i,t-1} \times \Delta C_{t-1}$		0.0166 (2.21)	0.0148 (2.24)	0.0159 (2.30)	0.0168 (2.29)
[Earnings announc. ret.] $_{i,t}$			0.320 (13.14)	0.320 (13.14)	0.315 (12.36)
[Δ Earnings forecast] $_{i,t}$			0.0592 (5.02)	0.0596 (5.08)	0.0587 (4.45)
$g_{i,t-1} \times$ [ESG flows] $_t$				0.0753 (0.79)	0.0813 (0.77)
$g_{i,t-1} \times$ [ESG assets] $_{t-1}$				-0.00160 (-0.58)	-0.000847 (-0.33)
$\ln(\text{BE/ME})_{i,t-1}$					-0.000741 (-0.52)
Observations	218,208	151,294	131,689	131,689	114,320

Daily Response of the Green Factor to Climate News

- Slope coefficients β_τ from the time-series regression

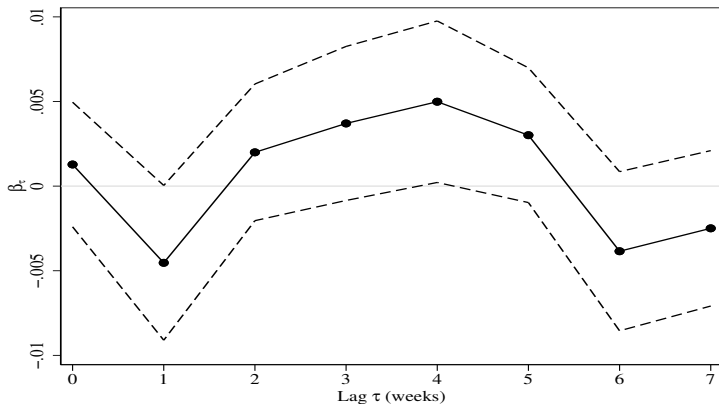
$$\tilde{f}_{g,t} = a + \sum_{\tau=0}^T \beta_\tau MCCC_{t-\tau} + e_t$$



Weekly Response of the Green Factor to Climate News

- Slope coefficients β_τ from the time-series regression

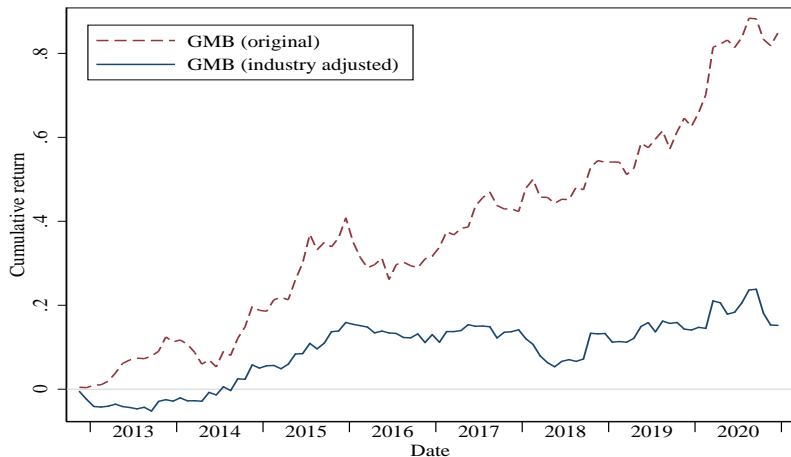
$$\tilde{f}_{g,t} = a + \sum_{\tau=0}^T \beta_\tau MCCC_{t-\tau} + e_t$$



Sources of GMB Returns

	(1)	(2)	(3)
Δ Climate concerns (same month)	0.0409 (2.45)	0.0378 (2.42)	0.0407 (2.47)
Δ Climate concerns (prev. month)	0.0178 (0.92)	0.0180 (1.03)	0.0193 (1.10)
Earnings announcement returns (GMB)		0.784 (2.62)	0.850 (3.00)
Δ Earnings forecasts (GMB)		0.0792 (0.50)	0.118 (0.81)
ESG flows			0.327 (1.49)
ESG assets			-0.00553 (-0.79)
Observations	68	68	68
R^2	0.125	0.242	0.173

Effect of Industry Adjustment



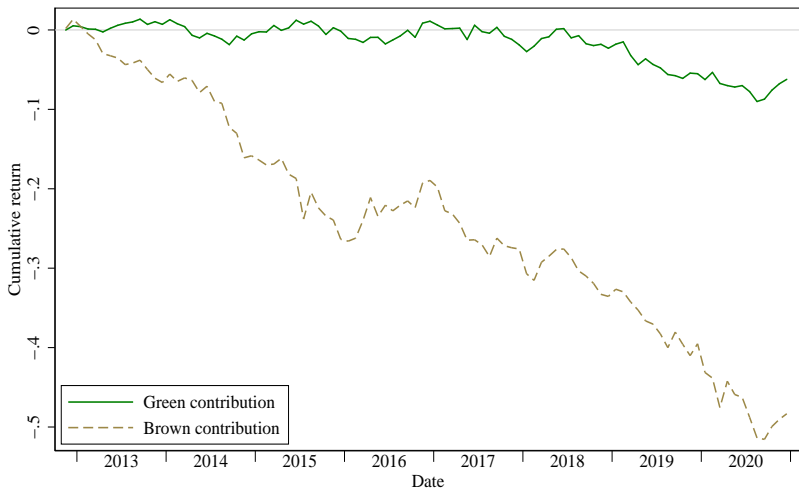
Greenness and Individual Stock Returns: Industry Effects

	(1)	(2)	(3)	(4)	(5)
$gAcross_{i,t-1}$	0.00248 (2.14)	-0.0000328 (-0.02)	-0.000256 (-0.21)	-0.00443 (-0.93)	-0.00574 (-0.92)
$gWithin_{i,t-1}$	0.000685 (1.11)	0.000128 (0.17)	-0.000251 (-0.32)	0.00244 (0.78)	0.00261 (0.75)
$gAcross_{i,t-1} \times \Delta C_t$		0.0107 (1.29)	0.0109 (1.51)	0.0115 (1.45)	0.0112 (1.27)
$gWithin_{i,t-1} \times \Delta C_t$		-0.00386 (-0.76)	-0.00301 (-0.55)	-0.00424 (-0.78)	-0.00441 (-0.82)
$gAcross_{i,t-1} \times \Delta C_{t-1}$		0.0189 (2.04)	0.0171 (2.10)	0.0185 (2.19)	0.0192 (2.12)
$gWithin_{i,t-1} \times \Delta C_{t-1}$		0.00785 (1.50)	0.00586 (1.07)	0.00531 (0.96)	0.00715 (1.21)
[Earnings announc. ret.] $_{i,t}$			0.320 (13.14)	0.320 (13.15)	0.315 (12.36)
[Delta Earnings forecast] $_{i,t}$			0.0588 (5.01)	0.0594 (5.07)	0.0586 (4.46)
[Other insignif. variables]					
Observations	218,208	151,294	131,689	131,689	114,320

- **Realized return** > **expected return** for green assets in 2010s
 - Due to unanticipated increases in climate concerns
 - ⇒ Strong past performance does not imply strong future performance
- The **green factor**'s outperformance explains the historic **underperformance of value** stocks in the 2010s
 - **Value** stocks tend to be **brown**; **growth** stocks tend to be **green**
- Small stocks seem to **underreact** to climate news

Additional Slides

Green and Brown Contributions to the Green Factor



Sources of Green-Factor Returns: Green Component

	(1)	(2)	(3)
Δ Climate concerns (same month)	0.00294 (0.45)	0.000716 (0.11)	0.00243 (0.34)
Δ Climate concerns (prev. month)	-0.00682 (-1.35)	-0.00854 (-1.63)	-0.00800 (-1.47)
Earnings announcement returns		0.412 (0.92)	0.205 (0.43)
Δ Earnings forecasts		0.148 (0.33)	0.327 (0.75)
ESG flows			0.0811 (0.85)
ESG assets			-0.000749 (-0.27)
Observations	68	68	68
R^2	0.022	0.039	0.026

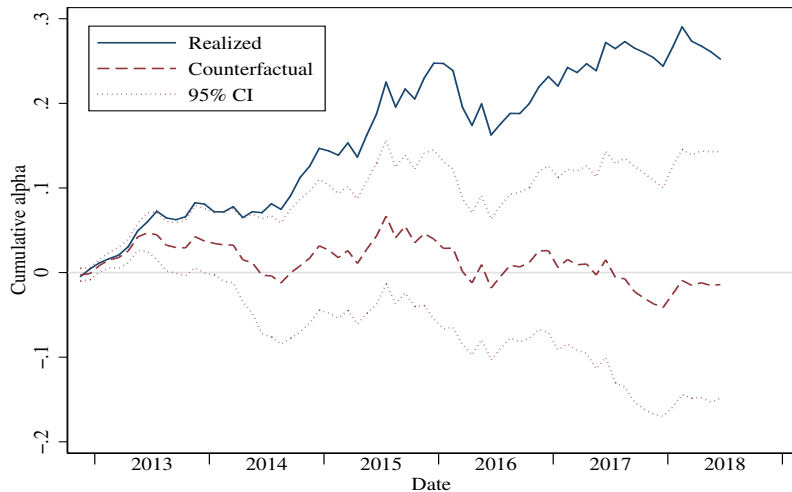
Sources of Green-Factor Returns: Brown Component

	(1)	(2)	(3)
Δ Climate concerns (same month)	-0.00898 (-0.63)	-0.00543 (-0.36)	-0.00425 (-0.28)
Δ Climate concerns (prev. month)	-0.0508 (-3.09)	-0.0480 (-2.80)	-0.0477 (-2.89)
Earnings announcement returns		-0.633 (-0.53)	-0.748 (-0.61)
Δ Earnings forecasts		-0.277 (-0.24)	-0.161 (-0.12)
ESG flows			0.000725 (0.00)
ESG assets			0.00220 (0.36)
Observations	68	68	68
R^2	0.166	0.172	0.173

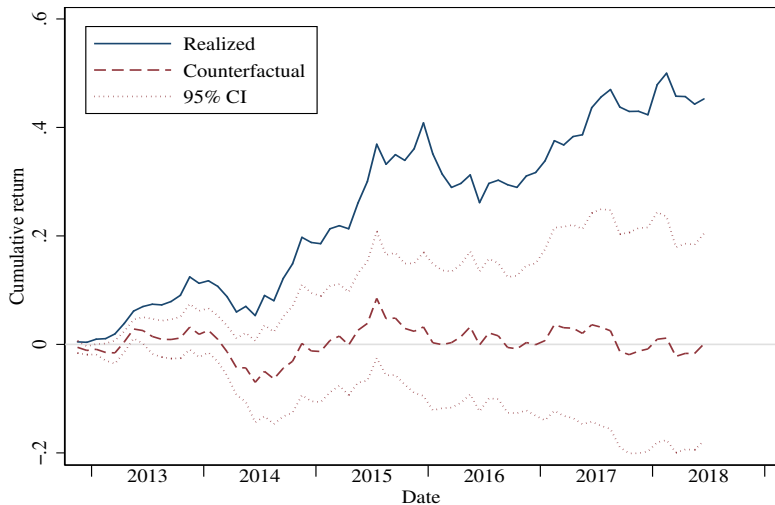
Sources of Green-Factor Alpha

	(1)	(2)	(3)
Δ Climate concerns (same month)	0.0137 (1.34)	0.0109 (1.08)	0.00932 (0.85)
Δ Climate concerns (prev. month)	0.0342 (3.32)	0.0318 (3.03)	0.0314 (3.06)
Earnings announcement returns		0.410 (0.53)	0.575 (0.66)
Δ Earnings forecasts		0.345 (0.39)	0.185 (0.21)
ESG flows			-0.0192 (-0.12)
ESG assets			-0.00208 (-0.48)
Observations	68	68	68
R^2	0.187	0.194	0.193

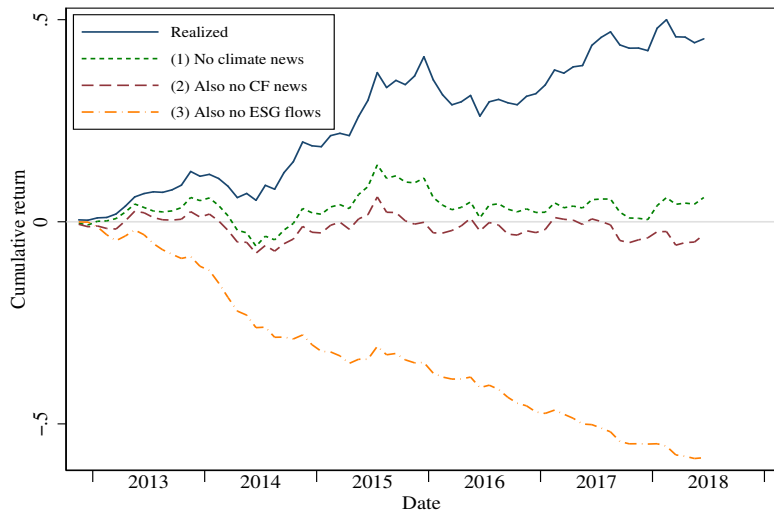
Counterfactual Green-Factor Alpha



Counterfactual GMB Returns



Components of GMB Returns



Sources of Green-Factor Returns

	(1)	(2)	(3)
Δ Climate concerns (same month)	0.0119 (0.95)	0.00615 (0.49)	0.00668 (0.54)
Δ Climate concerns (prev. month)	0.0440 (2.85)	0.0394 (2.52)	0.0397 (2.59)
Earnings announcement returns		1.045 (0.98)	0.953 (0.87)
Δ Earnings forecasts		0.426 (0.41)	0.487 (0.42)
ESG flows			0.0804 (0.46)
ESG assets			-0.00295 (-0.59)
Observations	68	68	68
R^2	0.171	0.190	0.181

Sources of G (Green) Returns

	(1)	(2)	(3)
Δ Climate concerns (same month)	0.0221 (2.94)	0.0206 (2.85)	0.0207 (2.84)
Δ Climate concerns (prev. month)	-0.00274 (-0.34)	-0.00311 (-0.40)	-0.00300 (-0.41)
Earnings announcement returns (GMB)		0.182 (1.37)	0.205 (1.63)
Δ Earnings forecasts (GMB)		0.0471 (0.78)	0.0525 (0.92)
ESG flows			0.0721 (0.92)
ESG assets			-0.00267 (-0.89)
Observations	68	68	68
R^2	0.132	0.180	0.203

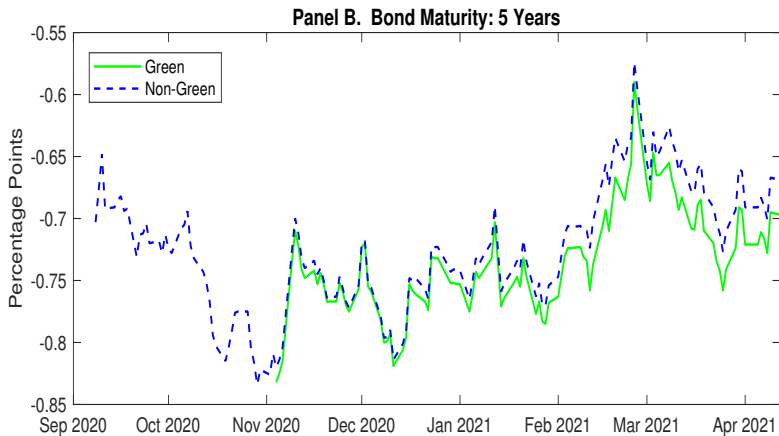
Sources of B (Brown) Returns

	(1)	(2)	(3)
Δ Climate concerns (same month)	-0.0178 (-1.54)	-0.0159 (-1.41)	-0.0181 (-1.41)
Δ Climate concerns (prev. month)	-0.0228 (-1.68)	-0.0232 (-1.89)	-0.0242 (-1.82)
Earnings announcement returns (GMB)		-0.563 (-2.39)	-0.628 (-2.78)
Δ Earnings forecasts (GMB)		-0.0460 (-0.37)	-0.0789 (-0.68)
ESG flows			-0.296 (-1.56)
ESG assets			0.00606 (1.05)
Observations	68	68	68
R^2	0.099	0.202	0.052

Industry-Adjusted GMB Performance

	(1)	(2)	(3)	(4)	(5)	(6)
Constant	0.157 (0.99)	0.295 (1.59)	0.121 (0.82)	0.116 (0.78)	0.118 (0.79)	0.115 (0.79)
Mkt-Rf		-0.111 (-1.99)	-0.0150 (-0.36)	-0.00838 (-0.18)	-0.0112 (-0.26)	-0.00915 (-0.24)
SMB			-0.350 (-5.57)	-0.346 (-5.37)	-0.332 (-4.89)	-0.312 (-4.50)
HML			-0.137 (-2.40)	-0.121 (-1.91)	-0.135 (-2.44)	-0.193 (-3.48)
UMD				0.0272 (0.65)		
LIQ					-0.0315 (-0.69)	
RMW						0.0937 (1.00)
CMA						0.168 (1.68)
Observations	98	98	98	98	98	98
R^2	0.000	0.084	0.441	0.444	0.444	0.466

German Twin Bonds: 5-Year Yields



German Twin Bonds: 5-Year Expected vs. Realized Returns

