Dissecting Green Returns

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Expect Superior Returns from Sustainable Investments?

- **Investors** often say "yes"
  - Surveys by BlackRock (2020), BNP Paribas (2019), Schroders (2020)
- Asset **managers** often say "yes"
  - 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 that leads to positive portfolio performance"*
- Superior **historical performance** (seemingly) says "yes"
  - E.g., Edmans (2011), Nagy et al. (2016), In et al. (2019)

Expect Superior Returns from Sustainable Investments?

- We say "no"
- **Theory:** Pástor, Stambaugh, and Taylor (JFE 2021)
  - Green investments have **lower expected returns**, because
    - Investors like holding green & dislike holding brown assets
    - Green assets offer a hedge against climate risk
  - An efficient market already prices any superior expected profits

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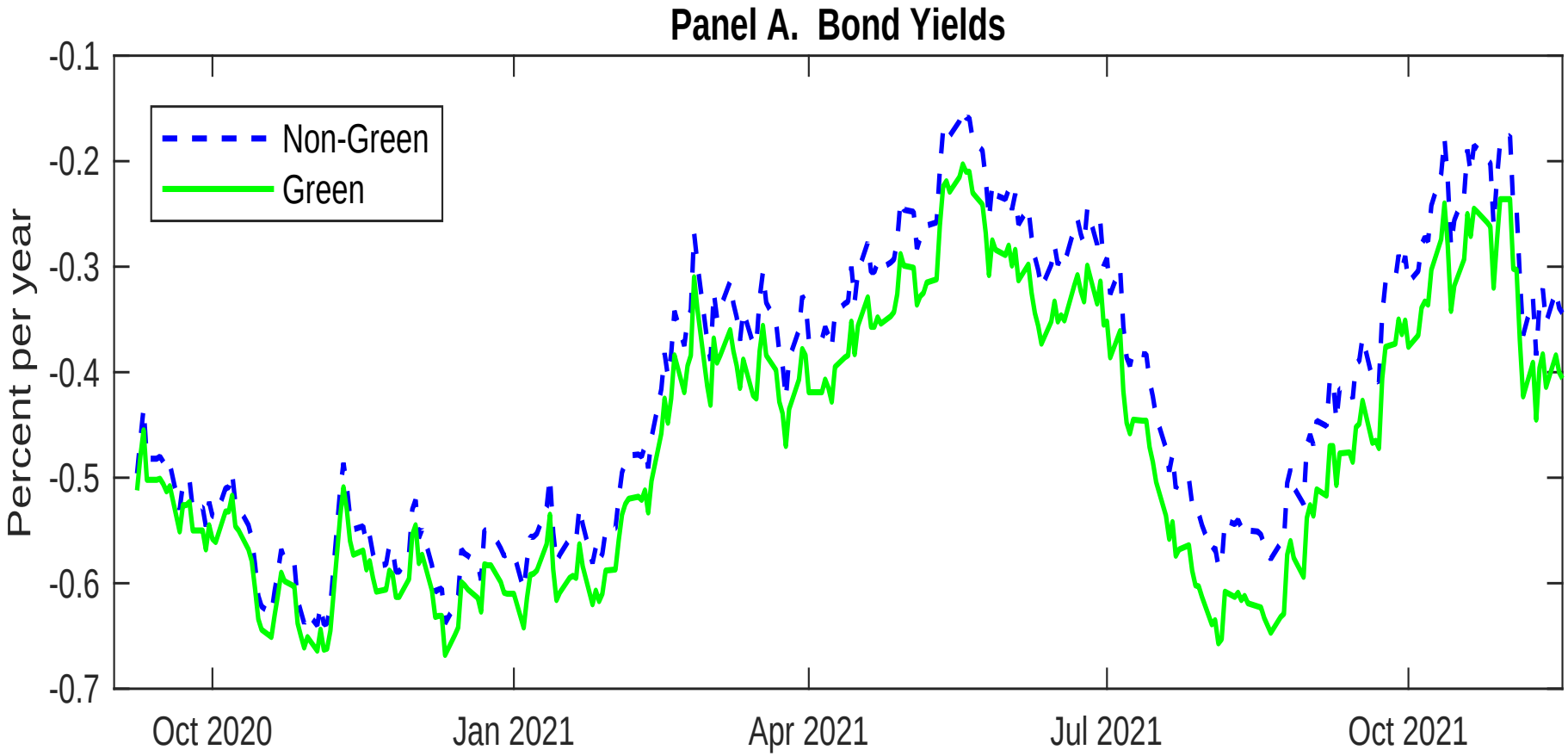
- **Evidence:** Past superior performance was **unexpected**
  - Climate concerns increased more than anticipated
    $\Rightarrow$ Investor demand for sustainable financial assets $\uparrow$
    $\Rightarrow$ Customer demand for sustainable goods/services $\uparrow$
- Past performance $\not\Rightarrow$ Future performance

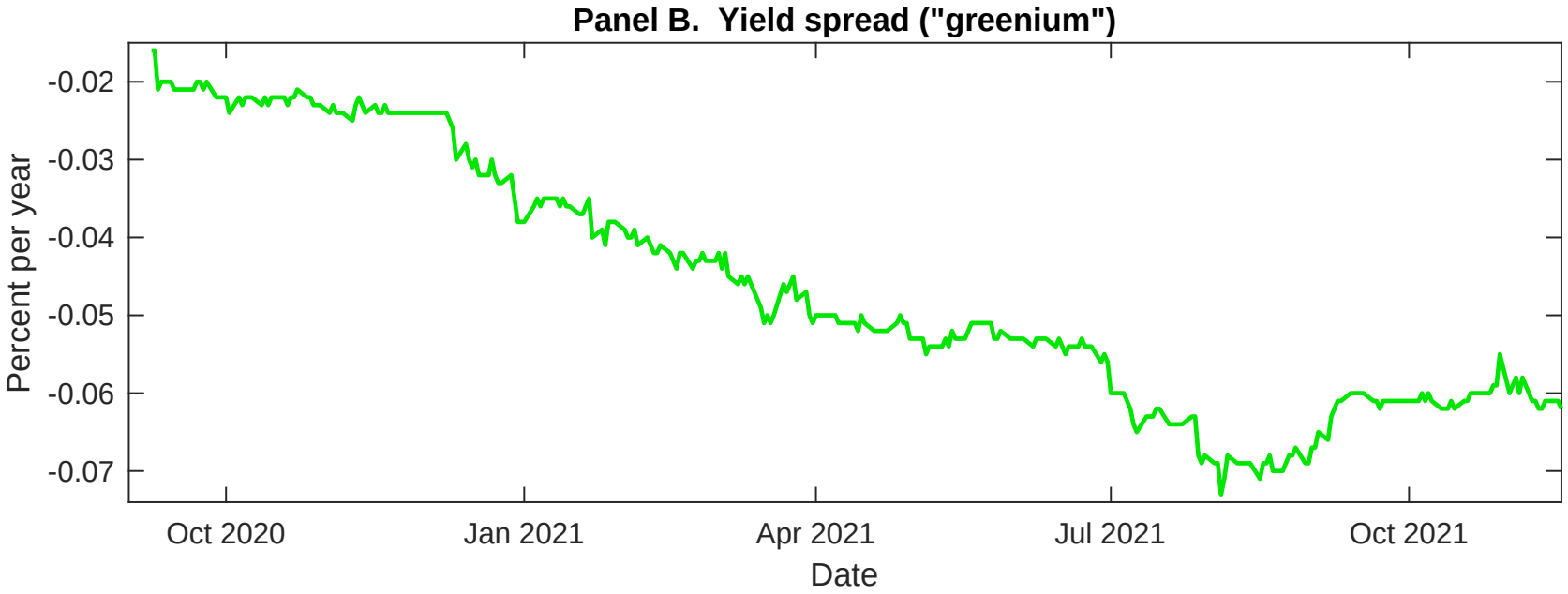
Example: German Twin Bonds

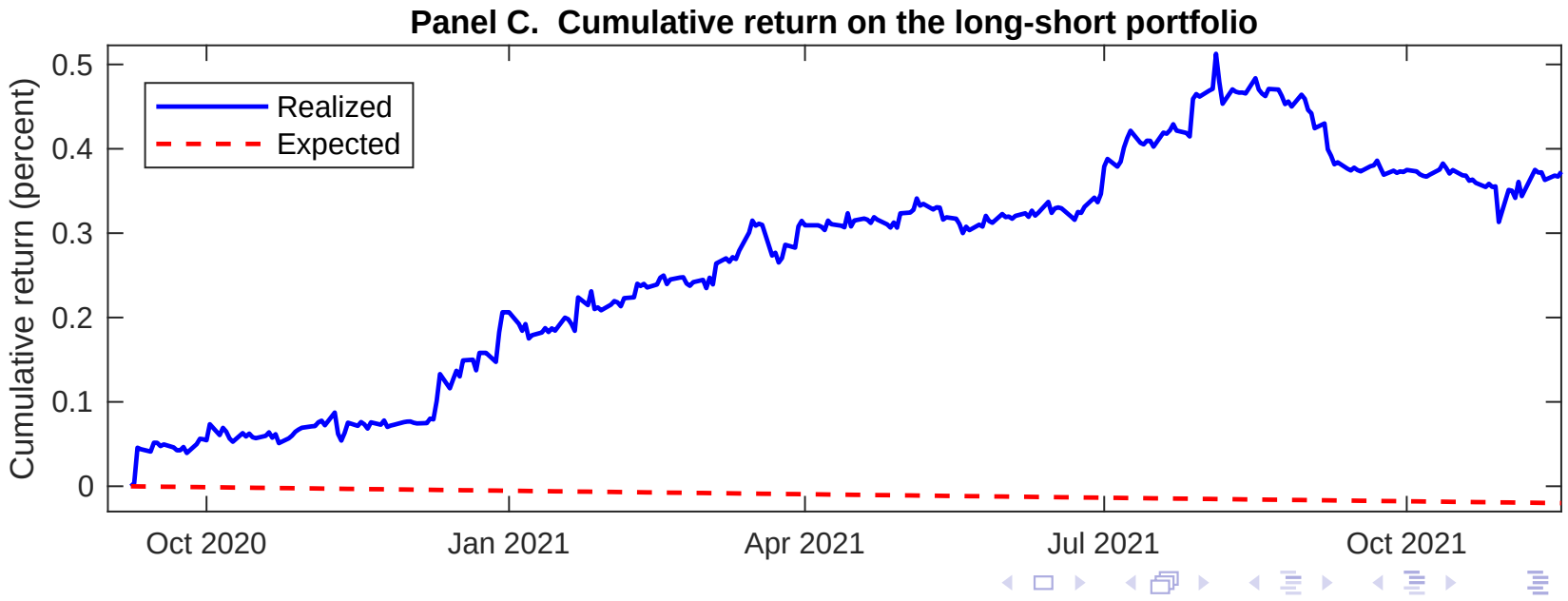
- German government has been issuing green bonds since 2020
  - First issue: September 2020 (10-year, zero coupon; 6.5 billion euros)
- Each green bond has a conventional "twin"
  - Same issuer, maturity date, coupon rate, coupon payment dates
- Twin bonds offer identical cash flows but different greenness
  - 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 average return: +65 bp per month ($t = 3.2$)
  - Green factor: Long green, short brown stocks

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- The green factor reacts to climate-concern shocks with a delay
  - Small stocks seem to **underreact** to climate news

Measuring Stocks' Greenness

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

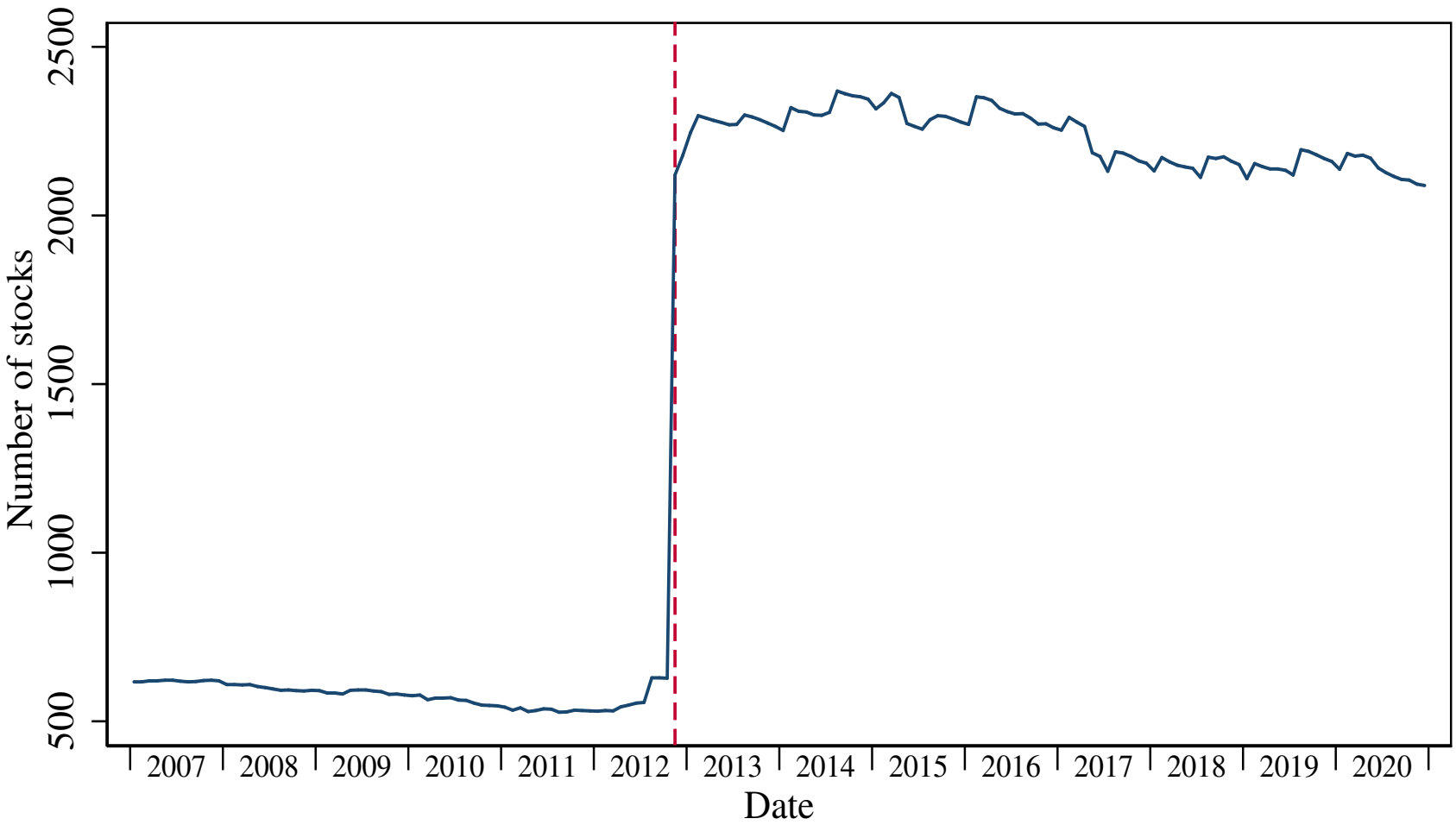
$$G_{i,t} = -(10 - E\_score_{i,t}) \times E\_weight_{i,t}/100$$

  - 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
- 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: $g_{i,t} = G_{i,t} - \overline{G}_t$
  - $\overline{G}_t$ is the value-weighted average of $G_{i,t}$ across all firms

Industries Ranked by Environmental Scores (Dec 2019)

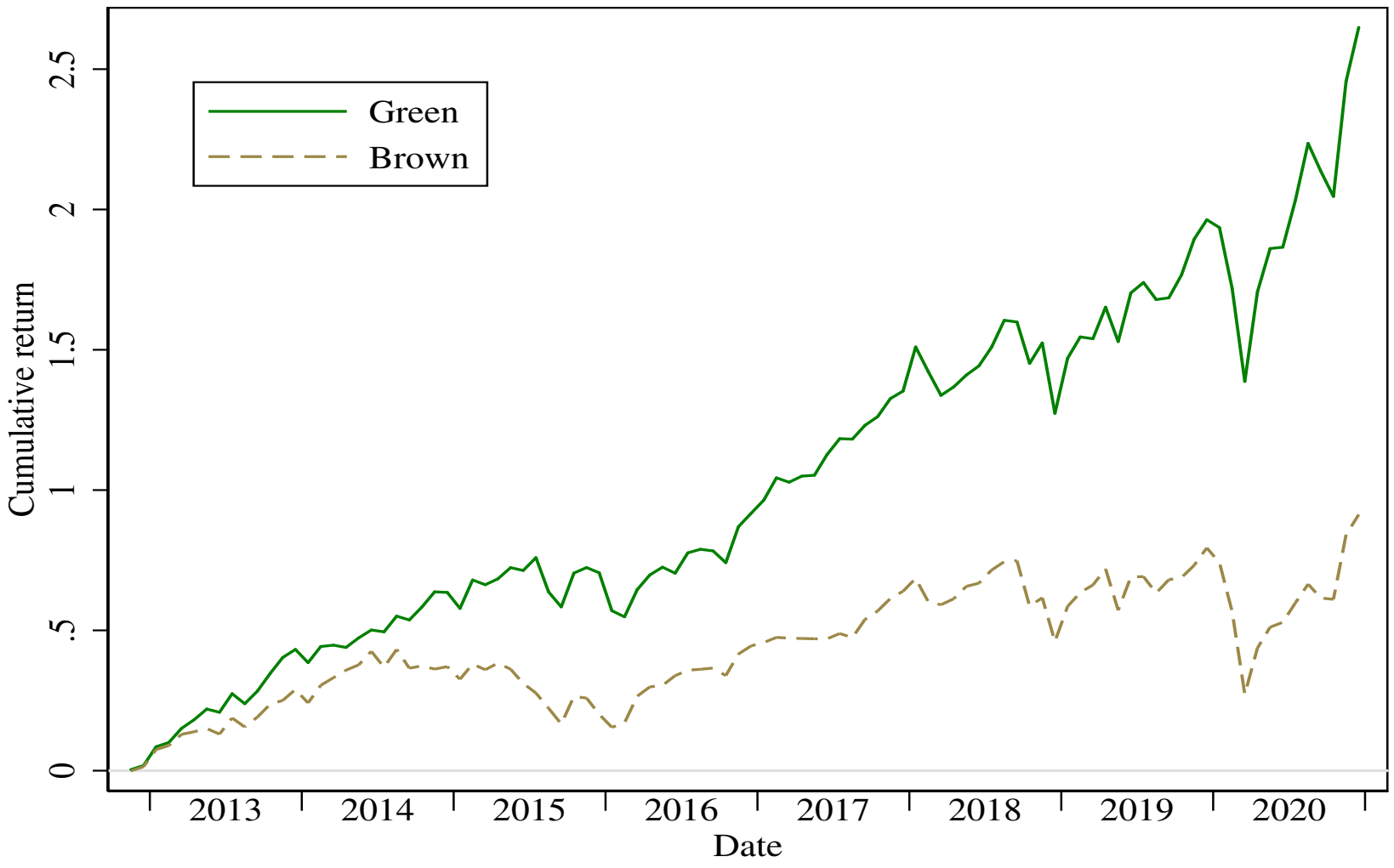
Rank	MSCI Industry	Avg. g	Rank	MSCI Industry	Avg. g
1	Asset Management & Custody Banks	0.870	33	Textiles, Apparel & Luxury Goods	-0.502
2	Professional Services	0.850	34	Auto Components	-0.505
3	Telecommunication Services	0.841	35	Property & Casualty Insurance	-0.506
4	Consumer Finance	0.837	36	Casinos & 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**	**0.712**	**0.496**	**0.472**	**0.500**	**0.496**
	(3.23)	**(2.91)**	**(2.23)**	**(2.14)**	**(2.25)**	**(2.38)**
Mkt-Rf		-0.0508	0.0156	0.0473	0.0106	0.0363
		(-0.78)	(0.32)	(0.87)	(0.21)	(0.77)
SMB			-0.137	-0.114	-0.162	-0.262
			(-1.49)	(-1.23)	(-1.56)	(-2.59)
HML			-0.262	-0.182	-0.265	-0.212
			(-3.36)	(-1.99)	(-3.26)	(-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

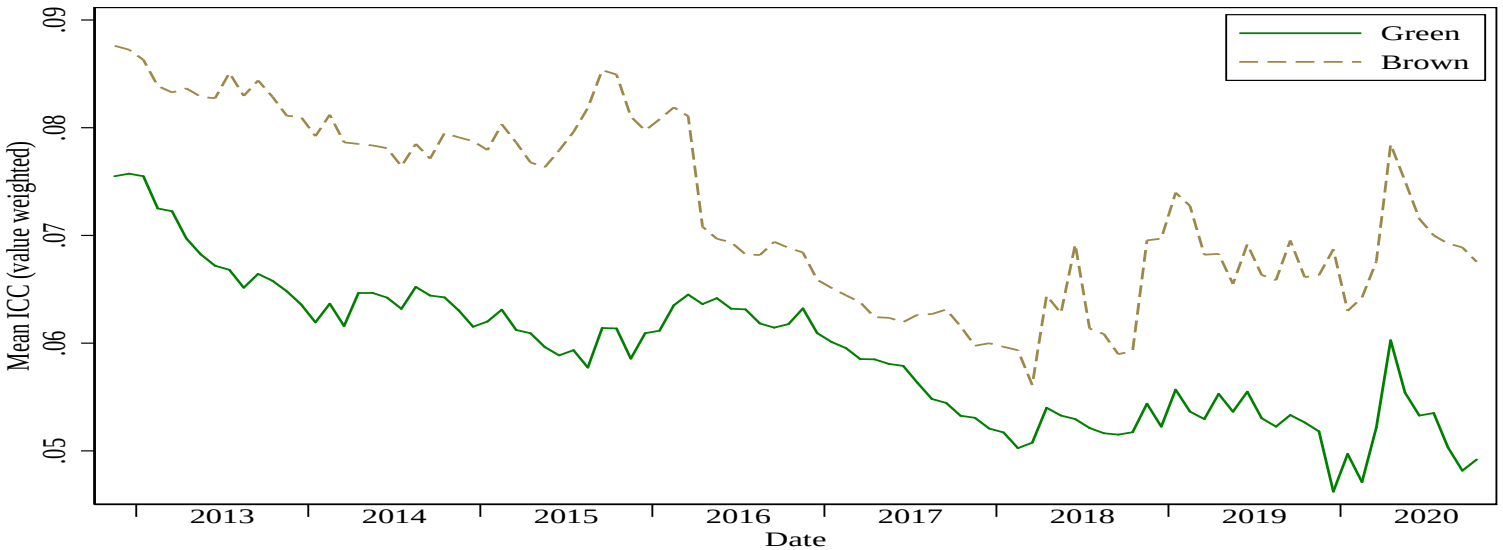
Expected GMB Return

- Proxy for expected stock return: **Implied cost of capital**
  - ICC = Discount rate that equates the stock's market value to the present value of its expected future cash flows
- We follow the Hou, van Dijk, and Zhang (2012) approach
  - Builds on the classic approach of Gebhardt, Lee, Swaminathan (2001)
  - Replaces analysts' earnings forecasts with regression-based forecasts
  - The most precise ICC approach (Lee, So, and Wang, 2021)

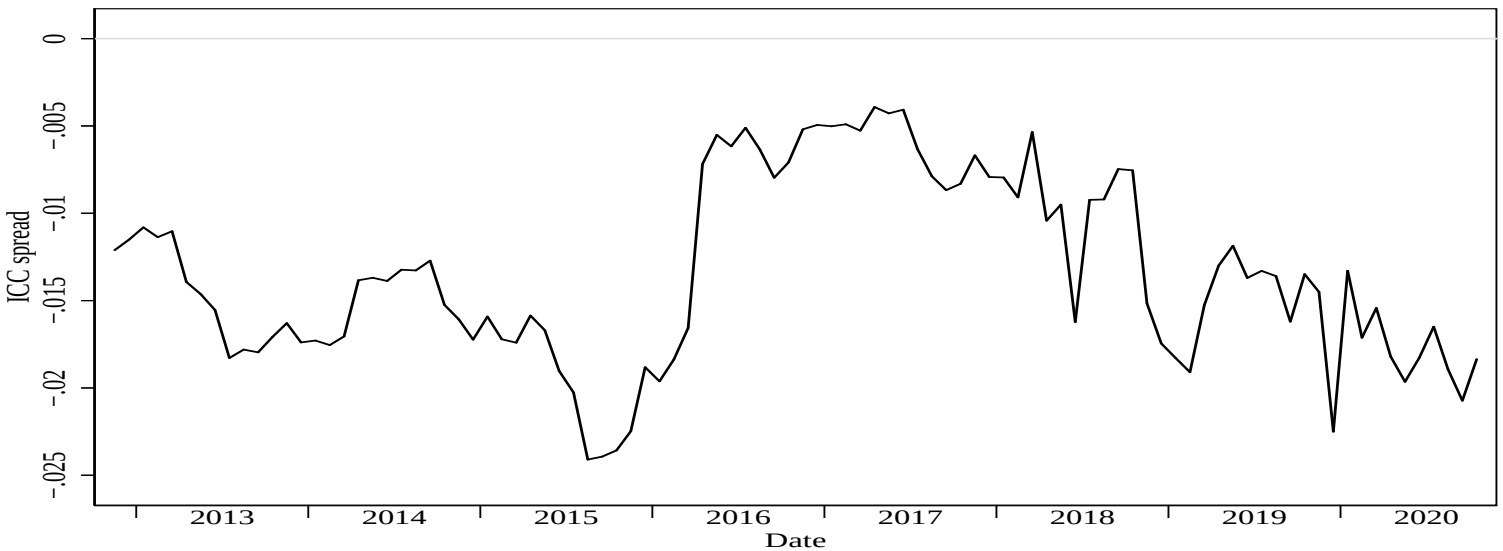
- **"Equity greenium"** = E(green return) − E(brown return)

Equity Greenium

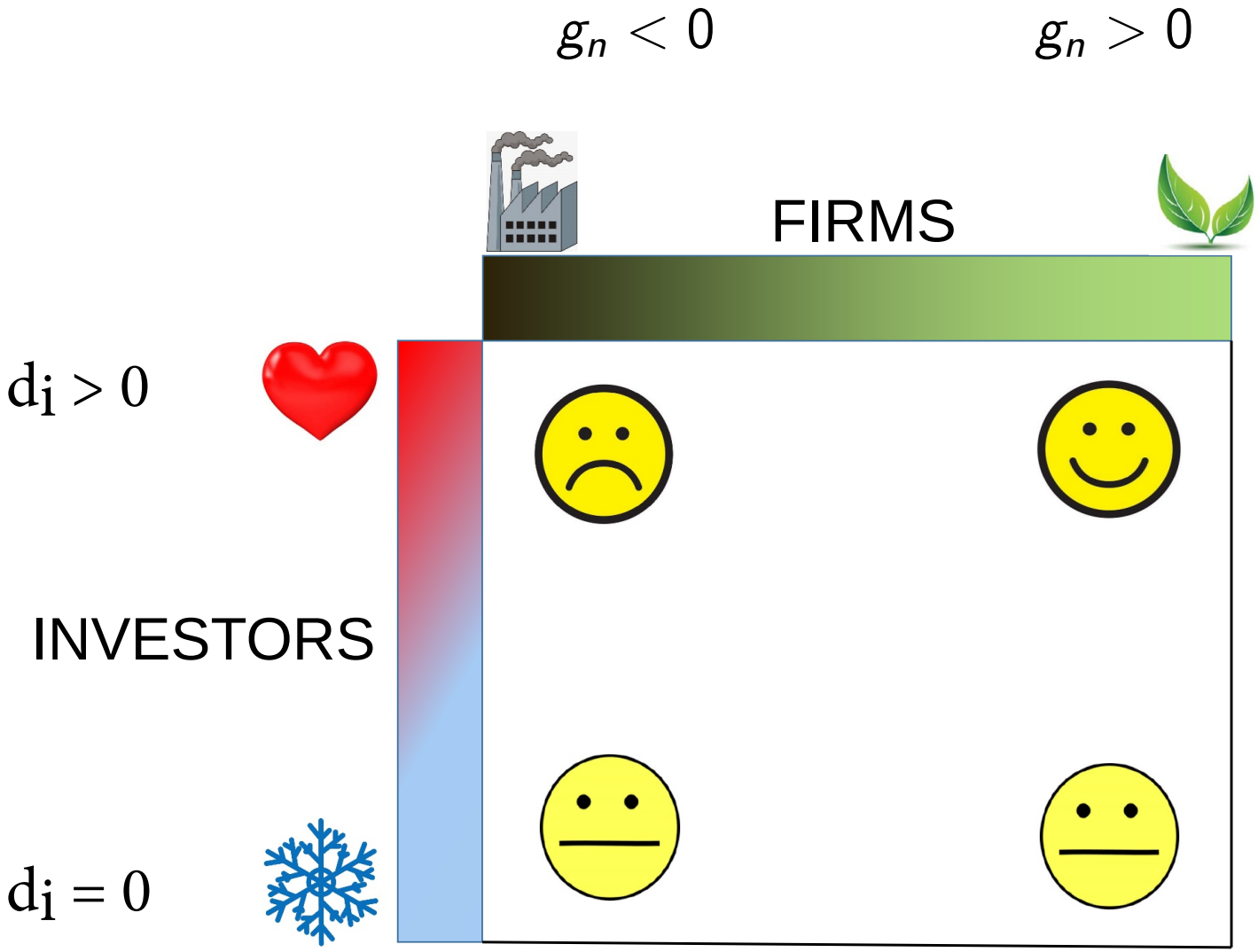
Panel A. ICCs of green and brown portfolios



Panel B. ICC spread (green minus brown: "equity greenium")



Background: Pástor, Stambaugh, and Taylor (JFE 2021)



Background: PST Model's Implications

- Greener assets have **lower expected returns**

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- Greener assets have **lower expected returns**
- Greener assets have **higher realized returns** while tastes are shifting unexpectedly toward green assets & products
- Green factor, $\tilde{f}_{g,t}$, captures shifts in customer and investor tastes
  - The factor is long green, short brown assets, weighted by g_n
  - The factor's **expected return is negative**

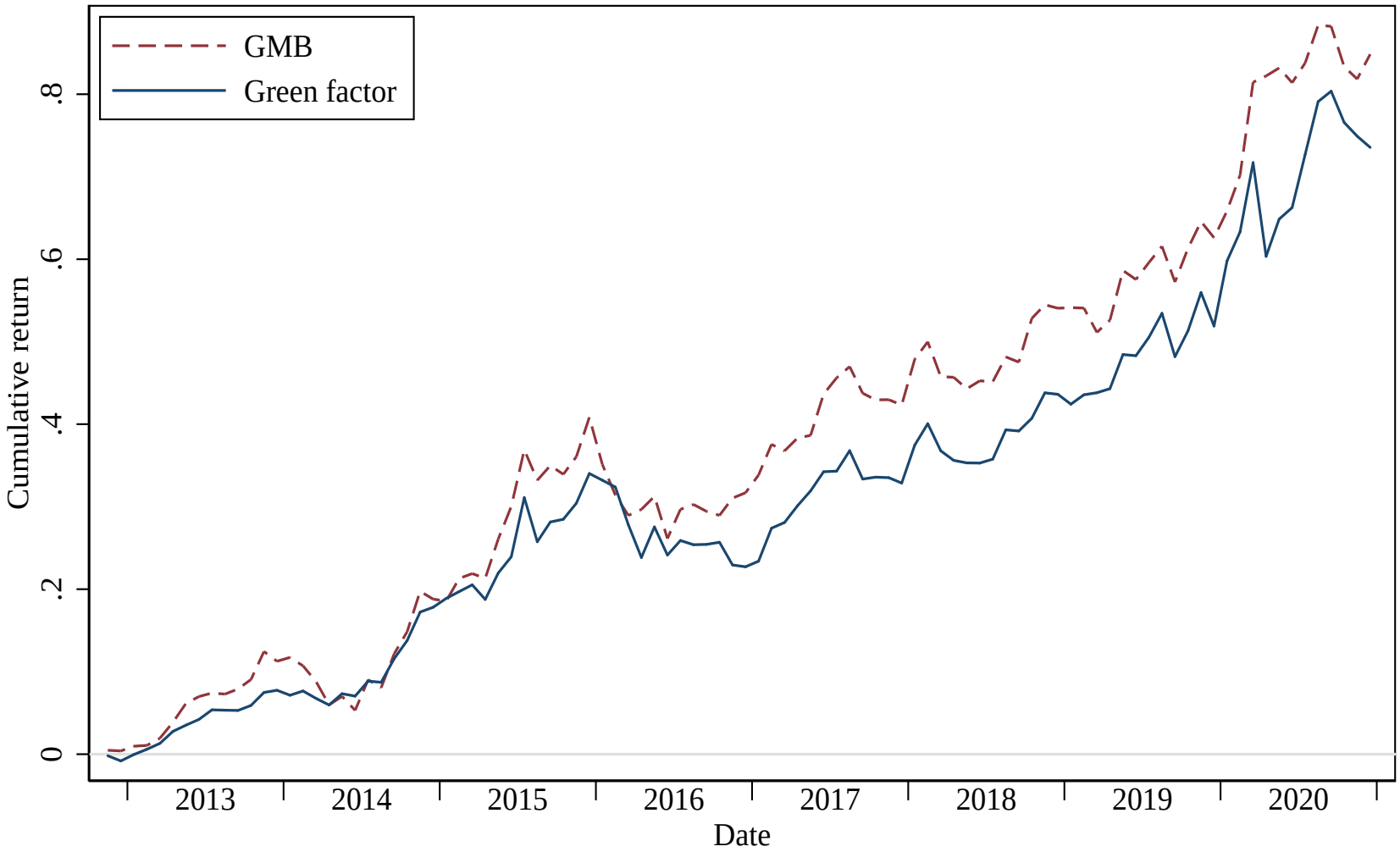
$$\mathrm{E}(\tilde{f}_{g,t}) = -\frac{\bar{d}}{a} \; < \; 0$$

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

  - Green factor and the market price assets in a **two-factor model**:

$$\tilde{r}_t \; = \; \beta \, \tilde{r}_{m,t} \; + \; g \, \tilde{f}_{g,t} \; + \; \tilde{\epsilon}_t$$

Green Factor versus GMB



▸ Green and Brown Contributions

Pricing Value and Momentum in the Green-Factor Model

- PST's two-factor model: Market + Green factor
- November 2012–December 2020

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

Measuring Climate Concerns

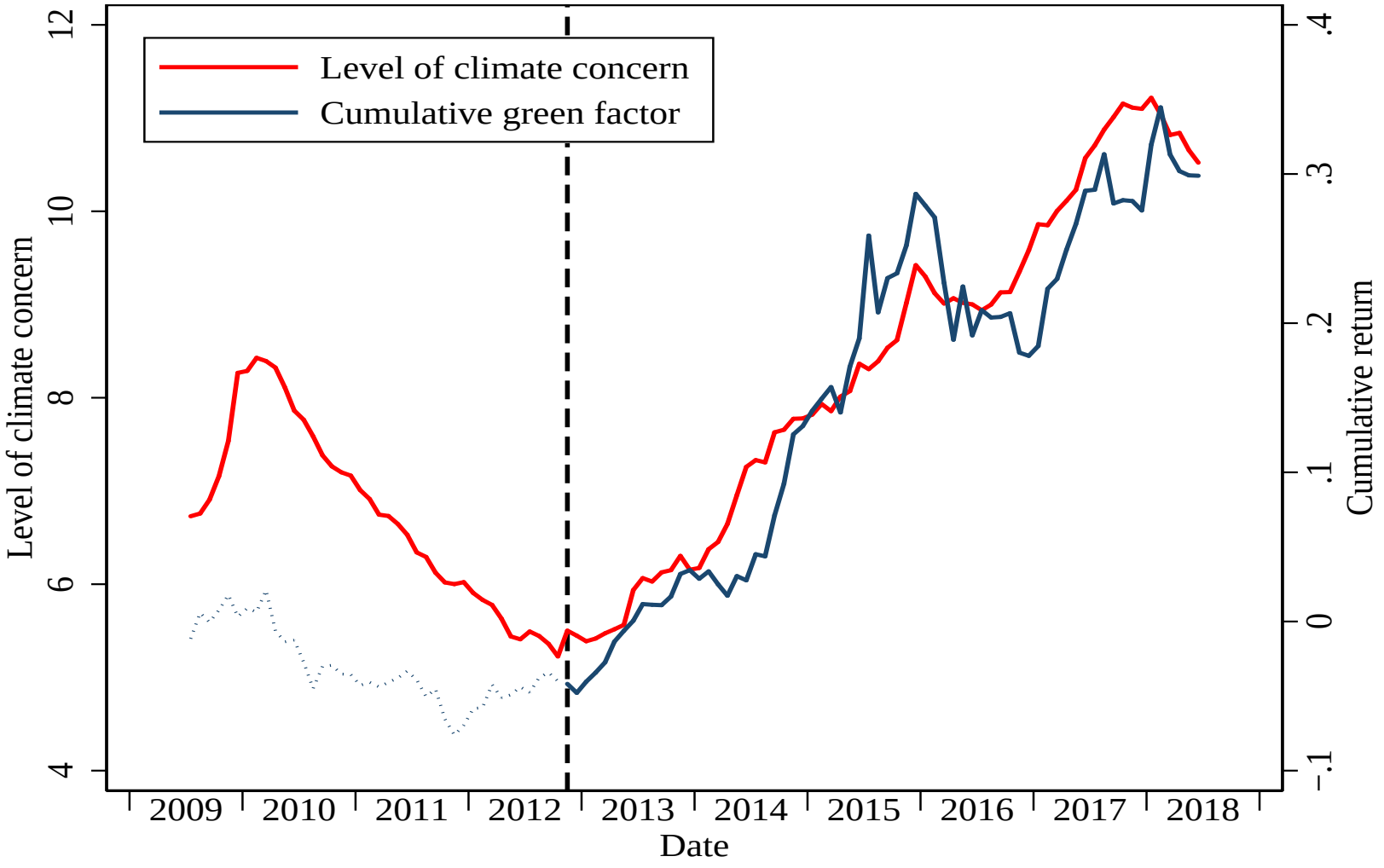
- We use the **Media Climate Change Concerns index** (MCCC) of Ardia, Bluteau, Boudt, and Inghelbrecht (2021)
  - Constructed by aggregating data from eight major U.S. newspapers
  - Captures the number of climate news stories each day as well as their negativity and focus on risk, as measured by textual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

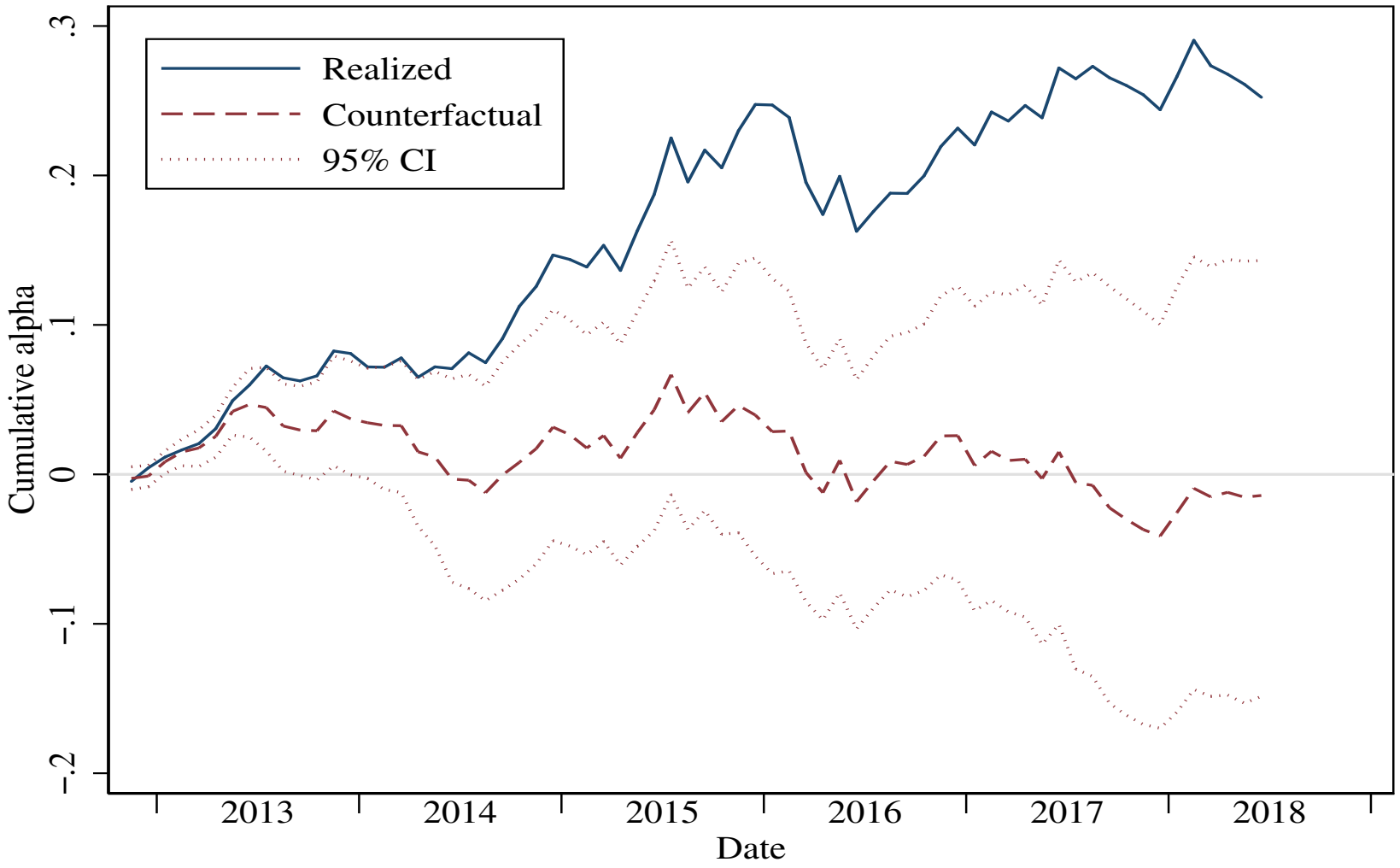


Sources of Green-Factor Returns

	(1)	(2)	(3)
Δ Climate concerns (same month)	0.0119	0.00615	0.00668
	(0.95)	(0.49)	(0.54)
Δ Climate concerns (prev. month)	**0.0440**	**0.0394**	**0.0397**
	(2.85)	**(2.52)**	**(2.59)**
Earnings announcement returns		1.045	0.953
		(0.98)	(0.87)
Δ Earnings forecasts		0.426	0.487
		(0.41)	(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 GMB Returns ▸ Sources of Green-Factor Alpha ▸ Green Component ▸ Brown Component

Counterfactual Green-Factor Performance



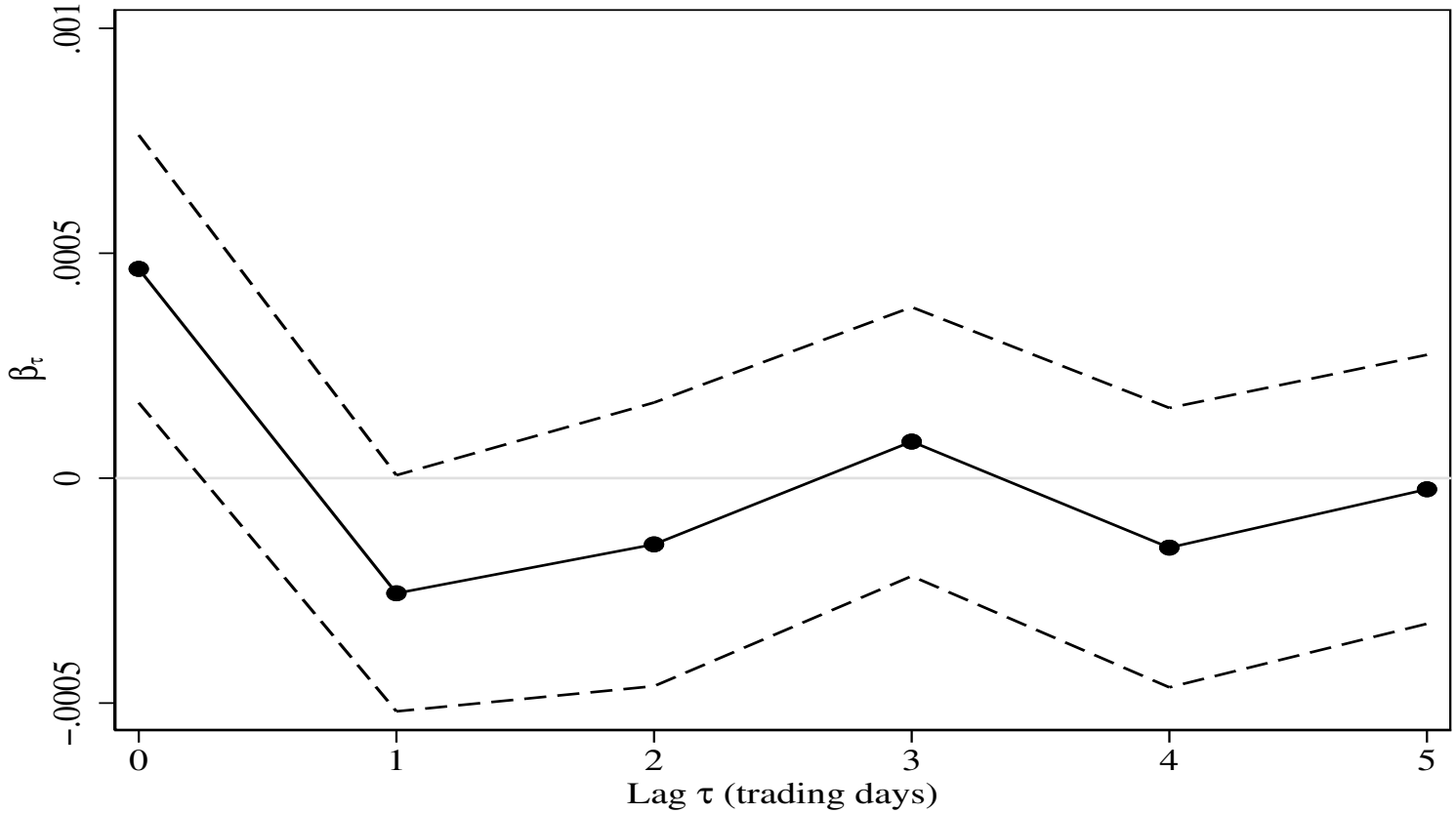
Greenness and Individual Stock Returns

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

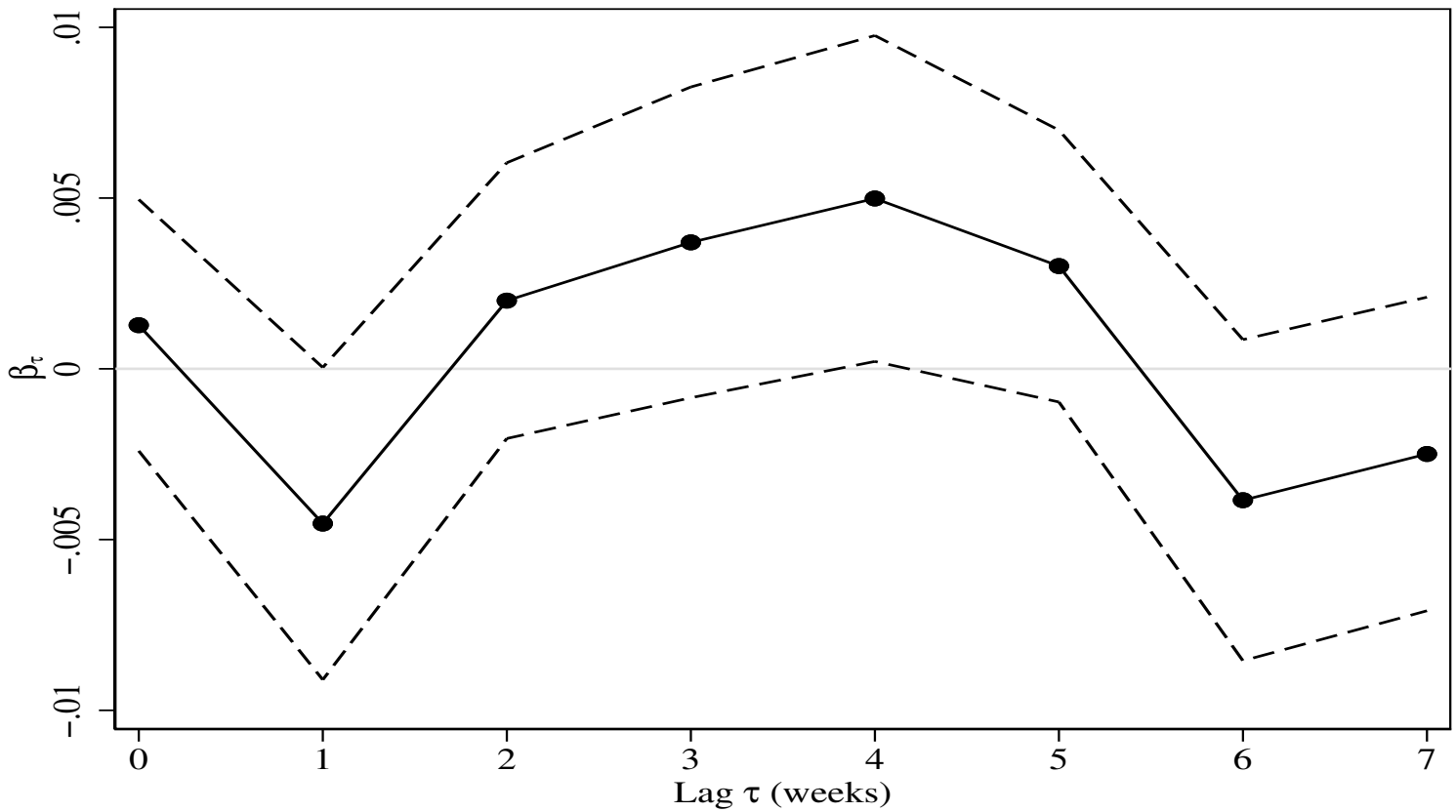
$$\tilde{f}_{g,t} = a + \sum_{\tau=0}^{T} \beta_\tau MCCC_{t-\tau} + e_t$$



Weekly Response of the Green Factor to Climate News

- Slope coefficients β_τ from the time-series regression

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



Conclusions

- **Realized return** $>$ **expected return** for green assets in 2010s
  - Due to unanticipated increases in climate concerns
  - Green stocks had consistently lower ICCs than brown
  - Strong **past** performance $\not\Rightarrow$ 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

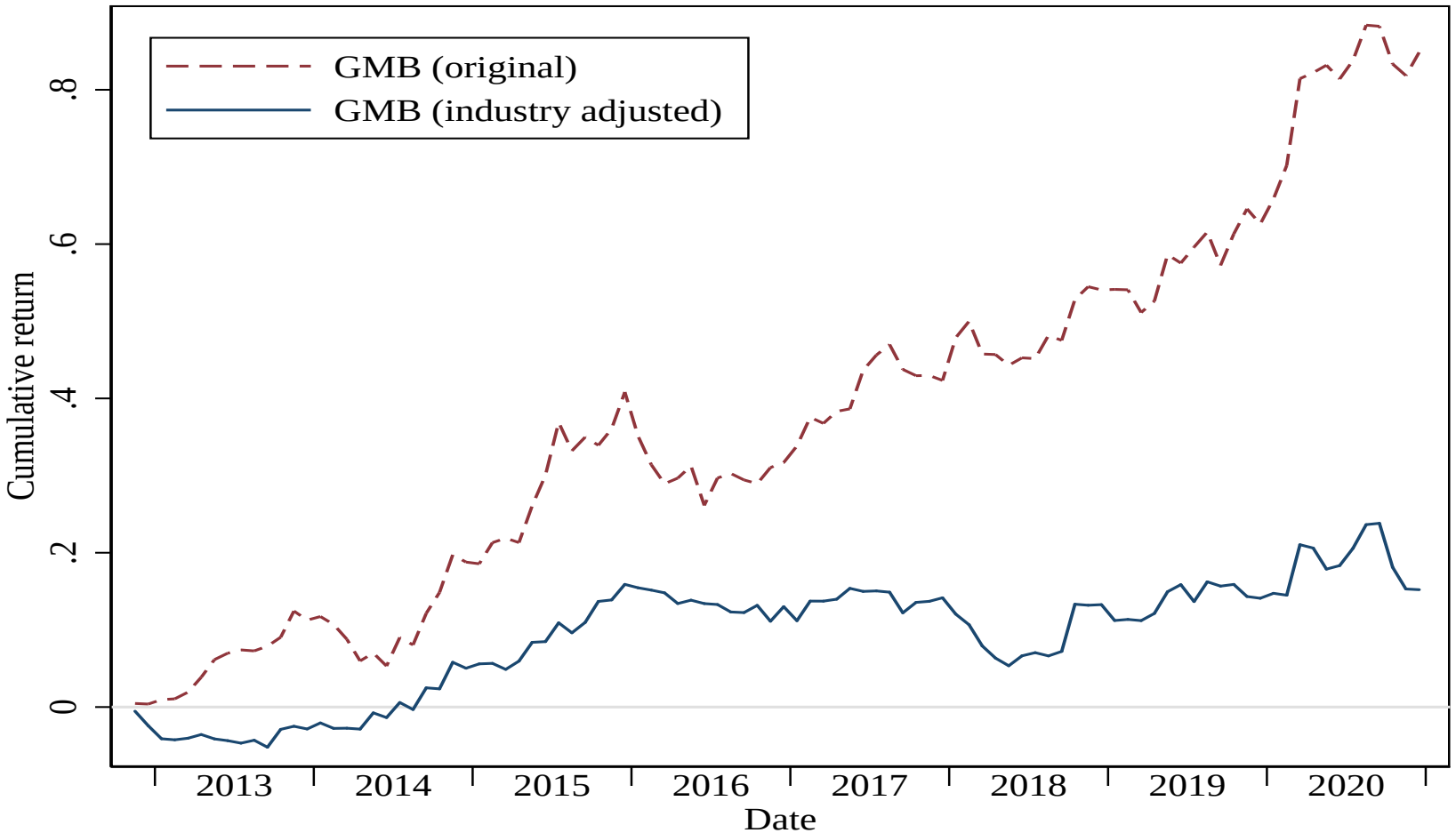
Additional Slides

Sources of GMB Returns

	(1)	(2)	(3)
Δ Climate concerns (same month)	**0.0409**	**0.0378**	**0.0407**
	(2.45)	**(2.42)**	**(2.47)**
Δ Climate concerns (prev. month)	0.0178	0.0180	0.0193
	(0.92)	(1.03)	(1.10)
Earnings announcement returns (GMB)		0.784	0.850
		(2.62)	(3.00)
Δ Earnings forecasts (GMB)		0.0792	0.118
		(0.50)	(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

▸ Sources of Green-Factor Returns ▸ Sources of G Returns ▸ Sources of B Returns

Effect of Industry Adjustment

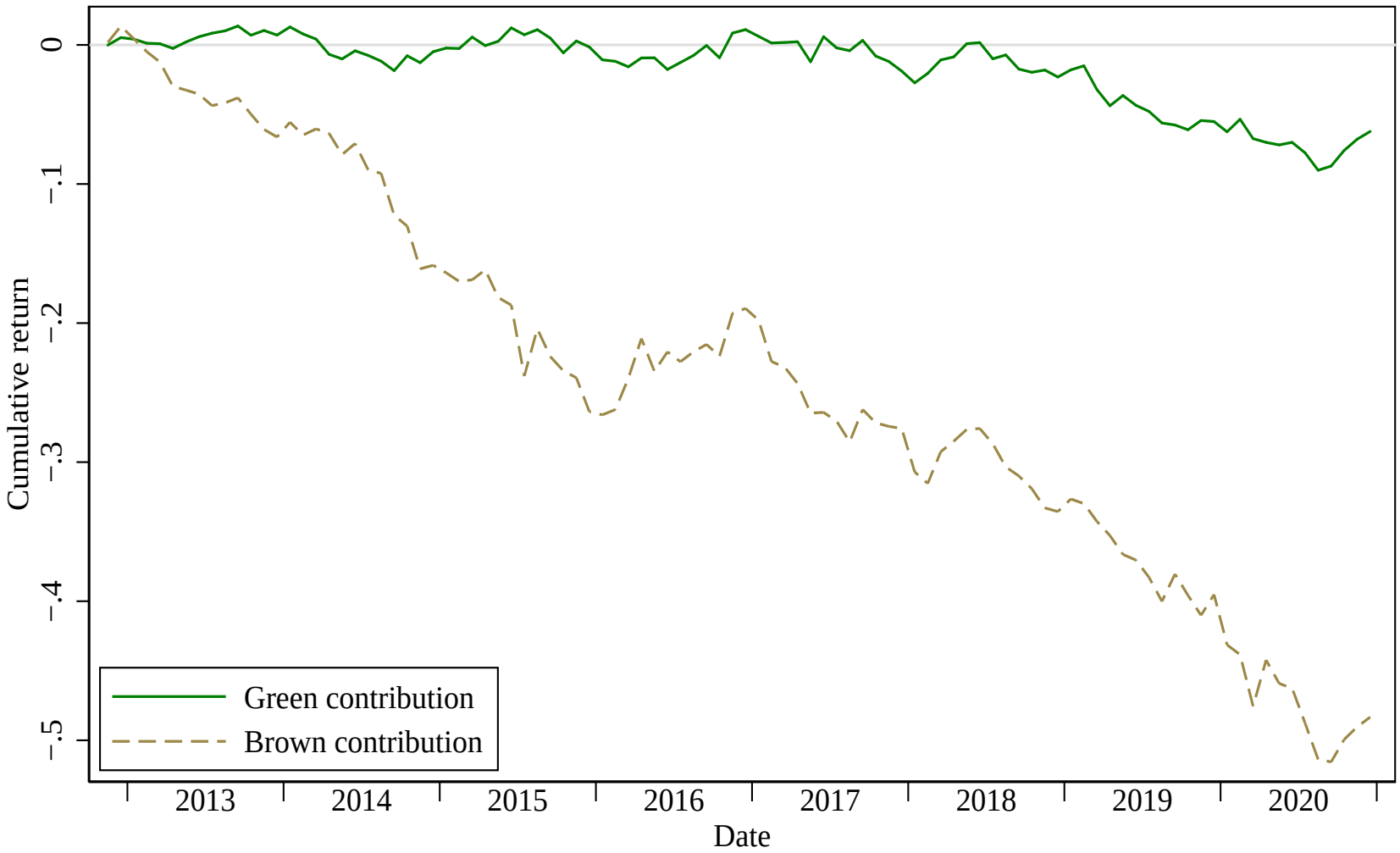


▸ Industry-Adjusted GMB Performance

Greenness and Individual Stock Returns: Industry Effects

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

Green and Brown Contributions to the Green Factor



Back

Sources of Green-Factor Returns: Green Component

	(1)	(2)	(3)
Δ Climate concerns (same month)	0.00294	0.000716	0.00243
	(0.45)	(0.11)	(0.34)
Δ Climate concerns (prev. month)	-0.00682	-0.00854	-0.00800
	(-1.35)	(-1.63)	(-1.47)
Earnings announcement returns		0.412	0.205
		(0.92)	(0.43)
Δ Earnings forecasts		0.148	0.327
		(0.33)	(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

Back

Sources of Green-Factor Returns: Brown Component

	(1)	(2)	(3)
Δ Climate concerns (same month)	-0.00898	-0.00543	-0.00425
	(-0.63)	(-0.36)	(-0.28)
Δ Climate concerns (prev. month)	**-0.0508**	**-0.0480**	**-0.0477**
	(-3.09)	**(-2.80)**	**(-2.89)**
Earnings announcement returns		-0.633	-0.748
		(-0.53)	(-0.61)
Δ Earnings forecasts		-0.277	-0.161
		(-0.24)	(-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

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Sources of Green-Factor Alpha

	(1)	(2)	(3)
Δ Climate concerns (same month)	0.0137	0.0109	0.00932
	(1.34)	(1.08)	(0.85)
Δ Climate concerns (prev. month)	**0.0342**	**0.0318**	**0.0314**
	(3.32)	**(3.03)**	**(3.06)**
Earnings announcement returns		0.410	0.575
		(0.53)	(0.66)
Δ Earnings forecasts		0.345	0.185
		(0.39)	(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

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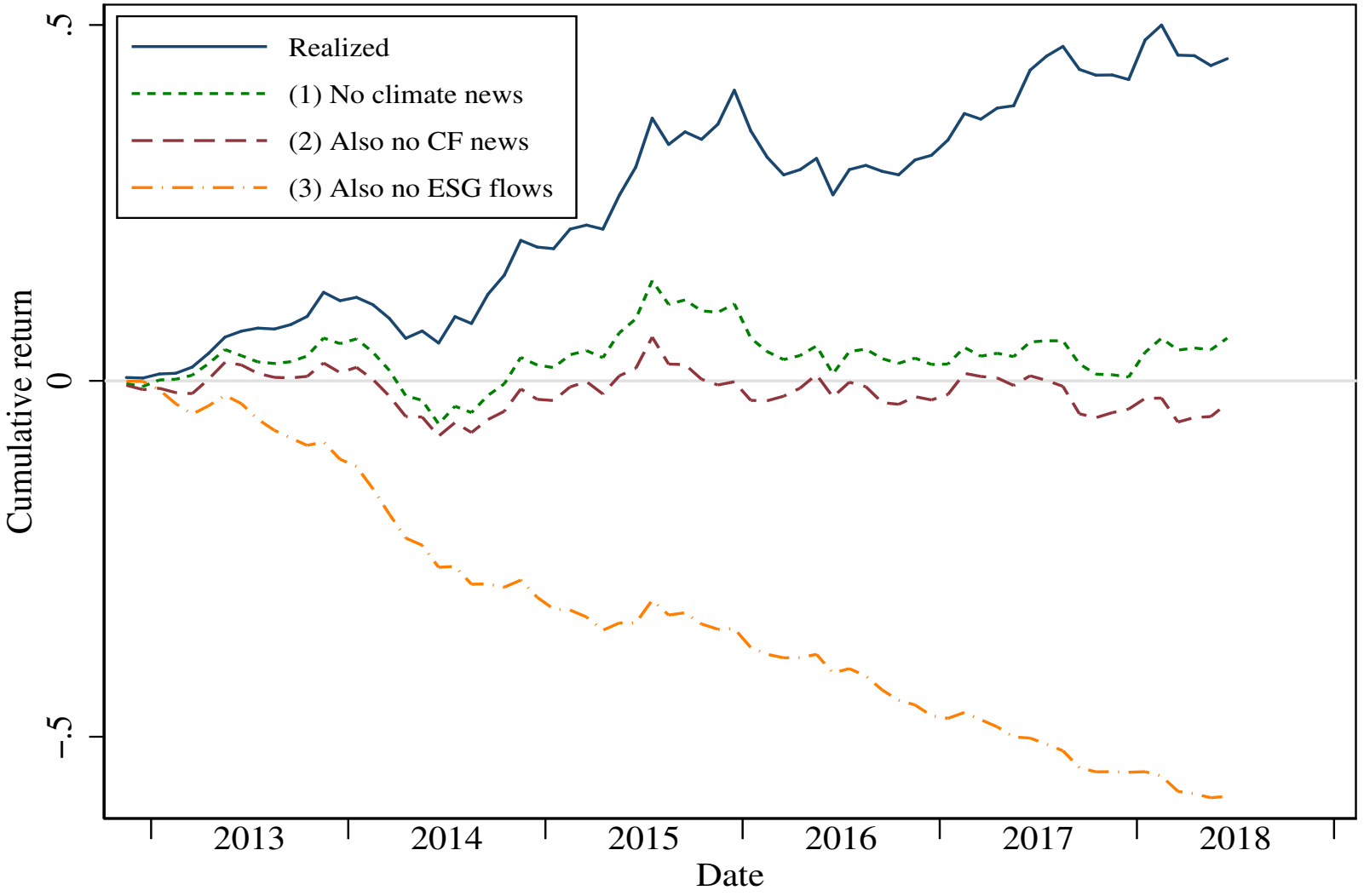
Components of GMB Returns



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Sources of G (Green) Returns

	(1)	(2)	(3)
Δ Climate concerns (same month)	**0.0221**	**0.0206**	**0.0207**
	(2.94)	**(2.85)**	**(2.84)**
Δ Climate concerns (prev. month)	-0.00274	-0.00311	-0.00300
	(-0.34)	(-0.40)	(-0.41)
Earnings announcement returns (GMB)		0.182	0.205
		(1.37)	(1.63)
Δ Earnings forecasts (GMB)		0.0471	0.0525
		(0.78)	(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

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Sources of B (Brown) Returns

	(1)	(2)	(3)
Δ Climate concerns (same month)	-0.0178	-0.0159	-0.0181
	(-1.54)	(-1.41)	(-1.41)
Δ Climate concerns (prev. month)	-0.0228	-0.0232	-0.0242
	(-1.68)	(-1.89)	(-1.82)
Earnings announcement returns (GMB)		-0.563	-0.628
		(-2.39)	(-2.78)
Δ Earnings forecasts (GMB)		-0.0460	-0.0789
		(-0.37)	(-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

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Industry-Adjusted GMB Performance

	(1)	(2)	(3)	(4)	(5)	(6)
Constant	0.157	0.295	0.121	0.116	0.118	0.115
	(0.99)	(1.59)	(0.82)	(0.78)	(0.79)	(0.79)
Mkt-Rf		-0.111	-0.0150	-0.00838	-0.0112	-0.00915
		(-1.99)	(-0.36)	(-0.18)	(-0.26)	(-0.24)
SMB			-0.350	-0.346	-0.332	-0.312
			(-5.57)	(-5.37)	(-4.89)	(-4.50)
HML			-0.137	-0.121	-0.135	-0.193
			(-2.40)	(-1.91)	(-2.44)	(-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

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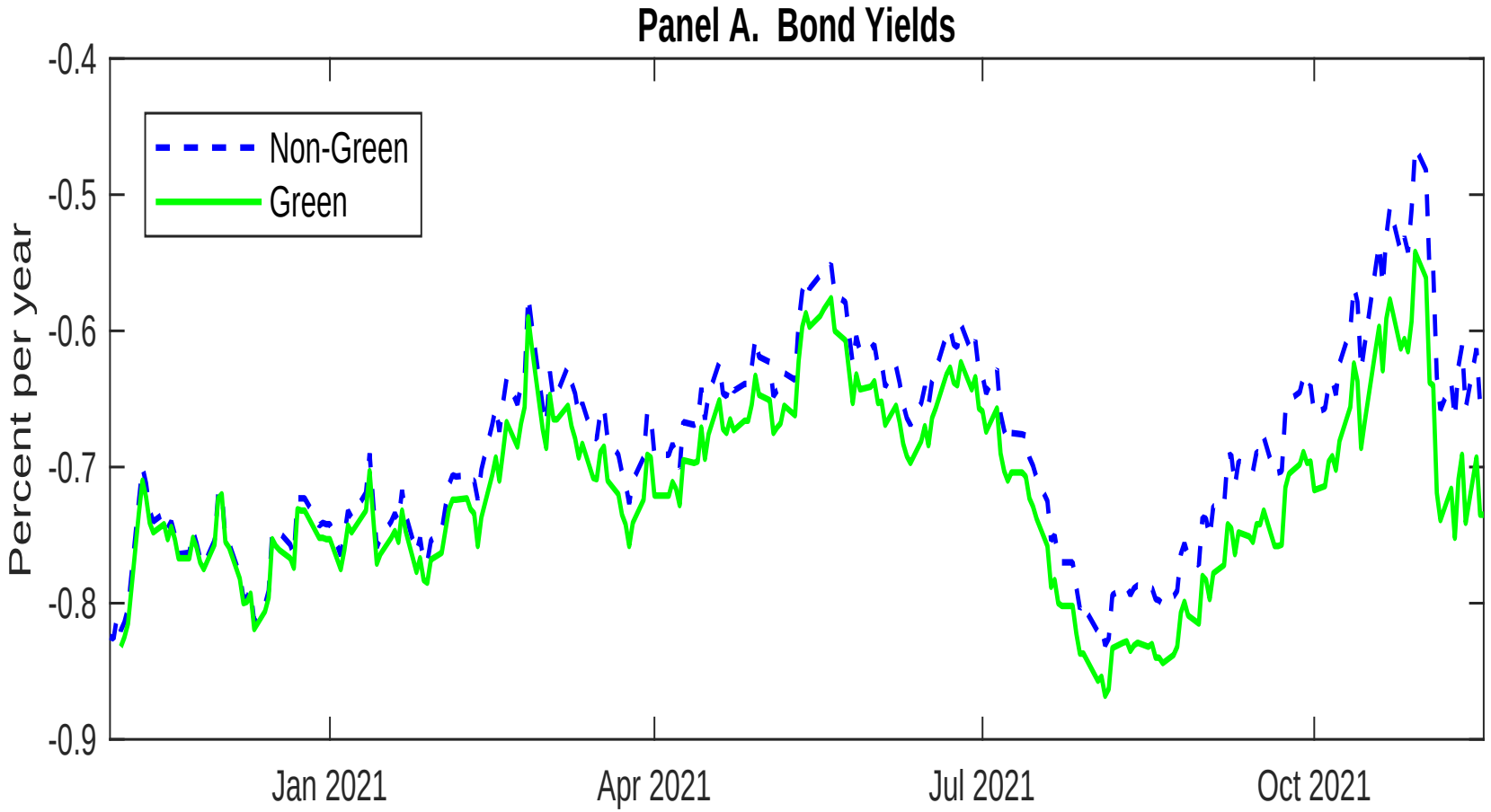
German Twin Bonds: 5-Year Yields



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