Market-based Green Firms

Konrad Adler, Oliver Rehbein, Matthias Reiner and Jing Zeng

September 22, 2023

Austrian Banking and Finance Workshop

What is a green firm?

There is a strong demand for measuring the "greenness" of firms.

- Investors use them to invest sustainably.
- Policymakers use them to enact targeted climate policy laws.
- Researchers use them as proxies for exposure to climate change risk (political, transition, physical).

Various measures for the greenness of a company exist

Different papers use different variables to proxy for climate risk:

- Environmental Scores (E-Scores)
- Carbon intensities $\frac{CO_2EE}{MV}$
- Textual analysis measures of earnings conference calls
- Oil betas
- Many other carbon ratings, variables and providers...

Various measures for the greenness of a company exist

Different papers use different variables to proxy for climate risk:

- Environmental Scores (E-Scores)
- Carbon intensities $\frac{CO_2EE}{MV}$
- Textual analysis measures of earnings conference calls
- Oil betas
- Many other carbon ratings, variables and providers...

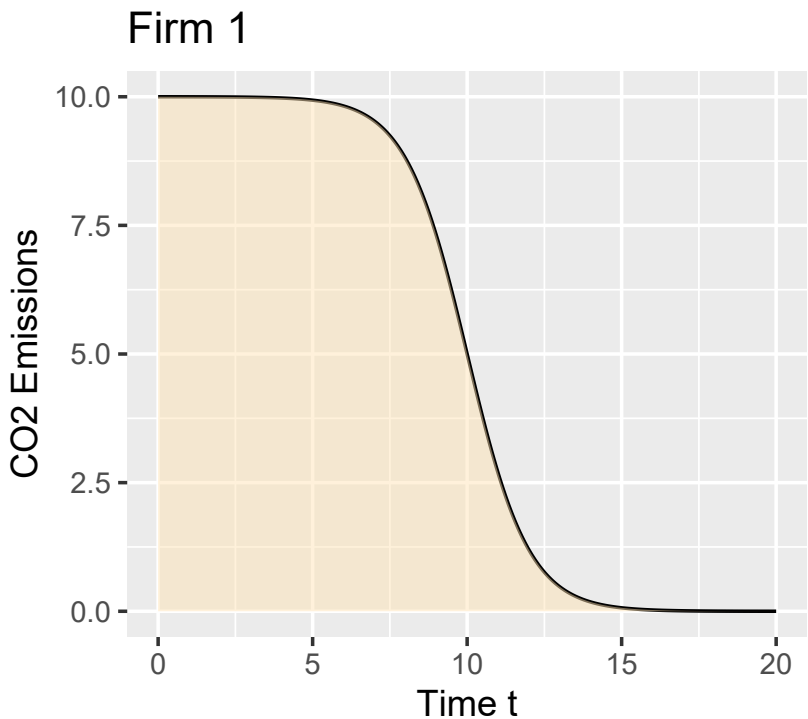
They all have one key problem:

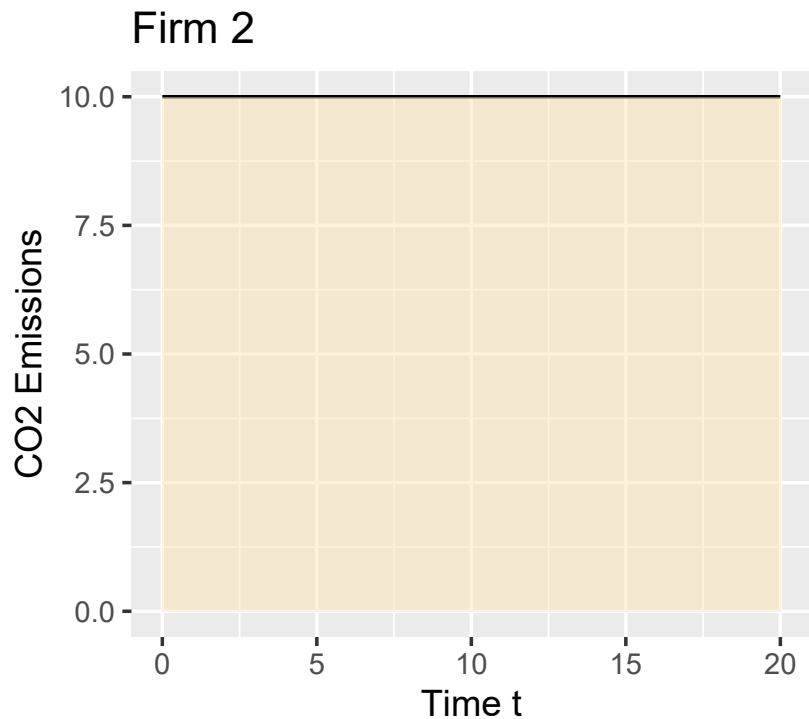
They look at the present or past, not the future.

Problem of traditional backward looking measures

- Not current, but **(expected) future emissions** matter!
- Two firms might have the same emissions at a certain point in time, but what matters is the area under the curve:

$$CO_2(t=0)^{\text{Firm1}} = CO_2(t=0)^{\text{Firm2}} \quad \text{but} \quad \int_0^\infty CO_2(t)^{\text{Firm1}} dt < \int_0^\infty CO_2(t)^{\text{Firm2}} dt \tag{1}$$





Financial Markets can provide forward looking measure!

- (Sovereign) bond markets reflect expected future interest rates
- Forwards, futures, derivatives reflect expected future prices
- Stock markets reflect expected future profits of firms

Our measure attempts to isolate expected **future emissions** by the reaction of stocks to green news events

Research Goal

Create a market-based measure for the greenness of a firm

- Use firms' abnormal returns around climate change (policy) events to infer firms' greenness?
- (firms climate risk)

Why is our measure useful?

Advantages of our measure:

- Our measure is **forward-looking**.
- Our measure **does not rely on self-reported data**.
- Our measure can be computed for any firm listed on a stock exchange.
- Our measure can be computed by anyone anytime and does not come with reporting delay.

Model

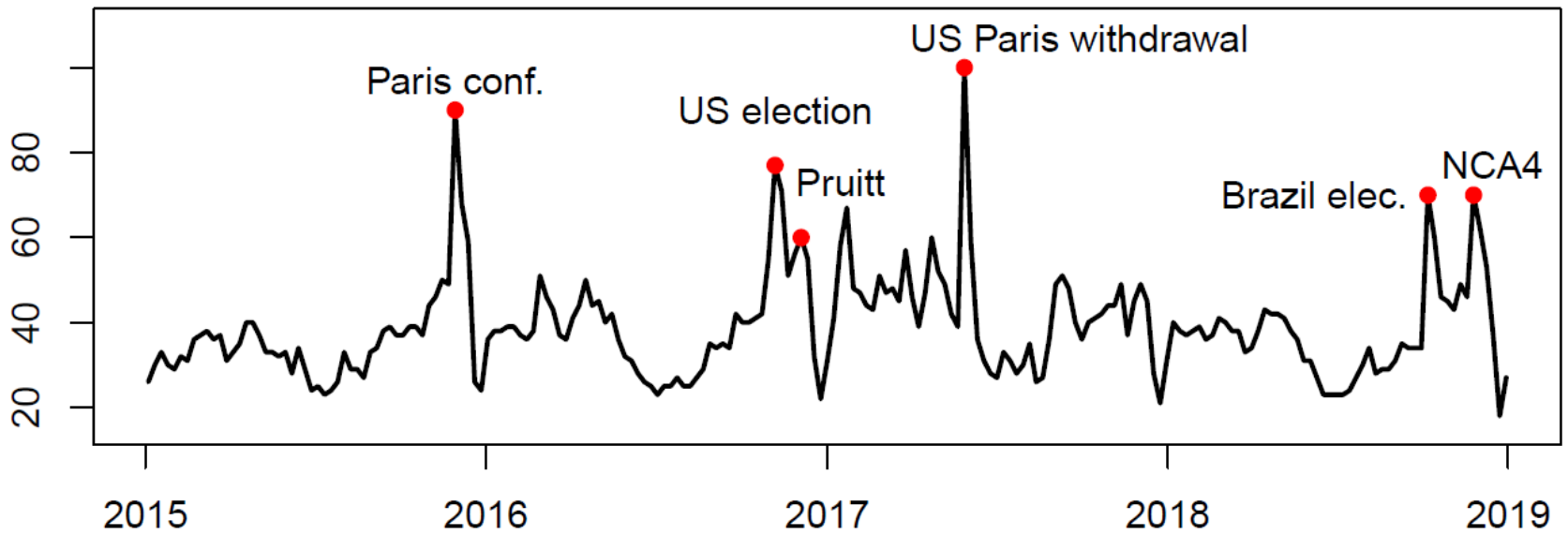
The paper includes a rational expectations equilibrium (REE) model of asset prices to show to what extent realized returns provide information about the "greenness" of a stock.

Main intuition:
When attention to climate change is high (news shocks), investors preferences shift from learning about idiosyncratic risk to learning about firms' climate risk.

$\rightarrow$ Firms' stock price becomes more informative about its greenness around green news events

Identification of climate policy shocks

Identification via attention data (Google Trends) ...



Weekly relative search volume for the term ”climate change”

Identification of climate policy shocks

... by browsing the literature ...

Date	Event	Shock Sign	Source
5-Jun-96	Solar Two Plant Demonstrates Low Cost Method of Storing Solar Energy	+	ProCon.org
18-Jul-96	COP 2, Geneva, Switzerland	+	IPCC
9-Oct-96	Hydrogen Future Act of 1996 Is Passed to Further Expand Hydrogen Power Development	+	ProCon.org
29-Oct-96	European Union adopts target of a maximum 2 °C rise in average global temperature	+	Wikipedia
5-Nov-96	Bill Clinton Elected POTUS	+	U.S. Presidential Elections
5-Dec-96	EV1 Electric Car Is Made Available to the Public For Lease; Lease Program and EV1 Later Dismantled by GM	+	ProCon.org
25-Jun-97	US Senate passes Byrd–Hagel Resolution rejecting Kyoto	-	Wikipedia
11-Dec-97	COP 3, The Kyoto Protocol on Climate Change	+	Wikipedia/IPCC
14-Nov-98	COP 4, Buenos Aires, Argentina	+	IPCC
5-Nov-99	COP 5, Bonn, Germany	+	IPCC
7-Nov-00	George W. Bush Elected POTUS	-	U.S. Presidential Elections
25-Nov-00	COP 6, The Hague, Netherlands	+	IPCC
28-Mar-01	President George W. Bush withdraws from the Kyoto negotiations	-	Wikipedia
27-Jul-01	COP 6, Bonn, Germany	+	IPCC
29-Sep-01	IPCC Third assessment report	+	IPCC
10-Nov-01	COP 7, Marrakech, Morocco	+	IPCC
13-May-02	Farm Security and Rural Investment Act	+	Wikipedia

Set of events we consider

Set 1: Paris agreement		
Date	Event	Shock Sign
2015-12-12	UN climate change conference in Paris	+

Set 2: Google Trends events		
2015-12-12	UN climate change conference in Paris	+
2016-11-08	Donald Trump Elected POTUS	-
2016-12-07	Trump's nomination of Scott Pruitt to lead the EPA	-
2017-06-01	Announcement of US withdrawal from the Paris agreement	-
2018-10-08	IPCC special report	+
2018-11-23	Release of NCA4	+

Set 3: Barnett events		
2015-08-03	President Obama Announces Clean Power Plan	+
2015-12-12	UN climate change conference in Paris	+
2016-02-09	Supreme Court issues stay on Clean Power Plan	-
2016-11-08	Donald Trump Elected POTUS	-
2017-06-01	Announcement of US withdrawal from the Paris agreement	-

Table: Different sets of climate change events

Construction of our measure

Once we have our events we compute abnormal returns around the events:

- CAPM as benchmark model: Use 1 year of preceding daily return data to compute β to get

$$E(R_t) = [r_f + \beta(E(R_m) - r_f)] \tag{2}$$

- Compute daily abnormal returns around event dates:

$$AR_t = R_t - E(R_t) \tag{3}$$

- Compute cumulative abnormal returns:

$$CAR_{t_1,t_2} = \prod_{t=t_1}^{t_2} (1 + AR_t) - 1 \tag{4}$$

Definition of our measure

We distinguish between ”positive” (1) and ”negative” climate shocks (-1). Our greenness measure for firm i at event e_t is

$$GreenMeas_{i,e_t} = \begin{cases} (C)AR_{i,e_t} \text{ , if sgn}(e_t) = 1 \\ -(C)AR_{i,e_t} \text{ , if sgn}(e_t) = -1 \end{cases} \tag{5}$$

Alternative: Use return rankings instead of returns (caveat: not information-preserving)

$$RankMeas_{i,e_t} = \begin{cases} \text{rank}\left[(C)AR_{i,e_t}\right] \text{ , if sgn}(e_t) = 1 \\ \text{rank}[-(C)AR_{i,e_t}] \text{ , if sgn}(e_t) = -1 \end{cases} \tag{6}$$

For multiple events our cross-sectional measure is then the average:

Does it work? CAR ranking after Paris

BTU: ”Peabody Energy is the leading global pure-play coal company”.

WPX: ”WPX Energy, Inc. was a natural gas and oil exploration and production company”.

	date	permno	industry	mktcap	AR	Ticker
1	2015-12-14	88991	Mining	142.35	-0.136	BTU
2	2015-12-14	13141	Mining	1580.08	-0.102	WPX
3	2015-12-14	63765	Mining	2733.65	-0.100	SWN
4	2015-12-14	52337	Services	3019.97	-0.096	THC
5	2015-12-14	90071	Utilities	3697.85	-0.095	NRG
6	2015-12-14	90352	Utilities	1615.42	-0.094	DYN
7	2015-12-14	27422	Mining	242.41	-0.091	CLF
8	2015-12-14	82196	Mining	709.35	-0.085	DNR
9	2015-12-14	12503	Manufacturing	720.86	-0.078	NAV
10	2015-12-14	13919	Finance	634.67	-0.075	AMBC
⋮	⋮	⋮	⋮	⋮	⋮	⋮

Does it work? CAR ranking after Paris

At the other end of the table we have e.g. a solar panel company (FSLR), electronic companies and electric vehicle assemblers (ANET, CVG) or lithium miners (CXO).

	date	permno	industry	mktcap	AR	Ticker
⋮	⋮	⋮	⋮	⋮	⋮	⋮
560	2015-12-14	15401	Manufacturing	26481.39	0.028	BXLT
561	2015-12-14	39538	Manufacturing	9229.65	0.029	MAT
562	2015-12-14	14541	Manufacturing	169308.05	0.03	CVX
563	2015-12-14	92239	Mining	11992.4	0.031	CXO
564	2015-12-14	82298	Mining	2894.05	0.032	DO
565	2015-12-14	75828	Services	21303.2	0.034	EA
566	2015-12-14	86305	Services	2427.6	0.038	CVG
567	2015-12-14	14714	Manufacturing	5274.13	0.04	ANET
568	2015-12-14	91611	Manufacturing	6715.6	0.053	FSLR

Relationship to other ”greenness” measures?

We expect and find a negative correlation with carbon intensities.

Pooled panel regression for different sets of events. Sample: S&P 500 firms. The estimated equation is
$CarbInt_{it} = \alpha + GreenMeas_{it} + \epsilon_{it}$

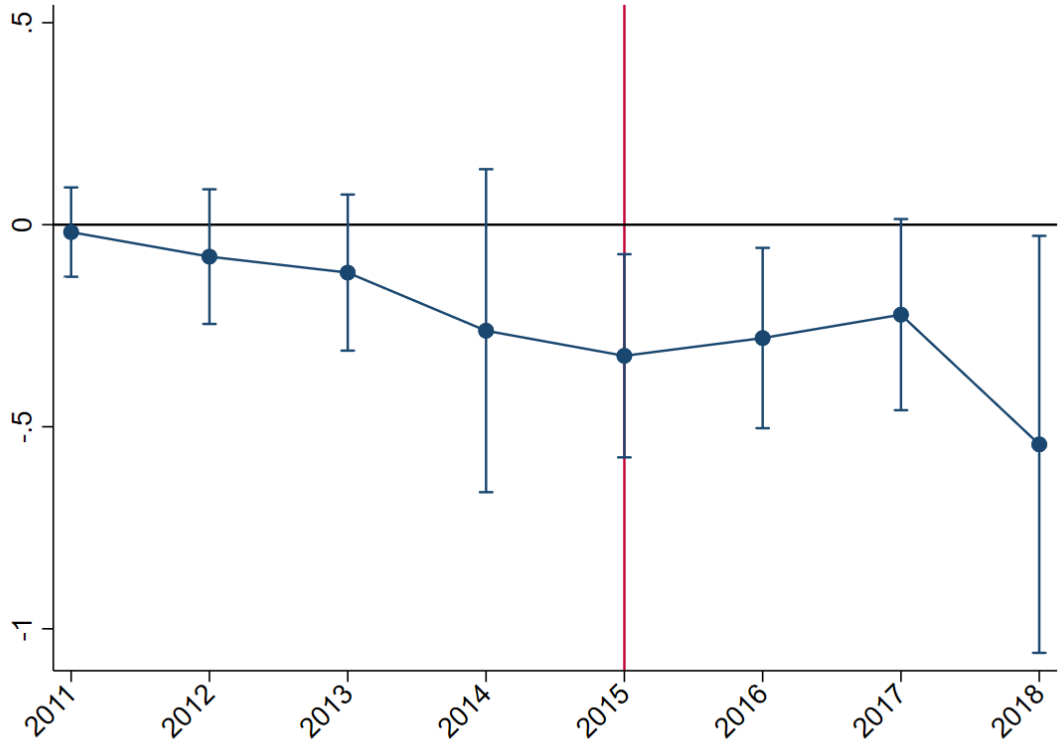
We also test correlations with E-scores and textual analysis scores.

	Dependent variable:						
	CarbInt						
	CAR_{00}	CAR_{01}	CAR_{-10}	CAR_{-22}	CAR_{00}	CAR_{01}	CAR_{-10}
Panel A: Paris climate summit							
Greenness	−2.9e+04*	−1.3e+04	−1.8e+04*	−5.3e+03			
	(1.7e+04)	(1e+04)	(9.6e+03)	(5e+03)			
Greenness rank					−2.34*	−0.68	−2.2*
					(1.27)	(1.08)	(1.28)
Panel B: 6 Google Trends Events							
Greenness	−9.6e+03**	−7.9e+03	−4.8e+03	−5e+03			
	(4.9e+03)	(6.1e+03)	(3.3e+03)	(4.1e+03)			
Greenness rank					−1.4**	−0.56	−1.03**
					(0.54)	(0.91)	(0.52)
Panel C: 5 Significant Barnett Events							
Greenness	−4.7e+03	−2.4e+03	−1.8e+03	728.36			
	(7.7e+03)	(7.2e+03)	(4.1e+03)	(1.5e+03)			
Greenness rank					−0.44	−0.39	0.12
					(0.94)	(1.09)	(0.9)
Note:							*p<0.1; **p<0.05; ***p<0.01

Evidence of green-washing?

	Dependent variable:							
	EScore							
	CAR_{00}	CAR_{01}	CAR_{-10}	CAR_{-22}	CAR_{00}	CAR_{01}	CAR_{-10}	CAR_{-22}
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Paris climate summit								
Greenness	25.33	−39.47	40.94	22.99				
	(58.24)	(42.95)	(35.2)	(26.46)				
Greenness rank					8.3e-03	3.6e-03	0.01*	0.01*
					(8.3e-03)	(8.6e-03)	(8.2e-03)	(8.6e-03)
Panel B: 6 Google Trends Events								
Greenness	−120.42	−182.44***	−261.98***	−48.37				
	(122.45)	(64.27)	(100)	(66.45)				
Greenness rank					2.8e-03	−0.03*	−0.04**	−0.01
					(0.02)	(0.02)	(0.02)	(0.02)
Panel C: 5 Significant Barnett Events								
Greenness	16.72	−101.5	−234.86**	−115.07**				
	(119.7)	(81.42)	(111.96)	(48.55)				
Greenness rank					0.02	7.7e-03	−0.05***	−0.03*
					(0.02)	(0.02)	(0.02)	(0.02)
Note:								*p<0.1; **p<0.05; ***p<0.01

Correlation with future carbon intensities



Correlation between Paris Climate Agreement CAR (0,0) and carbon intensity over time

Climate change hedge portfolios

- We apply and follow the portfolio-mimicking approach used in Engle et al. (2020).
- We gather monthly data of NYSE, AMEX and NASDAQ firms from CRSP and Compustat from 1980-2022 (excluding penny and microcap stocks).
- We compute firm characteristics Z_t: Size, Book-to-Market, Greenness (using our methodology) and Market Share.
- We standardize most variables to create a set of characteristic-sorted portfolios $\tilde{r} = Z'_{t-1} r_t$ that span the factor space.

Climate change hedge portfolios

- We apply and follow the portfolio-mimicking approach used in Engle et al. (2020).
- We gather monthly data of NYSE, AMEX and NASDAQ firms from CRSP and Compustat from 1980-2022 (excluding penny and microcap stocks).
- We compute firm characteristics Z_t: Size, Book-to-Market, Greenness (using our methodology) and Market Share.
- We standardize most variables to create a set of characteristic-sorted portfolios $\tilde{r} = Z'_{t-1} r_t$ that span the factor space.
- We then project the climate risk factor CC_t provided by Engle et al. (innovations to the WSJ climate news index) onto these portfolios to obtain the weights for the hedge portfolio:

$$CC_t = \xi + w_{SUS} Z^{SUS\prime} r_t + w_{SIZE} Z_{t-1}^{SIZE\prime} r_t + w_{HML} Z_{t-1}^{HML\prime} r_t + w_{MKT} Z_{t-1}^{MKT\prime} r_t + e_t \quad (9)$$

In-sample results

The sustainability portfolio sorted based on our greenness measures performs better in times of more climate change news $\Rightarrow$ we can "hedge climate change news".

	Dependent variable:			
	wsj_AR1_Innovation *10^4		chneg_AR1_innovation *10^4	
Sus_portf_Paris	0.173		0.106*	
	(0.105)		(0.062)	
Sus_portf_GT		0.413***		0.287***
		(0.148)		(0.091)
size_portf	0.044	0.068	−0.068	−0.073
	(0.116)	(0.115)	(0.076)	(0.074)
value_portf	0.131***	0.148***	0.038**	0.047***
	(0.031)	(0.031)	(0.018)	(0.018)
market_portf	21.784	17.356	11.545	12.337
	(33.512)	(33.219)	(27.040)	(26.222)
Observations	401	401	119	119
R^2	0.054	0.066	0.078	0.131
Adjusted R^2	0.045	0.057	0.045	0.100
Note:				*p<0.1; **p<0.05; ***p<0.01

Final slide

Thank you for your attention!

Literature I