Is the Korean Green Premium in Equilibrium?

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Recap of Pástor, Stambaugh, and Taylor (2021a,b)

Theory

Pástor et al., "Sustainable investing in equilibrium", JFE2021

- Green assets have **LOW** expected returns due to investors' preferences and hedging needs.

- Nevertheless, green assets **outperform** when positive shocks hit the ESG factor.
  · Customers' tastes for green products
  · Investors' tastes for green holdings

- Two factor model of Market and **ESG factor**

- **Dispersion** of investors' ESG preferences → ESG investment industry

- Sustainable investing → **Positive social impact**
  : making firms greener and
   shifting real investment to green firms.

https://youtu.be/acWcJ-2xDaE

Evidence

Pástor et al., "Dissecting green returns", WP2021

- Green assets delivered **HIGH** returns in recent years.

  ⓐ German green bonds' widened "greenium"
  ⓑ U.S. green stocks outperformance

- NOT high expected returns BUT reflecting **unexpectedly** strong increases in **environmental concerns**.

- **Counterfactual returns** without climate-concern shocks have **NO** positive alpha.

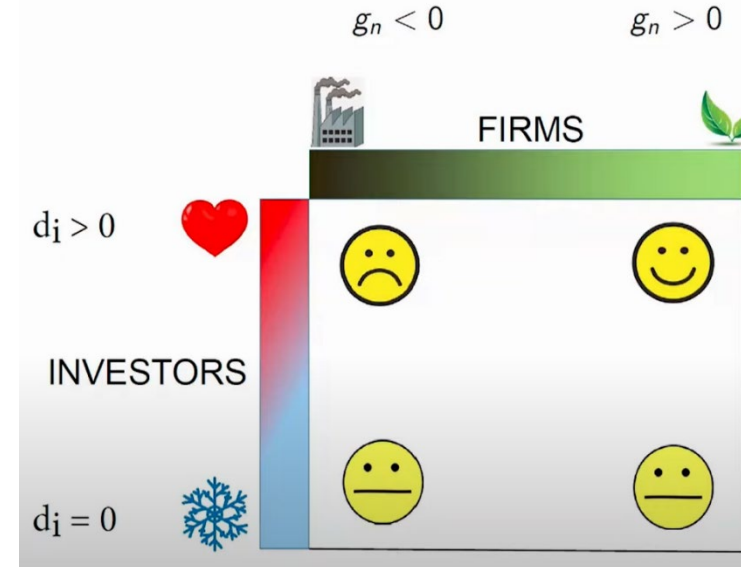- Green factor explains the recent **underperformance of value stocks**.

https://youtu.be/s9zXPoTR6J0

  ※ **Debate of Lu Zhang (2021) on ≪Growth vs. Value≫**
    ≪Green vs. Brown≫ vs. ≪Intangible vs. Tangible≫

    https://youtu.be/3mPUq1FPXh4

Perspective from Investment Industry

View on the investors' movements

Source : Taylor, Presentation for "CEPR/EBRD/ECB Symposium, June 2021"

"Because **capital markets pull future risk forward**, we will see changes in capital allocation more quickly than we see changes to the climate itself. In the near future – and sooner than most anticipate – there will be **a significant reallocation of capital**."

"Larry Fink's 2020 letter to CEOs: a fundamental reshaping of finance", BlackRock

Motivation
So, what is the case in Korean stock market?

- **Evidences that investors have utility in nonpecuniary aspects of companies**

  ✓ **VC** Investors are willing to pay higher in their investment for their mission objectives. (Barber et al., JFE2021)

- **The impact of environmental factors on asset prices is likely to expand.**

  ✓ As investors are considering seriously the environmental risk, they can price the **transition risk** to a carbon-neutral society into the asset prices. (**Stranded assets**)

  ✓ Evidences that the climate risk is priced in as investors are increasing climate impact investing.
    - Baldauf et al., "Does climate change affect **real estate** prices? Only if you believe in it" (RFS2020)
    - Bolton and Kacperczyk, "Do investors care about **carbon risk**?" (JFE2021)
    - Flammer, "**Corporate** green bonds" (JFE2021)
    - Painter, "An inconvenient cost: The effects of climate change on **municipal bonds**" (JFE2020)

➔ **Need to see the environmental risk premium and environmental beta of each company!**

Research Question!

Environmental Risk Premium of the Korean stock market

We ask that~

a. whether the Korean stock market lie in the **EQUILIBRIUM STATE** or not according to the equilibrium model of Pástor et al. (2021a).

b. Is there any **DYNAMICS** in the environmental risk premium as shown in the evidences of Pástor et al. (2021b)?

c. How are the environmental **BETA** of each company on environmental factor distributed on average in each industry?

Findings

1. **"Negative (-)" environmental risk premium = "Equilibrium" state of PST (2021a)**

   ✓ The realized environmental risk premium of **-0.23% per month** during the period 2012-2020 (107 months)

   ✓ This conforms with the equilibrium state of PST theoretical model, i.e. **return(Green) < return(Brown)**.

   ✓ This result secure the **robustness** to the changes in methodology and data.

2. **However, the Korean environmental risk premium moves in upward direction.**

   ✓ As environment concerned investors increase in Korea, the realized premium is getting similar with the case of the US stock market.

3. **The environment beta of each company.**

Contributions

1. **Finding the evidence of environmental premium in the Korean stock market**

   ✓ Consistent with the prediction of equilibrium model, which has a **negative (-)** environmental premium

   ✓ And we pose the possible changes in its sign as shown in the US stock markets.

2. **Making the background for further analysis in policy research such as Climate Stress Tests.**

   ✓ Act as a **TOOL** for making a scenario for conducting the stress test for climate change transition risk

3. **Implications for the practitioners in the ESG investment industry**

   ✓ There is **NO** evidence that the environment concerned investment can make a positive **outperformance**.

   ✓ However, the increase in ESG investment flow can make the better investment returns temporarily and give a positive real impact on companies reducing their cost of capital. (**nonpecuniary benefit**)

Data

Environmental Rating of KCGS and Monthly Stock Returns

- **E rating of KCGS** (Korea Corporate Governance Service)

  - ✓ **"Management process model"**
    - • Industry-specific assessments of environmental risk management and performance
    - • Industry-dependent environmental sensitivity scale applied (high-medium-low)
    - • Environmental management system, performance, stakeholder response quality assessed

  - ✓ **6 grades of A+, A, B+, B, C, and D**

Distribution of Environmental Grades

Year	A+	A	B+	B	C	D	-	Total
2012	10	29	134	280	220	0	37	710
2013	6	36	122	299	205	25	0	693
2014	6	40	135	309	174	30	0	694
2015	5	41	142	233	130	145	0	696
2016	3	63	133	232	107	175	0	713
2017	4	58	147	217	79	228	0	733
2018	7	53	144	215	111	197	2	729
2019	5	36	89	241	176	199	0	746
2020	10	58	101	220	169	202	0	760
Total	56	414	1,147	2,246	1,371	1,201	39	6,474
Percentage (%)	0.86	6.39	17.72	34.69	21.18	18.55	0.6	100

Monthly Return Distribution

Environmental grade	N	Average	Standard deviation	Minimum	Maximum
A+	672	0.21	9.20	-40.14	39.39
A	4,960	0.45	10.46	-47.82	117.18
B+	13,759	0.58	12.21	-56.92	252.01
B	26,863	1.15	14.53	-98.44	466.40
C	16,426	1.22	13.77	-91.20	286.84
D	14,409	0.98	15.15	-62.58	397.79

"the higher the E grade, the lower the return"

Returns Evolution

- **Stocks with high E tend to have improved in their returns since 2016.**

  - ✓ **Investors' concern in environmental issues such as carbon emissions may have begun to increase.**

  - ✓ **Any changes in investors' perceptions and movements in investment flows may have impacted stock prices.**

Average Monthly Return by Year					
	A+	A	B+	B	C	D
2012	0.54	0.21	0.77	1.2	1.19	
2013	-0.63	0.17	0.53	0.96	1.01	0.62
2014	-1.05	-1.23	0.23	1.53	2.33	2.09
2015	0.72	-0.26	1.44	2.74	2.69	2.9
2016	0.55	0.28	0.46	0.2	0.55	0.28
2017	1.85	1.36	0.48	0.27	0.5	0.32
2018	-0.98	-0.28	-0.35	0.08	-0.11	0.22
2019	0.66	-0.04	-0.12	0.33	0.04	0.51
2020	0.76	2.66	1.85	2.89	2.14	2.06

Greenness and Excess Returns

- **Grade to Score**

  ✓ "A+"=10, "A"=9, "B+"=8, "B"=7, "C"=5, "D"=3

- **Greenness**

  ✓ $Greenness = (G_{i,t} - \mu_t)/\sigma_t$

  ✓ "**Yearly standardized environmental score**"
    by subtracting the cross-sectional mean
    and dividing the standard deviation

- **Greener tend to be Underperformer!**

Environmental Score and Excess Returns by Industry

		# of observations	Greenness	Excess return (%)
1	Communications service	324	1.4	-0.01
2	Display	108	1.23	-0.38
3	Shipbuilding	1,013	0.73	-1.05
4	Banking	733	0.72	-0.49
5	Energy	1,746	0.59	-0.22
6	Transportation	1,655	0.58	-0.09
7	Hardware	2,238	0.45	0.86
8	Automobiles and parts	4,226	0.44	-0.24
9	Chemical	5,123	0.44	0.34
10	Construction	2,898	0.43	0.29
11	Metals and minerals	3,440	0.41	-0.05
12	Other materials	2,570	0.29	0.45
13	Household goods	799	0.26	-0.02
14	Utility	1,261	0.23	0.05
15	Other capital goods	4,839	0.12	0.21
16	Distribution	1,153	0.05	-0.42
17	Food and Tobacco	3,523	-0.01	0.25
18	Commercial service	436	-0.04	-0.37
19	Semiconductor	932	-0.08	1.66
20	Insurance	1,214	-0.16	-0.8
21	Medical	4,152	-0.34	1.88
22	Consumer service	1,055	-0.38	-0.14
23	Durable consumer goods and clothing	4,396	-0.43	0.62
24	Software	885	-0.5	1.02
25	Media	974	-0.8	0.05
26	Securities	2,315	-1.13	0.17
27	Other finance	393	-1.43	0.23

Empirical Methods

Green Factor Model

- **ESG equilibrium model of PST (2021a)**

  - ✓ Two factor equilibrium model that investors have market portfolio, risk-free assets, and ESG portfolio.

  - ✓ Investors have positive utility in owning green companies.

  - ✓ The environmental risk premium have negative value in equilibrium ($\mathrm{E}(\tilde{f}_g) < 0$).

  - ✓ A green firm's environmental beta has a positive value, and a brown firm's beta has a negative value.

$$\tilde{r} = \beta_m \tilde{r}_m + \beta_g \tilde{f}_g + \tilde{v}$$

- **Configuration of Environmental Factors and State Variable**

  - ✓ The environmental factor returns is estimated from cross-sectional regression of the individual company's market excess returns on the environmental characteristics variables (Greenness) for each month.

$$\hat{f}_{gt} = \frac{g\prime_{t-1} \tilde{r}_t^e}{g\prime_{t-1} g_{t-1}}$$

Factor Spanning Test

- **To examine whether the environmental factor portfolio is explained by existing risk factors.**

  - ✓ The environmental factor cannot act as a risk factor if the environmental factor return is explained by known risk factors.
  - ✓ Conversely, if the environmental factor cannot be explained by existing risk factors, E factor can act as a factor in the augmented asset pricing model with E factor.
  - ✓ Carhart 4 factor model (Fama and French 1993; Carhart 1997)

$$GF_t = \alpha + \beta_{MKT} \cdot MKT_t + \beta_{SMB} \cdot SMB_t + \beta_{HML} \cdot HML_t + \beta_{MOM} \cdot MOM_t + e_t$$

Environmental Beta Estimation

- **Time series factor regression**

    - ✓ A regression analysis of each company's monthly return on the environmental factor portfolio during the sample period.
    - ✓ We exclude sample companies with fewer than 60 observations of monthly returns.
    - ✓ We do not estimate the time variations of the environmental beta given the relatively small sample size of 107 months.

$$r_{i,t} = \alpha_i + \beta_{i,g} \cdot f_{gt} + e_{i,t}$$

Empirical Results

Core Results: Environmental Factor Portfolio Returns

- **Negative realized return premium of Environmental factor portfolio**

  ✓ The average monthly return of -0.23% (t-value = -2.98)

  ✓ Cumulative return of -21.91%

  ✓ Consistent with the forecast of the theoretical model of PST (2021a)
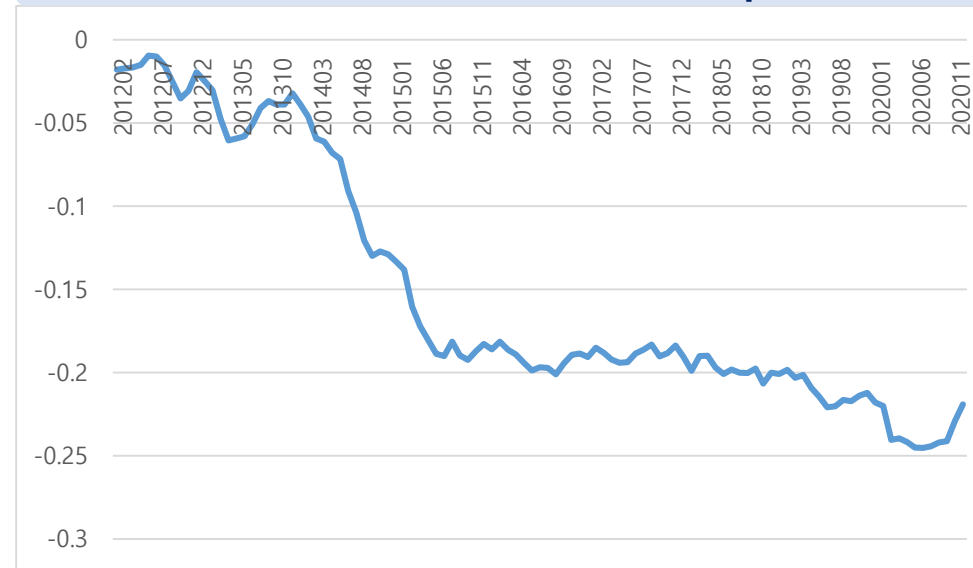
Average monthly Ret.	
Panel A. All periods	
	-0.23
	(-2.98)
Panel B. By year	
2012	-0.17
2013	-0.11
2014	-0.87
2015	-0.53
2016	-0.06
2017	0.05
2018	-0.17
2019	-0.13
2020	-0.07

Cumulative Returns of the E factor portfolio

E factor has its own explanatory power!

- **2-factor model with Environmental factor is possible.**

  - ✓ The alpha of the environmental factor range from -0.25% to -0.18%.
  - ✓ Positive loading on Market factor and Negative loading on Momentum factor

Factor spanning test of environmental factor				
	(1)	(2)	(3)	(4)
Intercept	-0.2461	-0.1855	-0.1890	-0.1807
	(-3.09)	(-2.20)	(-2.21)	(-2.19)
RMRF	0.0358	0.0381	0.0378	0.0403
	(1.93)	(2.08)	(2.05)	(2.28)
SMB		-0.0633	-0.0623	-0.0425
		(-1.93)	(-1.88)	(-1.30)
HML			0.0081	-0.0019
			(0.29)	(-0.07)
MOM				-0.0847
				(-2.96)
N	102	102	102	96
Adj. Rsq.	0.0281	0.0553	0.0460	0.1203

Robustness Checks

Consistently Negative Sign

① Using the methodology of Fama-French (1993)

② Using the CO2 emission data from NGMS

③ Using the energy consumption data from NGMS

④ Using the standardized E score by industry

⑤ Using the constituents of KRX EcoLeaders 100 Index (released in Dec., 2015)

Comparison of Environmental Factor Returns

|	(1)	(2)	(3)	(4)	(5)
				KCGS	KRX Eco
	GMB	CO2	TJ	(Industry Adjusted)	Leaders 100
Panel A. All period					
	-0.08	-0.17	-0.13	-0.21	-0.03
	(-0.47)	(-0.98)	(-1.02)	(-2.88)	(-0.13)
Panel B. By year					
2012		-0.50	-0.48	-0.12	1.33
2013	0.14	-0.17	-0.14	-0.13	-0.18
2014	-1.38	-0.57	-0.19	-0.85	-1.22
2015	-0.56	0.15	-0.36	-0.36	-0.35
2016	0.56	-0.30	-0.44	-0.11	-0.28
2017	0.26	0.32	0.50	0.10	1.57
2018	0.03	-0.93	-0.39	-0.36	-0.47
2019	0.09	0.29	0.23	-0.15	-0.09
2020	0.32	0.18	0.08	0.08	0.12

Question 1: **Does the Korean market lie in EQUILIBRIUM state according to the PST (2021a) model?**

- Yes!

- Highly E rated companies have LOWER returns than low rated ones potentially due to the investor's preferences and hedging demands.
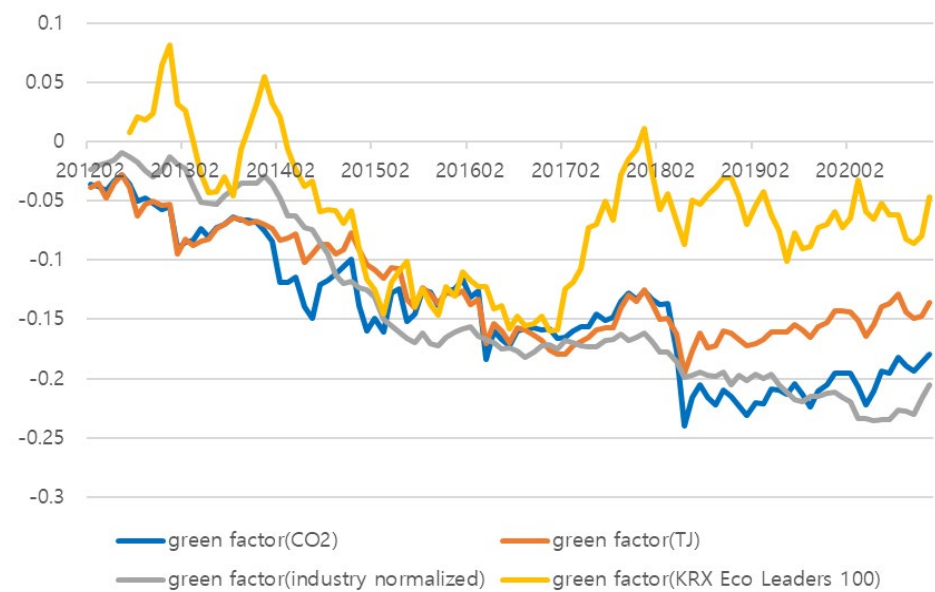
Cumulative Return on Green Factor

- **Similar patterns of Negative sign but recently upward movement since 2016**

  - ✓ (Methodology) The long-short portfolio of Green minus Brown shows the similar pattern with PST method.
  - ✓ (Data) Green factor returns from other data sources also show similarity.

Cumulative Returns of Green Factor: PST and GMB

cumulative return of the green factor: Pástor, Stambaugh, and Taylor (2021)
cumulative return of the green factor: GMB
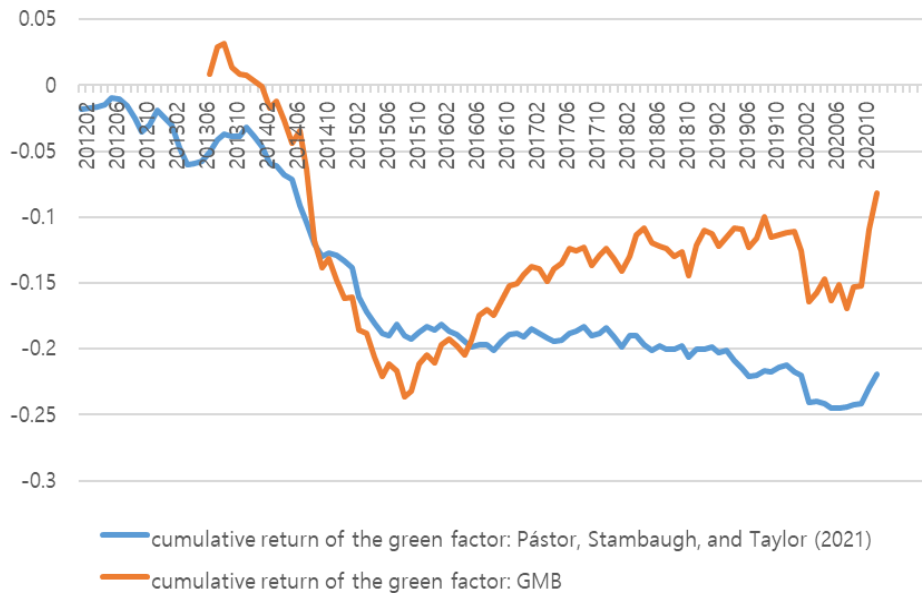
Comparison of Cumulative Returns of Green Factors

green factor(CO2)   green factor(TJ)
green factor(industry normalized)   green factor(KRX Eco Leaders 100)

Question 2: Is there any DYNAMICS in the environmental factor return as shown in the empirical results of PST (2021b)?

- Yes!

- The factor return has recently turned UPWARD suggesting that investors' concern and investment flow have boosted the valuation of Highly E rated companies.

Green Beta

- **Positive Beta → Lower Realize Return**

  ✓ From the fact that the realized green factor return was negative, we can induce that industries with positive green beta had negative environmental return.

Green Beta Estimation

	# of observations	Green beta	t
Shipbuilding	14	4.39	(3.91)
Transportation	23	2.29	(2.57)
Display	1	2.00	
Energy	23	1.77	(2.93)
Media	13	1.22	(1.22)
Automobiles and parts	47	1.08	(3.67)
Insurance	16	0.98	(1.68)
Distribution	17	0.97	(2.22)
Semiconductor	11	0.93	(0.84)
Other finance	9	0.84	(0.98)
Chemistry	58	0.79	(1.89)
Metals and minerals	36	0.67	(1.77)
Communication service	3	0.62	(7.17)
Hardware	22	0.56	(0.96)
Other capital goods	50	0.50	(1.55)
Commercial service	6	0.19	(0.24)
Software	14	0.15	(0.22)
Construction	34	0.14	(0.27)
Consumer service	12	-0.30	(-0.55)
Utility	15	-0.44	(-0.74)
Banking	15	-0.45	(-0.30)
Other materials	29	-0.62	(-1.20)
Food, beverage and cigarettes	40	-1.22	(-3.73)
Durable goods and garments	48	-1.39	(-3.00)
Household goods	12	-1.42	(-1.99)
Securities	24	-1.44	(-5.99)
Medicine	50	-1.98	(-4.47)

Question 3: Are the environmental **BETA** for green companies tend to be positive?

- Yes!

- Not all industries. But industries that have positive Greenness tend to have positive green beta. (12 industries out of 16)

Concluding Remarks

Environmental Factor Return: Ex-post vs. Ex-ante

① Historically, the environmental factor return of Korean stock market was **negative (-)**. And it **STILL** has negative expected return due to the investors' preference and hedging demand.

② However, we can see the **positive (+) realized return** premium of Korean environmental factor **temporarily** due to the shock in the environmental concern.

③ But this **enforce the negative (-) expected return** of E factor and make the cost of capital of environmentally friendly companies lower having positive social impact.

Appendix

Evidences of Environmental Risk Premium

Risk Premium of Brown Assets

- Bolton and Kacperczyk (2021), **"Do investors care about carbon risk?"** (JFE)
- Hsu, Li, and Tsou (2021), **"The pollution premium"** (JF, forthcoming)
- Capasso, Gianfrate, and Spinelli (2020), **"Climate change and credit risk"** (Journal of Cleaner Production)

Investor Base and Return Premium

- Hong and Kacperczyk (2009), **"The price of sin: The effects of social norms on markets"** (JFE)
- El Ghoul et al. (2011), **"Does corporate social responsibility affect the cost of capital?"** (JBF)
- Chava (2014), **"Environmental externalities and cost of capital"** (MS)
- Luo and Balvers (2017), **"Social screens and systematic investor boycott risk"** (JFQA)
- Zerbib (2020), **"A sustainable capital asset pricing model (S-CAPM)"** (SSRN WP)
- Choi, Gao, Jiang, and Zhang (2022), **"Global carbon divestment and firms' actions"** (SSRN WP)

Investors' Effect on Environmental Premium

- Choi, Gao, and Ziang (2020), **"Attention to global warming"** (RFS)
- Alok, Kumar, and Wermers (2020), **"Do fund managers misestimate climatic disaster risk?"** (RFS)
- Engle et al. (2020), **"Hedging climate change news"** (RFS)
- Ilhan, Sautner, and Vilkov (2021), **"Carbon tail risk"** (RFS)