The Carbon Reduction Index Funds: Evidence of a Double Bottom Line Effect in the Japanese Stock Market

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Background

- ESG investing is “the consideration of environmental, social, and governance factors alongside financial factors in the investment decision-making process.”
  - This definition is cited from MSCI - a NY-headquartered global financial service company.
- The idea is dated back to 2006 when Kofi Annan, the seventh Secretary-General of the United Nations, initiated the ***Principles for Responsible Investment (PRI)***, saying that:
  - *As institutional investors, we have a duty to act in the best long-term interests of our beneficiaries. In this fiduciary role, we believe that* ***environmental, social, and corporate governance (ESG) issues can affect the performance of investment portfolios****. We also recognise that applying these* ***Principles may better align investors with broader objectives of society.*** *(PRI Brochure, 2021)*
- Relevant trend in Japan
  - GPIF – the world’s largest pension fund - joined PRI in 2015.
  - Double Codes: Japan’s Stewardship Code (2014) and Governance Code (2015)
  - Fiduciary Duty (2017)
  - Fair Disclosure Rule (2018)

Two important concepts of ESG investing

- PRI represents two concepts of ESG Investing.

- Value Alignment as the First ESG Concept
  - Definition: Investments that are aligned with social values. (Brest, Gilson, and Wolfson, 2018)
  - Example: Only owing stock in companies whose activities are consistent with the investor's moral or social values.

- Double Bottom Line as the Second ESG Concept
  - Definition: Investments that strive to achieve measurable social and financial outcomes. (Clark, Rosenzweig, Long, and Olsen, 2004)
  - Example: Carbon Reduction Index Fund (which will be presented later)

  - **There have been massive and intensive discussions regarding the double bottom line in the finance literature.**

Research questions and the purpose of this research

- Can ESG investing give us a double bottom line - i.e., offering above-market risk-adjusted returns and doing something good for our environment and society?

- Show evidence of the double bottom line in the Japanese stock market.
  - CRIF: Carbon Reduction Index Fund

Agenda of this talk

- Research questions and the purpose of this research
- A Review of ESG Asset Pricing Models
- Evidence of Carbon Reduction Index Fund
- Conclusion

A Theory of ESG Asset Pricing

The asset price for ESG investing

- Theorem: Asset Price for ESG Investing (Ishijima and Maeda)

  The asset price for ESG investing is given endogenously at any point in discrete time t $(= 0,1,\cdots)$:

$$\boldsymbol{P}_t = E_t\left[(\boldsymbol{D}_{t+1} + \boldsymbol{P}_{t+1}) \cdot M^C_{t:t+1}\right] + E_t\left[\delta \cdot \mathbf{B}_{t+1} \cdot \boldsymbol{M}^Z_{t:t+1}\right]$$

- Equivalently, the price of asset i $(= 1,\cdots,N)$ for ESG investing is:

$$P_{i,t} = E_t\left[\left(D_{i,t+1} + P_{i,t+1}\right) \cdot M^C_{t:t+1}\right] + E_t\left[\delta \cdot \boldsymbol{b}_{i,t+1} \cdot \boldsymbol{M}^Z_{t:t+1}\right]$$

  - Equilibrium pecuniary consumption: $C_t = \mathbf{1}'\boldsymbol{D}_t + Y_t$
  - Equilibrium ESG attributes: $\boldsymbol{Z}_t = \mathbf{B}'_t\mathbf{1}$

Definition: Double Return for ESG Investing

- ESG investing provides the double return, the sum of Cash-flow return and ESG yield, and reflects the concept of the double bottom line of ESG investing.
  - **Double Return** $W_{i,t:t+1} \coloneqq X_{i,t:t+1} + Y_{i,t:t+1}$
  - **CF Return** $X_{i,t:t+1} \coloneqq \left(D_{i,t+1} + P_{i,t+1}\right)/P_{i,t}$
  - **ESG Yield** $Y_{i,t:t+1} \coloneqq b_{i,t+1} M^{Z}_{t+1:t+1}/P_{i,t}$

ESG CAPM

- Theorem ESG CAPM (Ishijima and Maeda)

$$
\begin{aligned}
E_t\left[W_{i,t:t+1}\right] - x^f_{t:t+1} &= \frac{Cov_t\left(W_{i,t:t+1}, M^C_{t:t+1}\right)}{Cov_t\left(W_{M,t:t+1}, M^C_{t:t+1}\right)} \cdot \left(E_t\left[W_{M,t:t+1}\right] - x^f_{t:t+1}\right) \\
&= \frac{Cov_t\left(W_{i,t:t+1}, a + b \cdot W_{M,t:t+1}\right)}{Cov_t\left(W_{M,t:t+1}, a + b \cdot W_{M,t:t+1}\right)} \cdot \left(E_t\left[W_{M,t:t+1}\right] - x^f_{t:t+1}\right) \\
&= \beta_i \cdot \left(E_t\left[W_{M,t:t+1}\right] - x^f_{t:t+1}\right)
\end{aligned}
$$

- where $\beta_i := Cov_t\left(W_{i,t:t+1}, W_{M,t:t+1}\right)/V\left[W_{M,t:t+1}\right]$.

An interpretation of ESG CAPM

- ESG CAPM says the risk-adjusted expected excess-double-return of any asset equals the market expected excess-double-return.

$$\frac{E_t\left[W_{i,t:t+1}\right]-x^f_{t:t+1}}{\beta_i}=\frac{E_t\left[W_{j,t:t+1}\right]-x^f_{t:t+1}}{\beta_j}=E_t\left[W_{M,t:t+1}\right]-x^f_{t:t+1}$$

$$\Leftrightarrow \underbrace{\frac{\left(E_t\left[X_{i,t:t+1}\right]-x^f_{t:t+1}\right)+E_t\left[Y_{i,t:t+1}\right]}{\beta_i}}_{[Risk-adjusted\ Double-Retun\ of\ i]}=\underbrace{\frac{\left(E_t\left[X_{j,t:t+1}\right]-x^f_{t:t+1}\right)+E_t\left[Y_{j,t:t+1}\right]}{\beta_j}}_{[Risk-adjusted\ Double-Retun\ of\ j]}$$

$$=\underbrace{\left(E_t\left[X_{M,t:t+1}\right]-x^f_{t:t+1}\right)+E_t\left[Y_{M,t:t+1}\right]}_{[Double-Return\ of\ the\ Market]}$$

Evidence of Carbon Reduction Index Fund

A return regression model for ESG investing

- The cash flow return can be decomposed as shown below:

$$W_{i,t:t+1} = X_{i,t:t+1} + Y_{i,t:t+1} \Leftrightarrow X_{i,t:t+1} = W_{i,t:t+1} - Y_{i,t:t+1}$$

$$\Leftrightarrow \underbrace{X_{i,t:t+1}}_{\left[\begin{smallmatrix}CF\ Return\\ =observable\end{smallmatrix}\right]} = \underbrace{W_{i,t:t+1}}_{\left[\begin{smallmatrix}W.Return\\ =latent\end{smallmatrix}\right]} - \underbrace{\frac{\overbrace{\left[\begin{smallmatrix}Observable\\ ESG\\ Attributes\end{smallmatrix}\right]}^{\boldsymbol{b}_{i,t+1}} \cdot \overbrace{\left[\begin{smallmatrix}latent\\ ESG\\ Price\end{smallmatrix}\right]}^{\boldsymbol{M}^{Z}_{t+1:t+1}}}{P_{i,t}}}_{[ESG\ Yields]}$$

$$\Leftrightarrow CF\ Return = Inter. - CO2\ Emissions \times \%Incr.EmissionsPrice + OtherESGs$$

$$\Leftrightarrow CF\ Return = Inter. + CO2\ Reductions \times \%Incr.ReductionsPrice + OtherESGs$$

$$\Rightarrow \underbrace{R_{i,t}}_{\left[\begin{smallmatrix}Depend.Var.\\ CF\ Return\end{smallmatrix}\right]} = \underbrace{CO2_{i,t}}_{\left[\begin{smallmatrix}Independ.Var.\\ Carbon\\ Reductions\end{smallmatrix}\right]} \cdot \underbrace{\alpha_t}_{\left[\begin{smallmatrix}Regression\ Coef.\\ \%Increase\ Reduction\ Price\end{smallmatrix}\right]} + \boldsymbol{CTRL}'_{i,t} \cdot \boldsymbol{c}_t$$

Estimation of Carbon Risk Premium

- Pooled Regression with respect to stock returns:

$$R_{i,t} = \alpha_t \cdot CO2_{i,t} + \boldsymbol{c}_t' \boldsymbol{CTRL}_{i,t} + \tau \cdot \mathbf{1}_{\{TIME\ t\}} + \gamma \cdot \mathbf{1}_{\{SECTOR\ j\}} + \eta \cdot \mathbf{1}_{\{FIRM\ i\}} + \varepsilon_{i,t}$$

  - $CO2_{i,t}$: **growth rate of carbon emissions** for firm i.
  - α_t: percentage increase in the stock price of firm i if it increases its carbon emissions by 1%
  - $\boldsymbol{CTRL}_{i,t}$: control variables for firm i. We used the following variables. LOG SIZE: natural logarithm of market capitalization. B/M: book value of equity divided by market value of equity. ROE: return on equity. LEVERAGE: book value of leverage is defined as the book value of debt divided by the book value of assets. MOM is the cumulative stock return over a one-year period. INVEST/A: CAPEX divided by the book value of assets. HHI: Herfindahl index of the business segments of a company with weights proportional to revenues. LOG PPE: natural logarithm of plant, property & equipment. BETA: CAPM beta calculated over the one-year period. VOLAT: monthly stock return volatility calculated over the one-year period.
  - Dummy variables: time dummies $\mathbf{1}_{\{TIME\ t\}}$, industry dummies $\mathbf{1}_{\{SECTOR\ j\}}$, and firm dummies $\mathbf{1}_{\{FIRM\ i\}}$.

"Positive" carbon risk premium in the US (Bolton and Kacperczyk, JFE, 2021)

Panel B: Growth rate in total emissions

Variables	(1)	(2)	(3)	(4)	(5)	(6)
ΔSCOPE 1	0.641***			0.627***		
	(0.153)			(0.144)		
ΔSCOPE 2		0.345**			0.321**	
		(0.125)			(0.120)	
ΔSCOPE 3			1.203***			1.186***
			(0.318)			(0.314)
LOGSIZE	−0.023	−0.013	−0.037	−0.107	−0.099	−0.121
	(0.110)	(0.112)	(0.111)	(0.114)	(0.115)	(0.117)
B/M	0.391	0.388	0.410*	0.771**	0.764**	0.789***
	(0.232)	(0.233)	(0.226)	(0.257)	(0.257)	(0.246)
LEVERAGE	−0.433*	−0.414*	−0.441*	−0.794***	−0.785***	−0.799***
	(0.217)	(0.216)	(0.213)	(0.213)	(0.217)	(0.214)
MOM	0.204	0.217	0.166	0.160	0.175	0.124
	(0.265)	(0.268)	(0.267)	(0.264)	(0.266)	(0.264)
INVEST/A	−2.508	−2.244	−2.638	−0.620	−0.463	−0.807
	(1.820)	(1.848)	(1.867)	(2.326)	(2.291)	(2.341)
ROE	0.009**	0.009**	0.009**	0.008**	0.008**	0.009**
	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)
HHI	−0.143	−0.112	−0.162	−0.072	−0.056	−0.089
	(0.154)	(0.153)	(0.151)	(0.098)	(0.097)	(0.102)
LOGPPE	−0.006	−0.015	0.006	0.053	0.045	0.066
	(0.058)	(0.057)	(0.060)	(0.041)	(0.041)	(0.044)
BETA	0.109	0.119	0.106	0.155	0.166	0.145
	(0.165)	(0.165)	(0.168)	(0.158)	(0.157)	(0.162)
VOLAT	1.853	2.004	1.800	1.373	1.504	1.341
	(4.240)	(4.226)	(4.274)	(4.072)	(4.075)	(4.107)
SALESGR	0.459	0.544	0.280	0.463	0.549	0.284
	(0.447)	(0.454)	(0.430)	(0.429)	(0.434)	(0.402)
EPSGR	0.573**	0.573**	0.568**	0.641**	0.641**	0.636**
	(0.247)	(0.246)	(0.250)	(0.263)	(0.263)	(0.266)
Year/month F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Industry F.E.	No	No	No	Yes	Yes	Yes
Observations	153,051	152,955	153,123	153,051	152,955	153,123
R-squared	0.218	0.218	0.218	0.221	0.221	0.222

- Table 8 of B.K. Paper.
- Estimated coefficients are significantly positive.
- Companies w. higher carbon emissions have higher stock returns.

"Negative" carbon risk premium in Japan (Ishijima et al., Preprint, 2021)

- Estimated coefficients are significantly negative.
- Companies w. higher carbon emissions have lower stock returns.

	Dependent variable:					
	RET					
	Time Fixed		Time and Ind. Fixed		Time and Corp. Fixed	
Δ ONTAI	−0.629		−0.836**		−1.256***	
	(0.423)		(0.426)		(0.462)	
Δ SCOPE3		−0.810**		−0.858**		−1.404***
		(0.375)		(0.380)		(0.414)
LOGSIZE	0.208***	0.120	0.096	−0.160	10.686***	12.613***
	(0.060)	(0.108)	(0.082)	(0.156)	(0.398)	(0.652)
BM	−1.678***	−1.799***	−2.298***	−2.841***	−4.658***	−4.469***
	(0.114)	(0.213)	(0.142)	(0.279)	(0.382)	(0.667)
LEVERAGE	0.009	0.002	−0.182***	−0.252***	−0.269**	−0.858***
	(0.019)	(0.030)	(0.040)	(0.071)	(0.115)	(0.223)
MOM	−0.460***	−0.437***	−0.501***	−0.502***	−1.380***	−1.556***
	(0.025)	(0.039)	(0.025)	(0.040)	(0.029)	(0.047)
INVESTA	−6.709***	−10.298***	−7.562***	−12.351***	−0.727	−20.081***
	(1.867)	(3.185)	(2.035)	(3.702)	(3.214)	(6.647)
ROE	0.294	−0.393	−0.819	−2.055**	−6.643***	−13.253***
	(0.481)	(0.777)	(0.509)	(0.865)	(0.793)	(1.680)
HHI	−0.320*	0.069	−0.019	0.200	−2.607***	0.391
	(0.181)	(0.276)	(0.204)	(0.325)	(0.919)	(1.402)
LOGPPE	−0.229***	−0.179*	−0.124	0.095	−1.255***	−0.729
	(0.053)	(0.098)	(0.076)	(0.146)	(0.368)	(0.706)
BETA	−1.695***	−0.861***	−1.972***	−0.970***	−4.867***	−4.727***
	(0.164)	(0.285)	(0.179)	(0.321)	(0.256)	(0.427)
VOLAT	0.281***	0.204***	0.299***	0.243***	0.387***	0.386***
	(0.015)	(0.030)	(0.015)	(0.031)	(0.018)	(0.036)
SALESGR	−0.953***	−0.671***	−0.939***	−0.630**	−1.820***	−1.268***
	(0.187)	(0.251)	(0.188)	(0.255)	(0.209)	(0.295)
EPSGR	1.148*	2.352**	1.756***	3.256***	3.978***	8.172***
	(0.617)	(1.058)	(0.626)	(1.074)	(0.723)	(1.263)
Constant	−1.008	−0.186	2.046	6.043*	−248.871***	−309.166***
	(1.225)	(2.253)	(1.648)	(3.084)	(10.136)	(17.610)
Observations	29,484	10,518	29,484	10,518	29,484	10,518
R^2	0.275	0.337	0.279	0.342	0.351	0.431
Adjusted R^2	0.274	0.332	0.276	0.336	0.335	0.409
Note:						*p<0.1; **p<0.05; ***p<0.01

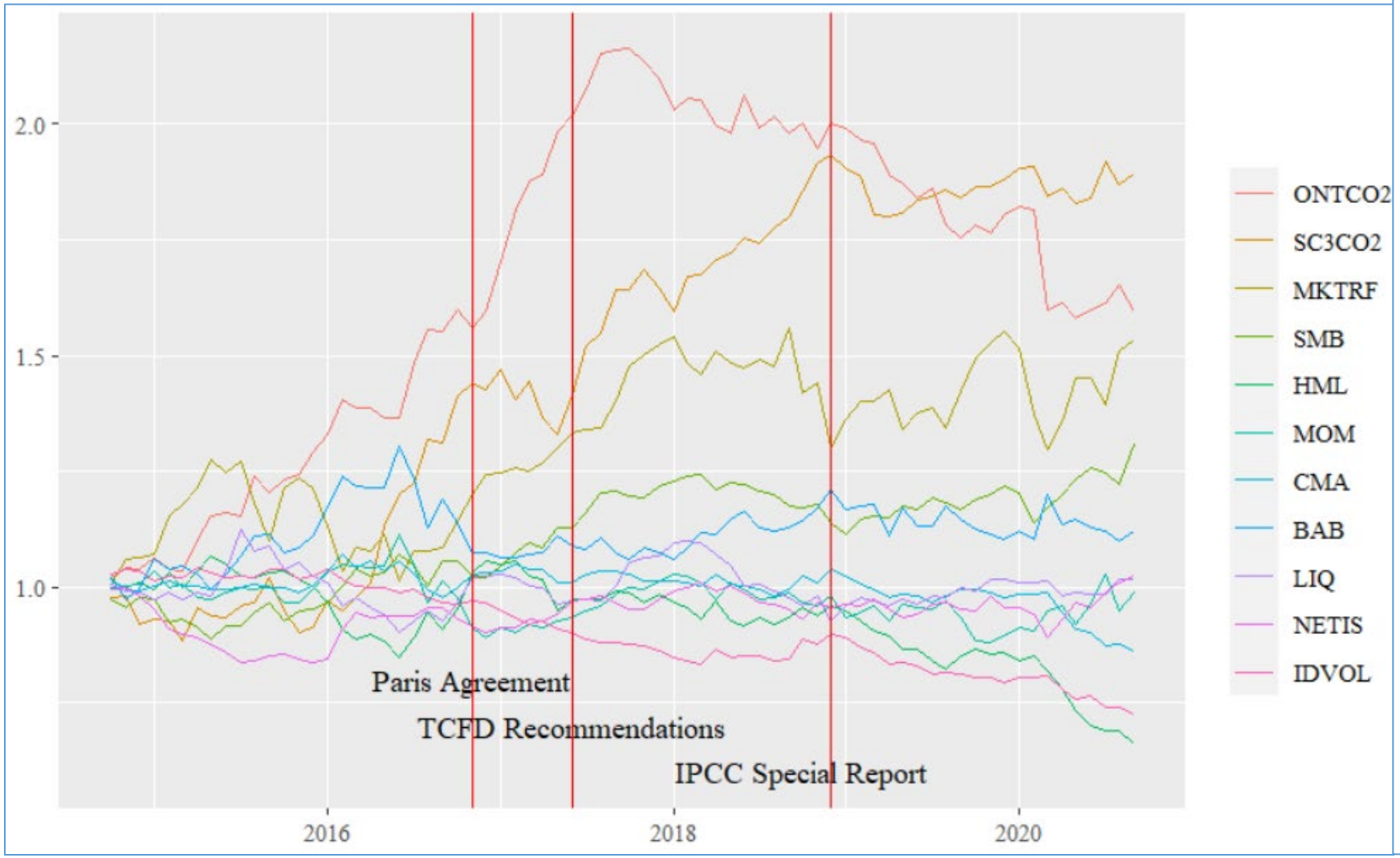
Carbon Reduction Index Fund created by cross-sectional regressions

- For 72 months, from Oct. 2014 to Sep. 2020, we conducted cross-sectional regressions monthly with respect to stock returns:

$$R_{i,t} = \alpha_t \cdot CO2_{i,t} + \boldsymbol{c}_t' \boldsymbol{CTRL}_{i,t} + \tau \cdot \mathbf{1}_{\{TIME\ t\}} + \gamma \cdot \mathbf{1}_{\{SECTOR\ j\}} + \eta \cdot \mathbf{1}_{\{FIRM\ i\}} + \varepsilon_{i,t}$$

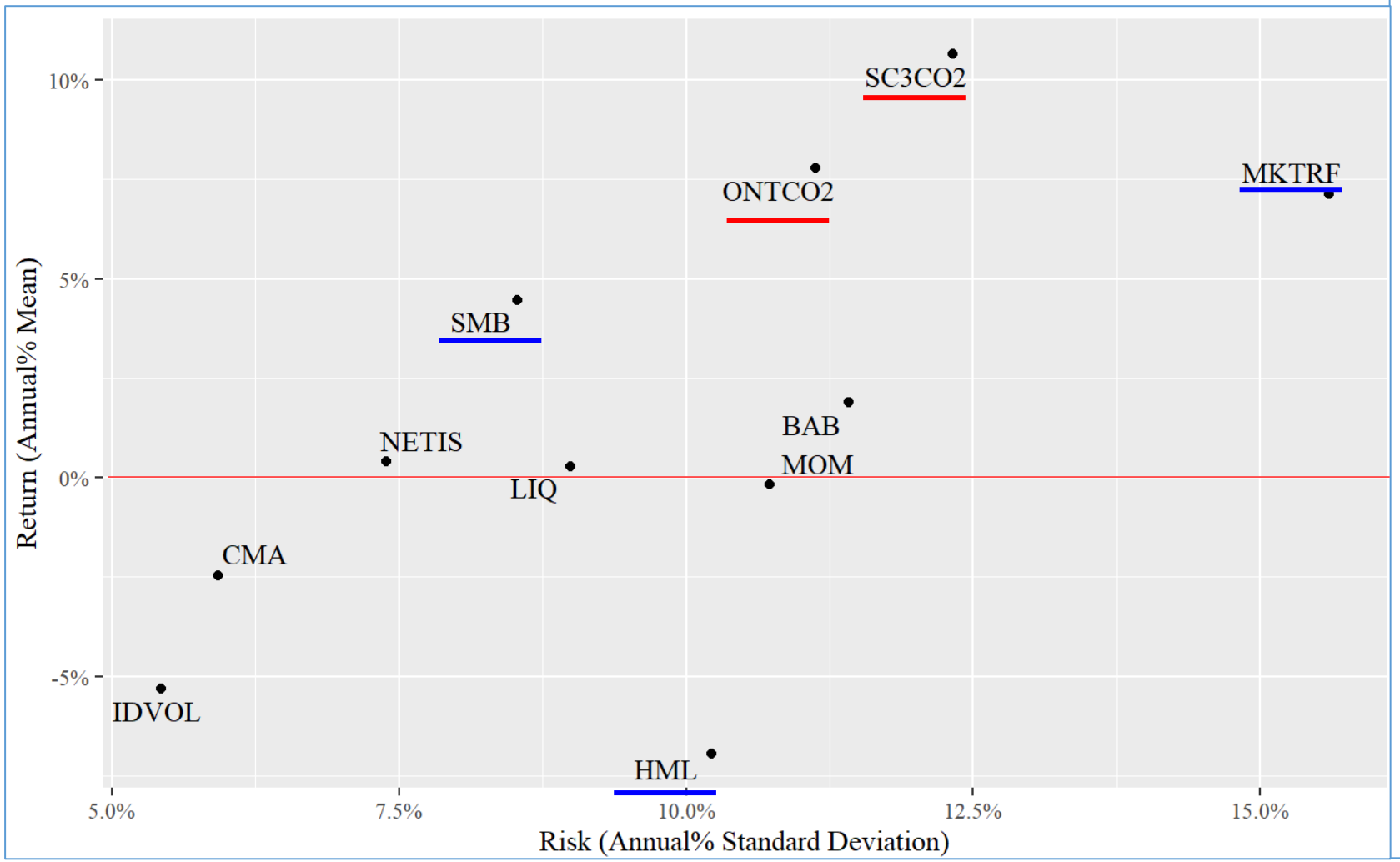
  - $CO2_{i,t}$: **reduction rate of carbon emissions** for firm i.
  - $\boldsymbol{CTRL}_{i,t}$: same control variables for firm i.
  - Dummy variables: time dummies $\mathbf{1}_{\{TIME\ t\}}$, industry dummies $\mathbf{1}_{\{SECTOR\ j\}}$, and firm dummies $\mathbf{1}_{\{FIRM\ i\}}$.
- **Interpretation of $\boldsymbol{\alpha_t}$**: percentage increase in the stock price of firm i if it reduces its carbon emissions by 1%
- **Another interpretation of $\boldsymbol{\alpha_t}$**: return on investment of CRIF – Carbon Reduction Index Fund - a fund that invests in companies that reduce carbon dioxide emissions.

Performance of Carbon Reduction Index Fund



- **ONTCO2**: ONTAI Carbon Reduction Index Fund.
- **SC3CO2**: Scope3 Carbon Reduction Index Fund.
- **MKTRF** (Market Benchmark): Return on the value-weighted stock market net of the risk-free rate.
- **HML** (Value Stocks): Return on the portfolio long value stocks and short growth stocks.
- **SMB** (Small Stocks): Return on the portfolio long small-cap stocks and short large-cap stocks.
- **MOM** (Momentum Factor): Return on the portfolio long 12-month stock winners and short 12-month past losers.
- **CMA** (Conservative Stocks): Return of a portfolio that is long on conservative stocks and short on aggressive stocks.
- **BAB** (Low-beta Stocks): Return of a portfolio that is long on low-beta stocks and short on high-beta stocks.
- **LIQ**: Liquidity factor of Pastor and Stambaugh.
- **NET ISSUANCE**: Return of a portfolio that is long on high-net-issuance stocks and short on low-net-issuance stocks.
- **IDIO VOL**: Return of a portfolio that is long on low idiosyncratic volatility stocks and short on high idiosyncratic volatility stocks.

Risk-return profile of carbon reduction index fund



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Correlation among factors (index funds)

	ONTCO2	SC3CO2	MKTRF	SMB	HML	MOM	CMA	BAB	LIQ	NETIS	IDVOL
ONTCO2	1.00	0.14	0.00	-0.04	0.18	-0.16	0.07	-0.16	-0.22	0.22	-0.03
SC3CO2		1.00	-0.16	-0.01	0.21	0.05	0.05	-0.10	0.12	0.07	0.13
MKTRF			1.00	-0.22	0.27	-0.50	-0.34	-0.59	0.36	-0.03	-0.18
SMB				1.00	-0.64	0.52	-0.18	0.49	-0.11	0.30	-0.45
HML					1.00	-0.62	0.32	-0.60	0.29	-0.37	0.43
MOM						1.00	0.03	0.65	-0.29	0.04	-0.15
CMA							1.00	0.32	-0.11	-0.30	0.55
BAB								1.00	-0.29	-0.06	0.07
LIQ									1.00	-0.16	-0.03
NETIS										1.00	-0.43
IDVOL											1.00

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Conclusion

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- I reviewed asset pricing models for ESG investing.
  - The model reflects the “double bottom line,” which provides
    - risk-adjusted returns
    - at the same time, something good for the environment, society, and governance.

- I showed evidence of the double bottom line by creating the Carbon Reduction Index Fund.