The Pollution Premium

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December 7, 2018

Fourth Geneva Summit on Sustainable Finance

Motivation and Research Question

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    - Tradeoff: economic growth versus environmental protection.
    - Firms' cash flows face the uncertainty of regime shifts
- This paper: theory and evidence of a positive pollution premium

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  - find a significantly positive premium (5.52-5.87 % p.a.)
- Theory:
  - a GE model with heterogenous firms, learning and regime shifts
  - formalize the intuition for the pollution premium
  - quantitatively account for the positive premium

Related Literature

- Policy Implications and Environmental Pollution:
  - Acemoglu (2002), Acemoglu, Aghion, Bursztyn, and Hermous (2012), Acemoglu, Akcigit, Hanley, and Kerr (2016), Aghion, Dechezlepretre, Hermous, Martin, and van Reenen (2015), Currie, Davis, Greenstone, and Walker (2015).

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- Social Responsibility and Climate Change:
  - Hong and Kacperczyk (2009), Chava (2014), Hong, Li, and Xu (2017), Choi, Gao, and Jiang (2018), Bansal and Ochoa (2016).

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- Social Responsibility and Climate Change:
  - Hong and Kacperczyk (2009), Chava (2014), Hong, Li, and Xu (2017), Choi, Gao, and Jiang (2018), Bansal and Ochoa (2016).
- Macroeconomic Uncertainty:
  - Baker, Bloom, and Davis (2016), Jurado, Ludvigson, and Ng (2015), Pastor and Veronesi (2012, 2013), Bali, Brown, and Tang (2017), Liu, Shu, and Wei (2017).

- Profitability Π_t^i evolves as

$$d\Pi_t^i = (\mu + \xi^i g)dt + \sigma dZ_t + \sigma_I dZ_t^i.$$

Model Setup

Firms in the Production Economy

- Profitability Π_t^i evolves as

$$d\Pi_t^i = (\mu + \xi^i g)dt + \sigma dZ_t + \sigma_I dZ_t^i.$$

- At time τ, a decision whether to change regulation:

$$\begin{cases} g^{\text{W}} & \text{for } t \leq \tau \\ g^{\text{W}} & \text{for } t > \tau \text{ if the weak regulation regime remains} \\ g^{\text{S}} & \text{for } t > \tau \text{ if there is a regime change to a strong regulation,} \end{cases}$$

where $g^{\text{W}} > 0$ and $g^{\text{S}} < 0$.

Model Setup

Stock Prices: Stock Prices and Risk Premia

- The dynamics of stock prices

$$\frac{dM_t^i}{M_t^i} = E_t\left[\frac{dM_t^i}{M_t^i}\right] + \sigma dZ_t + \sigma_I dZ_t^i + \beta_{M,t}^i d\hat{Z}_t^c,$$

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  - $\beta_{M,t}^i < 0$ and $\frac{\partial \beta_{M,t}^i}{\partial \xi^i} < 0$

- The risk premia is characterized by the Euler equation

$$\begin{aligned} \mathrm{E}_t\left[\frac{dM_t^i}{M_t^i}\right] &= -\mathrm{Cov}_t\left(\frac{dM_t^i}{M_t^i}, \frac{d\pi_t}{\pi_t}\right) \\ &= \sigma\lambda dt - \beta_{M,t}^i \lambda_{c,t} dt. \end{aligned}$$

- The expected return of firm H with high emissions

$$\mathrm{E}_t\left[\frac{dM_t^H}{M_t^H}\right] = \sigma\lambda dt - \beta_{M,t}^{i}\lambda_{c,t}dt,$$

- The expected return of firm L with high emissions

$$\mathrm{E}_t\left[\frac{dM_t^L}{M_t^L}\right] = \sigma\lambda dt - \beta_{M,t}^{L}\lambda_{c,t}dt,$$

- The long-short portfolio

$$\mathrm{E}_\tau\left[\frac{dM_t^H}{M_t^H} - \frac{dM_t^L}{M_t^L}\right] \quad = \quad \left[(-\beta_{M,t}^{i}) - (-\beta_{M,t}^{L})\right]\lambda_{c,t}dt$$

Table: . **Parameter Choices**

σ_c	η	μ	σ	σ_I	T	τ	γ	g^W	g^S
0.95	0.60	0.20	0.10	0.05	10	5	2	0.02	-0.06

Table: . **Aggregate Moments**

	Data	**Model**
Panel A: Real Quantities		
ROE	0.23	0.22
B/M	0.38	0.40
Panel B: Asset Price		
$E[R_m]$-R_f (%)	5.71	4.70

Table: . **Portfolios, Firm Characteristics, and Model Comparison**

Variables	**L**	**2**	**3**	**4**	**H**	**H-L**
			Panel A: Data			
$E[R]-R_f$ (%)	7.31	7.82	7.99	8.46	12.84	5.52
ROE	0.17	0.20	0.21	0.27	0.23	
ROE_{t+5}	0.35	0.19	0.25	0.20	0.17	
			Panel B: Model			
$E[R]-R_f$ (%)	2.51	3.57	4.68	5.90	7.21	4.70
ROE	0.20	0.21	0.22	0.23	0.24	
ROE_{t+5}	0.20	0.18	0.17	0.16	0.15	

Table: : **Univariate Portfolio Sorting on Emissions**

Variables	**L**	**2**	**3**	**4**	**H**	**H-L**
			Panel A: Simple Emissions			
E[R]-R_f (%)	7.31	7.82	7.99	8.46	12.84	5.52
[t]	2.46	2.29	2.72	2.51	4.13	3.18
Std (%)	14.17	15.97	13.55	15.29	14.48	9.73
SR	0.52	0.49	0.59	0.55	0.89	0.57
			Panel B: Toxicity-adjusted Emissions			
E[R]-R_f (%)	6.90	8.31	7.99	7.89	12.77	5.87
[t]	2.34	2.44	2.73	2.43	4.10	3.24
Std (%)	14.16	15.97	13.71	15.01	14.49	9.23
SR	0.49	0.52	0.58	0.53	0.88	0.64

Empirical Analysis

Tests for Model Assumptions: Future Profitability

- We use three proxies for uncertainty shocks:
  - changes number of firms to report their emissions,
  - changes in temperature,
  - changes in rainfall.

Table: : **Predicative Regressions - Future Profitability**

Variables	**Disclosure**	**Temperature**	**Rainfalls**
Emissions	-0.11***	0.01	-0.01
[t]	-5.53	0.59	-0.91
Shocks	-0.00	0.02	0.05***
[t]	-0.06	1.37	3.78
Emissions x Shocks	-0.12***	-0.10***	-0.03***
[t]	-6.25	-5.59	-2.68
Controls	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes

- Capital IQ: Key Development Screening Report
  - Lawsuits & Legal Issues/Regulatory Authority & Enforcement Actions

Table: **Predictive Regressions: Litigations**

	(1)	(2)	(3)
Variables	**Probit**	**NB**	**Poisson**
	Panel A: Simple Emissions		
Emissions	0.19***	0.51***	0.34***
[t]	3.92	2.89	4.12
Controls	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
	Panel B: Toxicity-adjusted Emissions		
Emissions	0.18***	0.47***	0.32***
[t]	4.02	2.72	3.81
Controls	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes

Table: : **Return Sensitivities to Signal Shocks**

Variables	**Disclosure**	**Temperature**	**Rainfalls**
Emissions	0.17	0.48***	0.38**
[t]	0.98	2.89	2.42
Shocks	-0.98***	-0.09	-0.27**
[t]	-7.71	-0.72	-2.16
Emissions x Shocks	-2.12**	-0.42**	-0.25*
[t]	-2.28	-2.47	-1.87
Controls	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes

Conclusion

- Theory guided empirical work on the cross-section of expected returns
  - Theory implies that firms with high emissions are more risky
  - We find supporting evidence for a positive pollution premium
- General equilibrium model to quantitatively account for:
  - The cross-section of emissions among firms
  - The positive pollution premium

Research Scheme

My research interest focuses on cross-sectional implications:

- Asset pricing implications of regulation regime changes:
  - The Pollution Premium: Hsu, Li, and Tsou (2018)
- Interesting findings on asset pricing implications of financial frictions:
  - The Leased Capital Premium: Li and Tsou (2018)
  - The Intangible Pledgeability Premium (JMP): Tsou (2018)
- Interesting findings on asset pricing implications of parameter learning:
  - Learning and the Capital Age Premium: Li, Tsou, and Xu (2018)
- Others (coming soon)...

Table: **Asset Pricing Factor Tests**

	L	**2**	**3**	**4**	**H**	**H-L**
	Panel A: Simple Emissions					
α_{FF5}	-1.36	0.15	1.11	-2.29	3.89	5.25
[t]	-0.88	0.10	0.76	-1.45	2.27	3.11
α_{HXZ}	-1.06	1.05	0.43	-1.98	4.00	5.06
[t]	-0.70	0.69	0.31	-1.27	2.22	3.06
	Panel B: Toxicity-adjusted Emissions					
α_{FF5}	-1.54	0.48	0.42	-1.97	3.75	5.30
[t]	-0.98	0.31	0.32	-1.36	2.21	3.09
α_{HXZ}	-1.31	1.54	-0.36	-1.66	3.84	5.15
[t]	-0.82	0.99	-0.30	-1.10	2.15	3.10

Appendix: Additional Empirical Evidence

Fama-Macbeth Regressions

$$R_{i,t+1} - R_{f,t+1} = a + b \times \text{Emissions}_{i,t} + \mathbf{X_{i,t}} + \varepsilon_{i,t+1}$$

Table: **Fama-Macbeth Regressions**

Variables	(1)	(2)	(3)	(4)
Emissons	7.18	9.85	6.80	9.48
[t]	2.55	2.65	2.66	2.83
Controls	No	Yes	No	Yes
Industry FE	Yes	Yes	Yes	Yes

The End