2019 ABFER Discussion

The Pollution Premium

By

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Synopsis

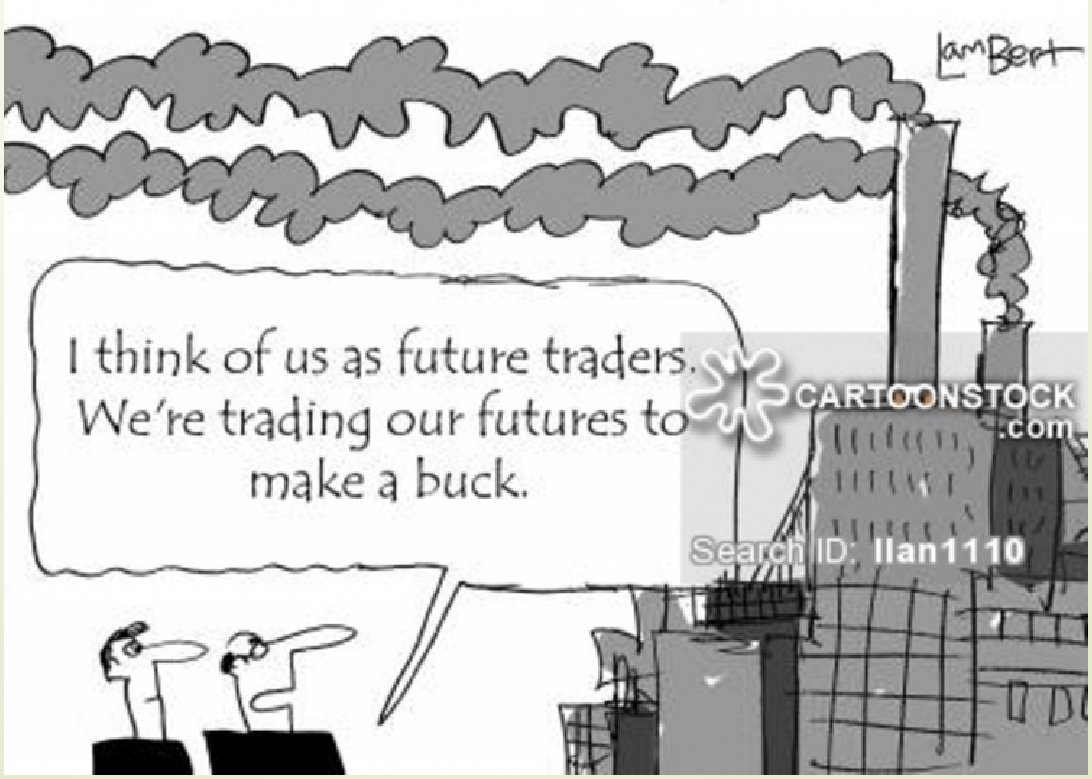
1. Main findings:
   - A general equilibrium model on why pollution can be priced under policy uncertainty
   - Firm ROE and returns are negatively related to the interaction between pollution and the likelihood of policy shocks
     - County-level emission data provides proxies of pollution
     - Policy shocks are proxied by growth rate of #firms report their toxic emissions, temperature, and rainfall.
   - Known factor models (noticeably FF5 and HXZ5) do not explain the pollution premium
2. Main interpretation/take-home message:
   - Pollution is a priced factor under policy uncertainty

Overall

- Very impressive work.
- The results (theory and empirical) are both important and interesting.
- I will discuss some broad-picture issues to further understand the importance of the framework, and then comment on a few minor issues.

1. To pollute or not to pollute

- Two key concerns on environmental economics:
  - **A negative externality**: firms do not have incentives to minimize the (social-environmental) cost of pollution.
  - **Policy concerns: encouraging clean technology** (e.g., subsidies on clean-tech R&D) vs. **curbing existing emissions** (e.g., carbon tax or cap-and-trade system)



The current model

- Firm profitability:

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

A high emission Firm

(i.e. $\xi^H > 0$)

A low emission Firm

(i.e. ξ^L such that $\xi^L < \xi^H$)

- Policy shock occurs

	Before policy shock $(g^W > 0)$	**After policy shock** $(g^S < 0)$
High Pollution Firm	Higher profitability benefits	Larger neg-shock
Low Pollution Firm	Lower profitability benefits	Smaller neg-shock

The model extends Pastor and Veronesi (2012, 2013). The setup is rich enough to allow for externality—with the stock market!

Industry vs. within-industry effects

- What prevents the negative externality? Conjectures:
  - 1) industry heterogeneity: pollution is more exogenous
  - 2) within-industry coordination mechanisms/frictions
- Reduced-form assumption describes a reasonable first-order effect, including both cross- and within-industry variations. The data:

FF48	Industry Name	Obs	Mean	Std
1	Agriculture	34	0.292	0.476
2	Food	686	2.800	14.574
3	Soda	118	0.353	0.566
4	Beer	120	1.068	1.822
5	Tobacco	88	1.430	2.049
6	Recreation	153	0.204	0.605
8	Books	82	0.403	0.671
9	Household	790	8.536	25.299
10	Apparel	86	0.197	0.301
11	Healthcare	36	0.145	0.122
12	Medical Equipment	526	0.539	1.286
13	Drugs	493	7.273	18.983
14	Chemicals	1290	38.941	176.595

- The empirical measure of industry-adjusted emission is important in this regard. At some stage, Industry-level analysis would be also interesting and, to some extent, better fit the model assumptions.

2. On Policy and Policy Failure

- Policy uncertainty arises when the government has a noisy observation of the cost of environment:

$$ds_t = c dt + \eta dZ_t^c.$$

- Policy adoption condition (Pastor and Veronesi 2013)

$$\max_{\tau>t}\left\{\mathrm{E}_\tau\left[\frac{\boxed{\Phi(C)}W_T^{1-\gamma}}{1-\gamma}\middle|\mathrm{W}\right], \mathrm{E}_\tau\left[\frac{\boxed{W_T^{1-\gamma}}}{1-\gamma}\middle|\mathrm{S}\right]\right\}$$

Environmental Costs

Investor welfare

- Environmental policy could be of particular interest due to the potential policy failure
  - E.g., Acemoglu et. al. (AER 2012) and Acemoglu et. al. (JPE 2016) show that inferior policies may create environmental disasters.

Potential Policy failure

- Policy failure may occur in this model as well: when both firms pollute, new (strong) policy might not be adopted.
  - This is because the policy change from $\boldsymbol{g^W > 0}$ to $\boldsymbol{g^S < 0}$ will significantly reduce the aggregate wealth of investors.
  - For policy shock to occur, the environmental consideration ($\Phi(C)$) needs to be sufficiently high. Hence policy failure can occur in the model under certain conditions.

$$\max_{\tau > t} \left\{ \mathrm{E}_\tau \left[\frac{\boxed{\Phi(C)} W_T^{1-\gamma}}{1-\gamma} \middle| \mathrm{W} \right], \mathrm{E}_\tau \left[\frac{W_T^{1-\gamma}}{1-\gamma} \middle| \mathrm{S} \right] \right\}$$

- Hence in policy perspective, the model is also very rich.
  - Great insights can be derived from endogenized cost (e.g., dynamic environmental evolution Acemoglu et al. 2012).
  - A new cost of capital channel (market disciplining effect): if asset price and cost of capital differ, firms could be disciplined by the capital market to avoid negative externality and thus policy failures.

3. On the economic grounds of clean-tech

- The adoption of clean-tech can be associated with several important economic grounds:
  - **Productivity/Innovation** and tech spillover: e.g., Acemoglu et al (2012) and Acemoglu et al (2012) examine how clean technologies can be adopted when dirty-tech is more advanced.
  - **Profitability/Cost**: e.g., Aghion et al (2016) shows how carbon tax (proxied by fuel price) can help promote clean-tech. This model as well.
  - **Cost of capital** (an important new channel): the model implies that dirty and clean firms will have different levels of risk—and thus cost of capitals.
- What can we say about these different channels from the data?

Profitability, Innovation, and cost of capital

- From Table 6, firm characteristics

	Simple Emissions				
Variables	L	2	3	4	H
Emissions	0.06	0.43	1.54	5.85	37.80
Log ME	10.99	11.58	11.72	10.76	10.77
B/M	0.40	0.37	0.36	0.39	0.39
I/A	0.06	0.06	0.06	0.06	0.06
AG	1.13	1.11	1.11	1.10	1.09
ROE	0.17	0.20	0.21	0.27	0.23
R&D/AT	0.10	0.10	0.09	0.12	0.12
O/AT	0.56	0.50	0.48	0.56	0.52
Leverage	0.37	0.37	0.34	0.33	0.40
Numbers	112	100	99	100	92

High polluting firms are more profitable: ROE H/L = .23/.17=135%

R&D is higher for higher polluting firms: High/low = 0.12/0.10 = 120%

Leverage is slightly higher for high polluting firms: H/L=0.40/0.37 = 108%

Profitability, Innovation, and cost of capital (2)

- Two very nice observations:
  - **All the three channels** play some economic role.
  - **Profitability** provides the strongest influence. This observation justifies the empirical focus of this paper
    - Leverage-adjusted ROE has a spread of about 17%.
    - Maybe also use ROA as a robustness check?
- Two observations call for follow-up research
  - **R&D**: which tech, clean or dirty, needs more innovation inputs? Maybe also check the patent data?
  - **Cost of capital** and leverage: high-polluting firms hypothetically should have the less capacity to borrow.
  - The adoption of innovation may involve or trigger some heterogeneity in firm characteristics in equilibrium (e.g., Akcigit and Kerr JPE 2018 on firm size). Eager to learn about the equilibrium effects of pollution-related tech on leverage and R&D.

4. Other Market Frictions

- Empirically, market frictions not included in the model may also play some role and thus need some additional scrutiny. Below are two examples from the firm and investor side:
  - E.g., corporate governance may influence both environmental policy and asset prices (esp in less competitive industries).
  - E.g., investor sentiment could be related to ESG. Moreover, investors often extrapolate recent information. Could they extrapolate policy shocks as well?
  - A further empirical control for such frictions could better highlight the model-predicted risk premium.

Minor comments (1)

- There are some interesting properties of the data that I don't fully understand yet.
- The coal industry is clean (so different from China)!

FF48	Industry Name	Obs	Mean	Std
29	Coal	99	0.072	0.191
30	Oil	635	37.615	86.372

- A large literature focuses on the oil industry to understand the policy/incentive issues related to pollution. How clean-tech is achieved in the coal industry could be of great interest.

Minor comments (2)

- Profitability: ROE on emission and policy shocks (Table 7).

Variables	Disclosure	Temperature	Rainfall
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

A bit surprising: High emission firms have no unconditional ROE advantage.

Consistent: High emission firms have negative profitability with high policy uncertainty

Minor comments (3)

- Maybe to measure the risk premium in a (new) factor model?
  - Here is the stochastic discount factor, according to which there will be in general two main factors.

$$\frac{d\pi_t}{\pi_t} = E_t\left[\frac{d\pi_t}{\pi_t}\right] - \lambda dZ_t + \lambda_{c,t} d\hat{Z}_t^c,$$

  - The empirical analysis mostly check the return-emission sensitivity at the firm level, and use existing factor models to adjust for risk.
  - Perhaps emission should be a risk factor on its own? Some discussions could be helpful.

Conclusions

- A very interesting paper with very impressive model and data on an extremely important topic.
- The model is rich, and can potentially incorporate many important features of econ-studies on pollution.
- The paper focuses on asset prices. It would be also fascinating to further examine related economic grounds in a parsimonious framework.