Noh et al. (2020)
"Unpacking the demand for sustainable equity investing"

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Overview

- Heterogeneity in investor demand for sustainability
  - Institutions increase their demand for sustainability
  - Price elastic insitutions demand more for sustainability and not undo the demand impact
  - The overall trend is driven by within-investor preference shift

- Effect of demand heterogeneity
  - Pressure for sustainability weakly pushes firm to increase their sustainability

Model

The model is from Koijen and Yogo (2019).

- $N+1$ financial assets: $n = 0, 1, ..., N$
- I investors: $i = 1, ..., I$
- $p_t(n) = \log(P_t(n))$ endogenous
- $x_t(n)$ exogenous characteristics: sustainability, investment, profitability

Optimal Portfolio Choice

The investor chooses port. weights $w_{i,t}(n)$ on each date to maximize the expected log utility at terminal T.

$$\max_{w_{i,t}} \mathbb{E}_{i,t}[\log(A_{i,T})]$$

$$\text{s.t. } A_{i,t+1} = A_{i,t}\{R_{t+1}(0) + w_{i,t}^{'}[R_{t+1} - R_{t+1}(0)]\}$$

$$w_{i,t} \geq 0; 1^{'} w_{i,t} < 1$$

Model

Optimal Portfolio Choice

The first order condition is the constrained Euler equation:

$$\mathbb{E}_{i,t}[(\frac{A_{i,t+1}}{A_{i,t}})^{-1}R_{t+1}] = 1 - (I - 1w_{i,t}^{'})(\Lambda_{i,t} - \lambda_{i,t}1)$$

The portfolio choice is

$$w_{i,t}^{(1)} \approx [\Sigma_{i,t}^{(1,1)}]^{-1}[\mu_{i,t}^{(1)} - \lambda_{i,t}1]$$

When the investor is not constrained, the Euler equation and portfolio choice are normal.

Model

Characteristics-base demand model:

- One factor model: $R_t(n) = \mu_t(n) + \beta(n) f_t + \epsilon_t(n)$
  - $\mu_{i,t}(n) = y_{i,t}(n)' \Phi_{i,t} + \phi_{i,t}$
  - $\Gamma_{i,t}(n) = y_{i,t}(n)' \Psi_{i,t} + \psi_{i,t}$

$\Rightarrow$ $w_{i,t}(n) = y_{i,t}(n)' \Pi_{i,t} + \pi_{i,t}$

Characteristics-base demand

$$\frac{w_{i,t}(n)}{w_{i,t}(0)} = \delta_{i,t}(n) = \exp\left[\alpha_{i,t} + \beta_{0,i,t} me_t(n) + \beta_{1,i,t} x_t(n)\right] \cdot \epsilon_{i,t}(n)$$

where $\epsilon_{i,t}(n)$ is the **latent demand**, and

$$w_{i,t}(n) = \frac{\delta_{i,t}(n)}{1 + \sum_{m \in N_{i,t}} \delta_{i,t}(m)}; w_{i,t}(0) = \frac{1}{1 + \sum_{m \in N_{i,t}} \delta_{i,t}(m)}$$

Model

- Assumption: $\beta_{0,i,t} < 1$ demand is downward sloping.
- $ME_t(n) = \sum_{i=1}^{I} A_{i,t} w_{i,t}(n)$
- $p = f(p) = \log\left(\sum_{i=1}^{I} A_i w_i(p)\right) - s$

Unique Equilibrium

$f(p)$ has a unique fixed point in $\mathbb{R}^N$ if all assets have ≥ 1 investor with $-1 < \beta_{0,i,t} < 1$.

Estimation

- Moment Condition: $\mathbb{E}[\epsilon_{i,t}(n)|me_t(n), x_t(n)] = 1$
- Since p is endogenous, the moment condition should be $\mathbb{E}[\epsilon_{i,t}(n)|\hat{me}_t(n), x_t(n)] = 1$
- The instrument could be

$$\hat{me}_{i,t}(n) = \log\left(\sum_{j\neq i} A_{j,t}\frac{I_{j,t}(n)}{1+\sum_{m=1}^{N} I_{j,t}(m)}\right)$$

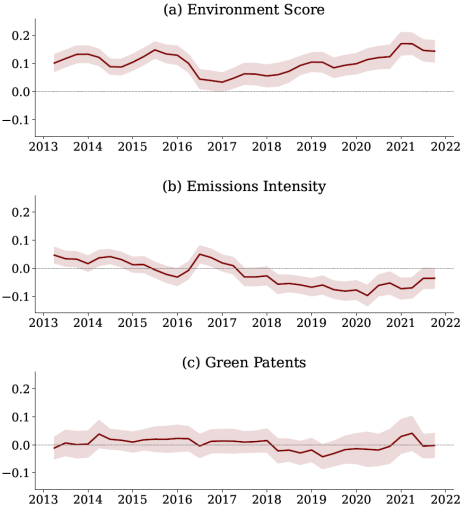
or

$$\hat{me}_{i,t}(n) = \log\left(\sum_{j\neq i} A_{j,t}\frac{I_{j,t}(n)BE_t(n)}{\sum_{m=1}^{N} I_{j,t}(m)BE_t(m)}\right)$$

Data

- Measure of sustainability
  - Emission intensity: Scope 1 CO_2 emission divided by revenue; S&P Trucost
  - Environment score: $g_t(n) = \frac{-[10-\mathbb{E}_t(n)]w_t^E(n)}{100}$; MSCI KLD
  - Green patents: identified by CPC or IPC code; PatentsView
- Portfolio holdings: FactSet
- Asset prices: CRSP
- Asset characteristics: Compustat

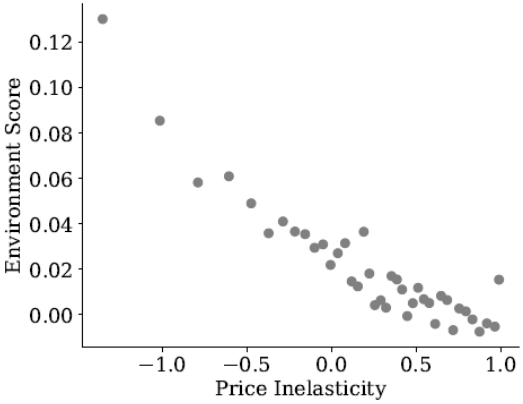
Investor demand

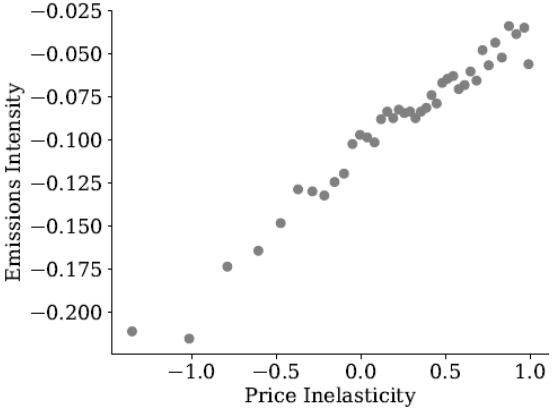


	AUM-Weighted		Equal-Weighted				
	Mean	SD	Mean	SD	Q10	Q50	Q90
Log Market to Book	0.699	0.365	0.349	0.615	-0.485	0.454	0.990
Log Book Equity	1.275	0.406	0.693	0.598	-0.053	0.674	1.498
Profitability	0.010	0.179	0.046	0.371	-0.376	0.034	0.480
Asset Growth	0.031	0.151	0.082	0.327	-0.279	0.057	0.476
Dividend / Book	0.079	0.205	0.027	0.336	-0.370	0.019	0.436
Market Beta	-0.028	0.176	-0.092	0.374	-0.556	-0.067	0.339
Non-Green Patents	0.020	0.210	-0.052	0.472	-0.562	-0.021	0.423
Environment Score	0.031	0.130	0.023	0.272	-0.287	0.013	0.343
Emissions Intensity	-0.023	0.126	-0.085	0.251	-0.394	-0.061	0.190
Green Patents	-0.003	0.168	-0.026	0.376	-0.407	0.004	0.341

- Large heterogeneity in investor demand for sustainability.

Investor demand



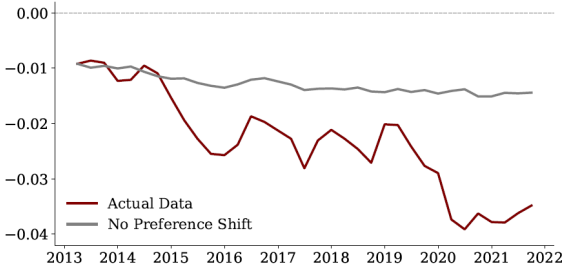


- Price-elastic investors have higher demand for sustainability on average for both environment score and emissions intensity.

Investor demand

The overall demand for sustainability could come from

1. within-investor preference shift: investor becomes more preferred to sustainability
2. cross-investor AUM shift: fund flows to sustainable institutions



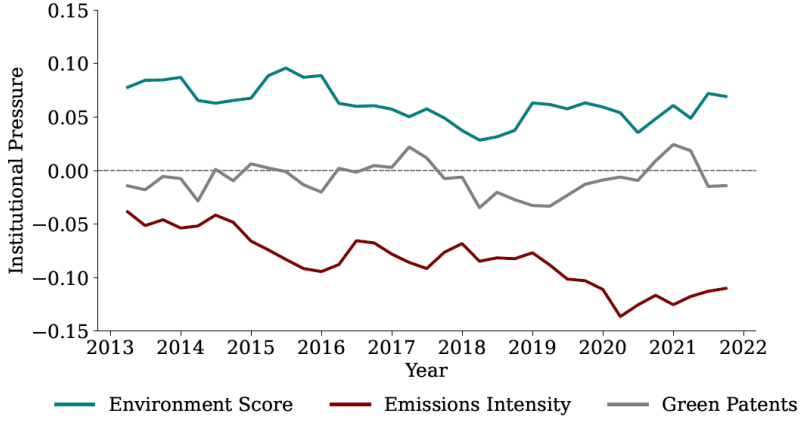
Shut off $\beta_{i,GHG,t}$ changes:
$\beta_{i,GHG,t} = \beta_{i,GHG,T_0}$

- The overall demand trend for sustainability is entirely driven by within-investor preference shift.

Effects of investor pressure for sustainability

Investor pressure for sustainability: $\frac{\partial mb_t(n)}{\partial s_t(n)}$

- Higher pressure: for an one unit increase of sustainability, the valuation gain is higher
- Firm thus has more incentive to increase sustainability



Effects of investor pressure for sustainability

	Forward 1-Year Outcome		
	(1) Environment Score	(2) Emissions Intensity	(3) Green Patents
Pressure: Environment Score	0.0187^{+}	-0.000276	-0.0147*
	[2.006]	[-0.0259]	[-2.248]
Pressure: Emission Intensity	-0.0279**	0.0251**	0.00184
	[-3.097]	[2.880]	[0.319]
Pressure: Green Patents	0.00181	0.00322	0.00983^{+}
	[0.206]	[0.342]	[1.996]
Environment Score	-0.228**	-0.0617**	-0.0103^{+}
	[-19.53]	[-2.963]	[-1.740]
Emission Intensity	-0.0323*	-0.0178	0.00130
	[-2.648]	[-1.225]	[0.268]
Green Patents	-0.00625	0.00685	0.769**
	[-0.706]	[0.703]	[37.07]
Time FE	✓	✓	✓
Non-Green Controls	✓	✓	✓
Within R^2	.053	.007	.668
Observations	51065	51065	51065

Counterfactual: ESG-agnostic mandates

If some institutions are not allowed to consider sustainability in portfolios

	Data	CF: Shut off Green Demand		
	(1)	(2) Active Inst	(3) All Inst	(4) All Inst + HH
Environment Score	0.115**	0.107**	0.114**	0.0698**
	[6.767]	[6.305]	[6.529]	[4.010]
Emissions Intensity	-0.0645**	-0.0345*	0.00311	0.00803
	[-4.261]	[-2.266]	[0.199]	[0.506]
Green Patents	-0.0115	0.0241	0.0150	0.00618
	[-0.603]	[1.262]	[0.784]	[0.327]
Time FE	✓	✓	✓	✓
Controls	✓	✓	✓	✓
Observations	26251	26251	26251	26251

Conclusion

- Institutions raise their demand for sustainability, but large heterogeneity across institutions
  - Price elastic insitutions demand more for sustainability and not undo the demand impact
  - The overall trend is driven by within-investor preference shift
- The insitutions' demand for sustainability has weak effect on firm's sustainability policies
  - The pressure pushes firm to improve sustainability
- The valuation will be affected if investors are not allowed to consider sustainability in portfolios

References

Koijen, R. S. and M. Yogo (2019). A demand system approach to asset pricing. *Journal of Political Economy 127*(4), 1475–1515.

Noh, D., S. Oh, and J. Song (2020, June). Unpacking the Demand for Sustainable Equity Investing.