SUSTAINABLE INVESTING

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Growing interest in **sustainable investing**

- Objectives: Financial + ESG (Environmental, Social, Governance)
- AUM of $30+ trillion globally at the start of 2018, growing fast (2018 Global Sustainable Investment Review)
- 2,600+ signatories to the UN Principles of Responsible Investment
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I will show results from two studies

Mutual Fund Performance and Flows During the COVID-19 Crisis

Ľuboš Pástor (Chicago Booth)
Blair Vorsatz (Chicago Booth)

Fund Performance under COVID-19

Panel A. Performance vs. FTSE/Russell
Sustainable Investing in Equilibrium

Ľuboš Pástor (Chicago Booth)
Rob Stambaugh (Wharton)
Luke Taylor (Wharton)

Main Theoretical Results

- Greener assets have lower **expected returns**
  - Because agents have green tastes & green assets hedge **climate risk**
  - Green assets have negative alphas, brown assets have positive alphas
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  - ESG factor captures shifts in customers’ and investors’ tastes
  - **Two-factor pricing**: Market + ESG factor
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- Sustainable investing leads to positive social impact
  - Green firms invest more, brown firms less
  - Firms become greener
Model Overview

FIRMS

INVESTORS
Model Overview

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INVESTORS

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Model Overview

\[ g_n < 0 \quad \text{FIRMS} \quad g_n > 0 \]

\[ \text{INVESTORS} \]

\[ \text{Heart} \quad \text{Sad} \quad \text{Happy} \]

\[ \text{Cold} \quad \text{Sad} \quad \text{Happy} \]
Model Overview

\[ g_n < 0 \quad g_n > 0 \]

\[ d_i > 0 \quad d_i = 0 \]

INVESTORS

FIRMS

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Model

- One period (from 0 to 1)
- **Firms** $n = 1, \ldots, N$
  - ESG characteristics $g$ ($N \times 1$)
    - $g_n > 0$: “green” firm, positive externalities
    - $g_n < 0$: “brown” firm, negative externalities
  - Excess stock returns $\tilde{r} = \mu + \tilde{\epsilon}$, where $\tilde{\epsilon} \sim N(0, \Sigma)$
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- **Agents** \( i \) (continuum), with CARA utility \(-e^{-A_i \tilde{W}_{1i} - b'_i X_i}\)
  - \( A_i \): Absolute risk aversion of agent \( i \)
  - \( \tilde{W}_{1i} = W_{0i} (1 + r_f + X'_i \tilde{r}) \): Wealth of agent \( i \) at time 1
  - \( X_i \): Portfolio weights of agent \( i \) \((N \times 1)\)
  - \( b_{i,n} = d_i g_n \): Nonpecuniary benefit agent \( i \) derives from holding stock \( n \)
    - \( d_i \geq 0 \) is agent \( i \)'s "ESG taste"
Equilibrium Expected Returns: Market-Level

**Equity premium:**

\[ \mu_m = a \sigma^2_m \]

where

- \( \mu_m = x' \mu \), \( \sigma^2_M = x' \Sigma x \)
- \( x \) = market portfolio weights
- \( \bar{d} \equiv \int d_i w_i d_i \)
- \( w_i \equiv W_0 i \int W_0 i d_i \)

\( x' g > 0 \Rightarrow \mu_m \) is decreasing in \( \bar{d} \)

\( x' g < 0 \Rightarrow \mu_m \) is increasing in \( \bar{d} \)

Assume \( x' g = 0 \) (market portfolio is ESG-neutral)
Equilibrium Expected Returns: Market-Level

- **Equity premium:**

\[
\mu_m = a \sigma_m^2 - \frac{\bar{d}}{a} w_m g
\]

where \( \mu_m = w'_m \mu, \sigma_m^2 = w'_m \Sigma w_m, w_m = \text{mkt. portfolio weights,} \)
\( \bar{d} = \text{average } d_i \text{ across agents (i.e., } \bar{d} \equiv \int_i \omega_i d_i di, \omega_i \equiv \frac{W_{0i}}{\int_i W_{0i} di} ) \)

- \( w'_m g > 0 \Rightarrow \mu_m \text{ is decreasing in } \bar{d} \)
- \( w'_m g < 0 \Rightarrow \mu_m \text{ is increasing in } \bar{d} \)

- Assume \( w'_m g = 0 \) (market portfolio is ESG-neutral)
Equilibrium Expected Returns: Firm-Level

- Expected excess stock returns:

\[ \mu = \mu_m \beta_m - \frac{\bar{d}}{\bar{a}}g \]

- Greener stocks have lower alphas:

\[ \alpha_n = -\frac{\bar{d}}{\bar{a}}g_n < 0 \]

**Green stocks have negative alphas**

**Brown stocks have positive alphas**
Expected excess return on agent $i$’s portfolio:

$$E(\tilde{r}_i) = \mu_m - \delta_i \left( \frac{\bar{d}}{a^3} g' \Sigma^{-1} g \right)$$

where $\delta_i \equiv d_i - \bar{d}$. Note:

- $\delta_i \uparrow \Rightarrow E(\tilde{r}_i) \downarrow$
- $\delta_i > 0 \Rightarrow E(\tilde{r}_i) < \mu_m$
- $\delta_i < 0 \Rightarrow E(\tilde{r}_i) > \mu_m$
Agent $i$’s equilibrium portfolio weights:

$$X_i = w_m + \frac{\delta_i}{a^2} \left( \Sigma^{-1} g \right)$$

“ESG tilt”

Three-fund separation:

1. Riskless asset
2. Market portfolio, $w_m$
3. “ESG portfolio”, $\Sigma^{-1} g$

- Agents with $\delta_i > 0$ (i.e., $d_i > \bar{d}$) tilt toward green assets
- Agents with $\delta_i < 0$ (i.e., $d_i < \bar{d}$) tilt toward brown assets
- Agents with $\delta_i = 0$ (i.e., $d_i = \bar{d}$) hold the market

No dispersion in ESG tastes $\Rightarrow$ everyone holds the market
Two-Factor Pricing with the ESG Portfolio

- Expected excess returns:
  \[ \mu = \mu_m \beta_m + \mu_g \beta_g, \]

  where \( \beta_g \) = loading on ESG portfolio return, \( \tilde{r}_g \)

- Excess returns obey the regression model
  \[ \tilde{r} = \beta_m \tilde{r}_m + \beta_g \tilde{r}_g + \tilde{\nu} \]

- CAPM alphas:
  \[ \alpha = \mu_g \beta_g \]
  \[ = -\left(\frac{d}{a}\right)g \]

  \[ [\alpha \text{ comes from omitted priced ESG risk factor}] \]
  \[ [\alpha \text{ comes from tastes, not aversion to ESG risk}] \]
ESG Factor

- ESG factor: excess return on a position in the ESG portfolio
  \[ \tilde{f}_g = \left( \frac{1}{g_g} \right) \tilde{r}_g \]

- Two-factor model:
  \[ \tilde{r} = \beta_m \tilde{r}_m + g \tilde{f}_g + \tilde{\nu} \]
  \[ \mathbb{E} \left\{ \tilde{f}_g \right\} = -\bar{d}/a < 0 \]

- How to measure the ESG factor:
  1. Cross-sectional regression of returns on \( \beta_m \) and \( g \)
  2. Special case: long green, short brown
Sources of ESG Factor Risk

- Strength of ESG concerns can change over time
  - “Investor” channel: $\tilde{d}$ shifts ($\Delta \tilde{d}$)
  - “Customer” channel: Demand for firms’ products shifts ($\tilde{z}_g$)
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- Green (brown) stocks perform better (worse) than expected if ESG concerns strengthen unexpectedly via either channel
Agent $i$’s utility:

$$-e^{-A_i \tilde{W}_i - b_i'X_i - c_i \tilde{C}}$$

where \textbf{climate} $\tilde{C} \sim N(0, 1)$

- $c_i \geq 0 \Rightarrow$ Agents dislike low realizations of $\tilde{C}$
- Let $\bar{c} \equiv \int_i \omega_i c_i \, di$
Extension: Climate Risk (cont’d)

- Expected excess returns in equilibrium:

\[
\mu = \mu_m \beta_m - \frac{\bar{d}}{a} g + \bar{c} \left(1 - \rho_{mC}^2\right) \psi
\]

where \(\psi\) = slopes on \(\tilde{C}\) in a regression of \(\tilde{r}\) on both \(\tilde{C}\) and \(\tilde{r}_M\)

Greener stocks likely better hedge climate risk: \(\text{Corr}(\psi_n, g_n) < 0\)

If \(\psi_n = -\xi g_n\), where \(\xi > 0\), then \(\alpha_n = -\left[\frac{\bar{d}}{a} + \bar{c} \left(1 - \rho_{mC}^2\right) \xi\right] g_n\)

Greener stocks have lower alphas for two reasons: tastes and risk
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Social impact of firm $n$:

$$S_n \equiv g_n K_n$$

where $K_n$ is the firm’s operating capital
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**Firm maximizes its market value** by choosing $\Delta K_n$ and $\Delta g_n$

- Firm is endowed with capital $K_{0,n}$ and ESG characteristic $g_{0,n}$

**Firm’s cash flows at time 1**: $\Pi_K K_n$ minus adjustment costs

- Capital adjustment costs: $\frac{k_n}{2} (\Delta K_n)^2$
- ESG adjustment costs: $\frac{\omega_n}{2} (\Delta g_n)^2$
Green tastes have **positive social impact**:

\[ S_n(\tilde{d}) > S_n(0) \]

- Green firms invest more (cost of capital ↓)
  
  Brown firms invest less (cost of capital ↑)

- All firms choose to become greener
Firm-Level Social Impact

- Firms become greener
- Green firms invest more, brown less
Conclusions

In our equilibrium model of sustainable investing,

- Greener assets have lower **expected returns**
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