ESG Confusion and Stock Returns: Tackling the Problem of Noise

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Overview

1. Motivation
2. Theory
3. Econometrics
4. Empirical Analysis
Outline

1. Motivation
2. Theory
3. Econometrics
4. Empirical Analysis
ESG investing affects stock returns

Flows into ESG are sharply on the rise

Global ESG equity funds

Monthly flows ($bn) - Cumulative flows ($bn)

Sources: EPFR Global; BofA US Equity & Quant Strategy
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...but ESG ratings are noisy

- The average correlation of scores from different ESG raters varies from 40% to 70%
  
  Source: Berg, Kölbel, and Rigobon (2020)

- Disagreement about aggregation

- Disagreement about measurement
This paper: ESG confusion and stock returns

- What is the effect of ESG investing on stock returns when ratings are noisy?

- Treat the ESG disagreement as an errors-in-variables problem

- We predict that noisy ESG signals have a diminished effect on stock returns

- We show empirically that correcting for errors-in-variables leads to larger coefficient estimates
Related Literature

- **Theory**: ESG investing leads to lower expected returns for high ESG firms
  - Heinkel et al. (2001); Fama and French (2007); Pastor et al. (2020); Oehmke and Opp (2019); Landier and Lovo (2020)

- **Empirical**: Expected returns for high ESG firms can be both higher or lower
  - **Higher**: Albuquerque, Koskinen, and Zhang (2019); Lins, Servaes, and Tamayo (2017); Khan, Serafeim, and Yoon (2016); Cheema-Fox, LaPerla, Serafeim, Turkington, and Wang (2019)
  - **Lower**: Chava (2014); Bolton and Kacperczyk (2020); El Ghoul, Guedhami, Kwok, and Mishra (2011)

- **ESG measurement**: noisy ratings
  - Berg, Kölbl, and Rigobon (2020); Chatterji, Durand, Levine, and Touboul (2016)
Model Features: Environment

- General equilibrium
- One period
- One stock and one risk-free asset with $r_f = 0$
- Stock’s cash flows are normally distributed: $D \sim N(\bar{D}, \sigma_D^2)$
- The firm also produces a non-pecuniary benefit $Y$ (valued by ESG investors):
  \[ Y \sim N(\bar{Y}, \sigma_Y^2) \]
  $Y$ is an ESG externality, generated by the firm, which ESG investors internalize
Investors and ESG Signals

Investors

- Two types of agents: traditional investors and ESG investors
- Traditional investors (mass $1 - \lambda$) have CARA preferences over wealth $W_1$
  \[ U(W_1) = \exp^{-\gamma W_1} \]
- ESG investors (mass $\lambda$) care additionally about the ESG benefit $Y$
  \[ U(W_1, Y) = \exp^{-\gamma(W_1 + \theta^{ESG} Y)} \]

ESG signals

- In period 0, investors receive noisy signals about cash flows $D$ and ESG benefit $Y$
  \[ s_D = D + \epsilon_D, \quad \epsilon_D \sim N(0, \sigma^2_{\epsilon_D}) \]
  \[ s_Y = Y + \epsilon_Y, \quad \epsilon_Y \sim N(0, \sigma^2_{\epsilon_Y}) \]
Model Implications

- ESG investors affect equilibrium stock prices

\[ S_0 = \overline{D} + \frac{\sigma_D^2}{\sigma_D^2 + \sigma_{\epsilon_D}^2} (s_D - \overline{D}) + A\lambda \frac{\sigma_Y^2}{\sigma_Y^2 + \sigma_{\epsilon_Y}^2} \left[ \overline{Y} + \frac{\sigma_Y^2}{\sigma_Y^2 + \sigma_{\epsilon_Y}^2} (s_Y - \overline{Y}) \right] \]

\[- A\gamma \overline{\theta} \frac{\sigma_D^2 \sigma_{\epsilon_D}^2}{\sigma_D^2 + \sigma_{\epsilon_D}^2} \left[ \frac{\sigma_D^2 \sigma_{\epsilon_D}^2}{\sigma_D^2 + \sigma_{\epsilon_D}^2} + \frac{\sigma_Y^2 \sigma_{\epsilon_Y}^2}{\sigma_Y^2 + \sigma_{\epsilon_Y}^2} \right] \]

- **Prediction 1**: The higher the ESG signal (rating) \( s_Y \), the higher the stock price and the **lower its expected return**

- **Prediction 2**: The higher the mass of ESG investors \( \lambda \), the higher the stock price

- **Prediction 3**: The noisier the ESG signal \( s_Y \), the lower its impact on stock prices
Prediction 3: Noise in ESG Signal is a Problem

- The empirical counterpart of the ESG signal is ESG ratings.
- ESG ratings are noisy.
- Our theory implies expected (per-share) stock returns are:
  \[ E(S_1) - S_0 = c_0 + \eta - c_{\text{impact}} \cdot c_{\text{noise}} \cdot (s_Y - \bar{Y}) \]

The coefficients \( c_{\text{impact}} \) and \( c_{\text{noise}} \) are:

\[
c_{\text{impact}} = A\lambda \frac{\sigma_D^2 \sigma_{\epsilon_D}^2}{\sigma_D^2 + \sigma_{\epsilon_D}^2}
\]

\[
c_{\text{noise}} = \frac{\sigma_Y^2}{\sigma_Y^2 + \sigma_{\epsilon_Y}^2}
\]

\( \eta \) corresponds to the terms that depend on the signal about the firm’s cash flows.
Estimation Challenge: Errors-in-Variables

- Structural model, to be estimated at individual stock level

\[ E(\Delta S_{t+1}) = \alpha + c_{\text{impact}} Y_t + \eta_t \]

- Regression equivalent

\[ \Delta S_{t+1} = a + b \cdot s_{i,t} + \eta_t + \nu_t \]

ESG rating agencies 1, 2, \ldots n measure ESG attribute Y with an indicator \( s_i \).

- The standard OLS regression estimate of \( b \) suffers from the attenuation bias

\[ \hat{b}_{\text{OLS}} = c_{\text{impact}} \cdot \frac{\sigma^2_Y}{\sigma^2_Y + \sigma^2_{\epsilon_{Y,i,t}}} < 1 \]
Tackling the Problem of Noise

- All rating agencies produce a noisy signal. Luckily, there are many agencies.

- Solution to the Errors-in-Variables problem: Instrumental variables

- Use ratings of other agencies as instruments

- We model ESG ratings as

  \[ s_{1,t} = Y_t + \epsilon_{Y_{1,t}} \]
  \[ s_{2,t} = Y_t + \epsilon_{Y_{2,t}} \]
  \[ \vdots \]
  \[ s_{n,t} = Y_t + \epsilon_{Y_{n,t}} \]
Proposition 2 (Ratings as Instrumental Variables) Suppose that $s_{i,t}$ is the noisy measure of an ESG attribute $Y_t$ from rating agency $i$, given by

$$s_{i,t} = Y_t + \epsilon_{Y,i,t},$$

where the error terms $\epsilon_{Y,i,t}$ are independent of each other and of the firms’ cash flow characteristics, i.e.,

$$E \left[ \epsilon'_{Y,i,t} \epsilon_{Y,j,t} \right] = 0, \quad \forall i \neq j,$$

$$E \left[ \epsilon'_{Y,i,t} \eta_t \right] = 0, \quad \forall i \in [1, n].$$

The true parameter $c_{impact}$ can be recovered by 2SLS using other rating agencies’ scores for the same ESG measure, $z_{i,t} \equiv \{s_{j,t}, \forall j \neq i\}$, as instruments. The estimated coefficient is consistent.

$$\hat{b}_{2SLS} = (z's)^{-1}(z'\Delta S_t)$$

$$\text{plim} \hat{b}_{2SLS} = c_{impact}$$
How Do We Test for the Attenuation Bias?

- Implement the Hausman specification test

- The Hausman specification test checks whether the difference

\[ \delta = |b_{2SLS} - b_{OLS}| \]

is statistically different from zero

- **Prediction:** OLS estimate is lower than 2SLS
We have multiple ESG ratings agencies in our sample.

We therefore have enough instruments for an overidentifying restrictions test.

In other words, we can formally test whether ratings of other agencies are valid instruments.
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We use data from 8 different ESG rating agencies: Reprisk, TrueValueLabs, MSCI IVA, Sustainalytics, ISS, Asset4, and S&P Global.

ESG raters rely on different data sources that qualitatively imply different levels of noise.
Data II

- 136,876 firm-month observations for 8 raters between 2014 and 2020

- Correlation Matrix

<table>
<thead>
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<th>MSCI</th>
<th>Sust.</th>
<th>Refinitiv</th>
<th>Vigeo-Eiris</th>
<th>TVL</th>
<th>Reprisk</th>
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ESG Ratings and Stock Returns: Main Specification

- First stage regression
  \[ s_{j,i,t} = a_1 + b_1 \cdot z_{j,i,t} + c_1 \cdot X_{j,t} + \varepsilon_{j,i,t} \]

- Second stage
  \[ r_{j,t+1} = a_{iv} + b_{2SLS} \cdot \hat{s}_{j,i,t} + c_{iv} \cdot X_{j,t} + \mu_t + \nu_{j,t} \]

- \( r_{j,t+1} \) – monthly returns on individual stock \( j \)
- \( \hat{s}_{j,i,t} \) – instrumented value of stock \( j \)'s ESG score from rater \( i \) the first stage; \( z_{j,i,t} \) – ratings for stock \( j \) from raters other than \( i \)
- \( X_{j,t} \) – stock-level controls (log Market Value, Book-to-Market, EBIT over Total Assets, Beta, Volatility, and Momentum)
- \( \mu_t \) – time fixed effects. We also include industry fixed effects as well as country fixed effects
Results for North America

<table>
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<tr>
<th>NorthAmerica</th>
<th>OLS Coefficients</th>
<th>OLS t-stat</th>
<th>2SLS 2 raters Coefficients</th>
<th>2SLS 2 raters t-stat</th>
<th>2SLS 7 raters Coefficients</th>
<th>2SLS 7 raters t-stat</th>
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<td>0.0037</td>
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</table>
Conclusion

- Standard estimates of the effects of ESG on stock returns suffer from attenuation bias.

- Noise-to-signal ratios are high for most raters. The attenuation bias is large and statistically significant.

- Solution: Instrumental variables. Use ratings of other agencies as instruments.
Thank You!


