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

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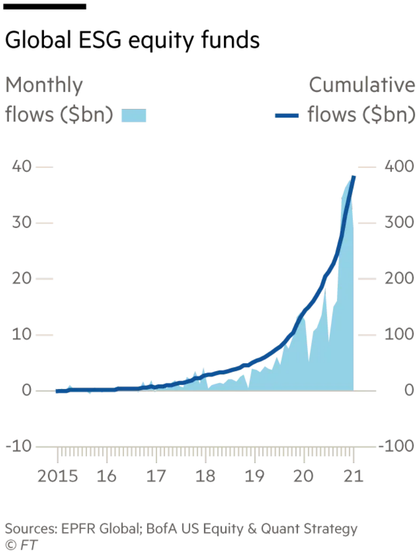
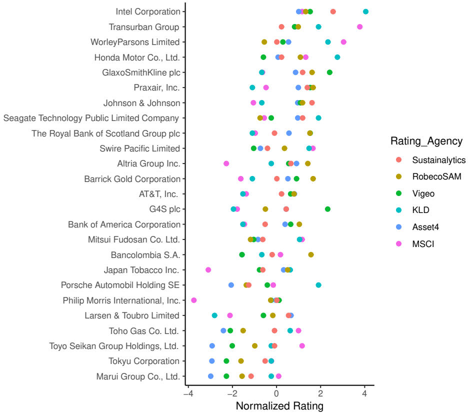
ESG investing affects stock returns



- Flows into ESG are sharply on the rise

...but ESG ratings are noisy



Berg, Kölbel, and Rigobon (2020)

- The average correlation of scores from different ESG raters varies from 40% to 70%
  Source:
- 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, Kölbel, and Rigobon (2020); Chatterji, Durand, Levine, and Touboul (2016)

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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 λ) 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

$$s_D = D + \epsilon_D, \qquad \epsilon_D \sim N(0, \sigma_{\epsilon_D^2})$$
$$s_Y = Y + \epsilon_Y, \qquad \epsilon_Y \sim N(0, \sigma_{\epsilon_Y^2})$$

Model Implications

- ESG investors affect equilibrium stock prices

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

- 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 λ, 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

$$E(S_1) - S_0 = c_0 + \eta - c_{impact} \cdot c_{noise} \cdot (s_Y - \overline{Y})$$

The coefficients c_{impact} and c_{noise} are

$$c_{impact} = A\lambda \frac{\sigma_D^2 \sigma_{\epsilon_D}^2}{\sigma_D^2 + \sigma_{\epsilon_D}^2}$$

$$c_{noise} = \frac{\sigma_Y^2}{\sigma_Y^2 + \sigma_{\epsilon_Y}^2}$$

η corresponds to the terms that depend on the signal about the firm's cash flows

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Estimation Challenge: Errors-in-Variables

- Structural model, to be estimated at individual stock level

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

- 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

$$\hat{b}_{OLS} = c_{impact} \cdot \underbrace{\frac{\sigma_Y^2}{\sigma_Y^2 + \sigma_{\epsilon^2_{Y,i,t}}}}_{c_{noise} < 1}$$

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

$$
\begin{aligned}
s_{1,t} &= Y_t + \epsilon_{Y_{1,t}} \\
s_{2,t} &= Y_t + \epsilon_{Y_{2,t}} \\
&\vdots \\
s_{n,t} &= Y_t + \epsilon_{Y_{n,t}}
\end{aligned}
$$

A Formal Statement

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

Icing on the Cake

- 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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Data: ESG Ratings

- 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

Source	**CSR Reports**	**Regulatory Filings**	**Media**	**Questionnaires**	**Modelled Data**
Availability	Public Self-reported	Public Self-reported	Public Third-party	Private Self-reported	Private Third-party
Reporting Noise Level	(Voluntary) Medium	(Mandatory) Low	(Involuntary) High	(Voluntary) Medium	(Involuntary) High

Data II

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

	MSCI	Sust.	Refinitiv	Vigeo-Eiris	TVL	Reprisk	ISS	SP Global
MSCI	1							
Sustainalytics	0.33	1						
Refinitiv	0.43	0.26	1					
Vigeo-Eiris	0.52	0.26	0.69	1				
TVL	0.19	0.04	0.07	0.10	1			
Reprisk	-0.02	0.13	-0.39	-0.32	0.17	1		
ISS	0.51	0.28	0.62	0.74	0.14	-0.24	1	
SP Global	0.41	0.23	0.68	0.67	0.07	-0.36	0.58	1

ESG Ratings and Stock Returns: Main Specification

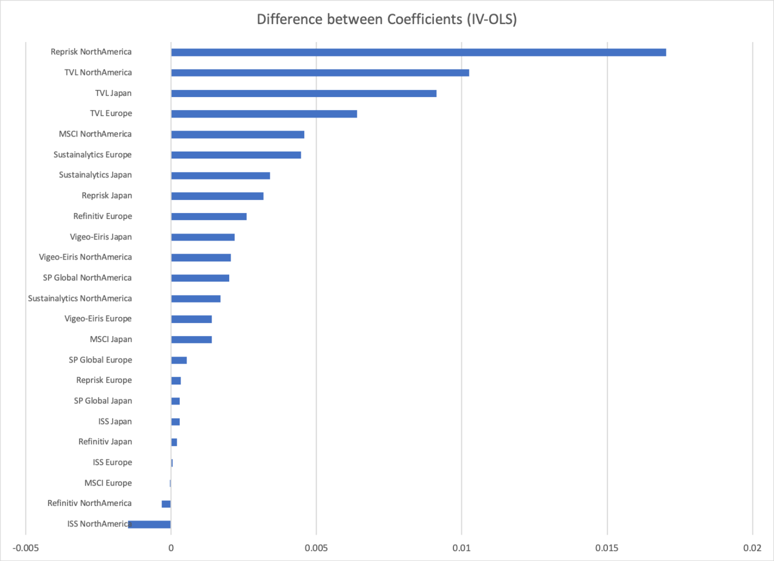
- First stage regression

$$s_{j,i,t} = a_1 + b_1 \cdot z_{j,i,t} + c_1 \cdot X_{j,t} + \varepsilon_{j,i,t}$$

- 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)
  - μ_t – time fixed effects. We also include industry fixed effects as well as country fixed effects


Difference between Coefficients (IV-OLS)
Reprisk NorthAmerica
TVL NorthAmerica
TVL Japan
TVL Europe
MSCI NorthAmerica
Sustainalytics Europe
Sustainalytics Japan
Reprisk Japan
Refinitiv Europe
Vigeo-Eiris Japan
Vigeo-Eiris NorthAmerica
SP Global NorthAmerica
Sustainalytics NorthAmerica
Vigeo-Eiris Europe
MSCI Japan
SP Global Europe
Reprisk Europe
SP Global Japan
ISS Japan
Refinitiv Japan
ISS Europe
MSCI Europe
Refinitiv NorthAmerica
ISS NorthAmerica
-0.005
0
0.005
0.01
0.015
0.02

Results for North America

	OLS		2SLS 2 raters		2SLS 7 raters	
NorthAmerica	Coefficients	t-stat	Coefficients	t-stat	Coefficients	t-stat
MSCI	0.0019	3.68	0.0064	3.15	-0.0019	-1.77
ISS	0.0019	2.82	0.0004	0.47	0.0010	1.06
Reprisk	0.0008	1.27	0.0178	2.76	0.0030	1.34
TVL	0.0013	1.90	0.0116	3.80	0.0078	2.94
Vigeo-Eiris	0.0005	0.57	0.0025	2.36	0.0025	2.42
SP Global	0.0001	0.18	0.0021	2.38	0.0019	2.26
Refinitiv	0.0007	1.21	0.0004	0.47	0.0015	1.79
Sustainalytics	0.0015	2.38	0.0032	1.72	0.0037	2.25

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!

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