

ESG factors explain one bit of price returns

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Research Questions

1. How much do ESG factors explain?
2. Do ESG factor explain more than fundamentals?
3. Doing better by doing good?

Learn to explain one idiosyncratic bit

Price return of an asset

$$r_t = r_{f,t} + \sum_k w_k F_{k,t} \underbrace{+\alpha + \epsilon_t}_{\text{idiosyncratic}}$$

Idiosyncratic bit

$$Y_t = \frac{1 + \text{sign}(\alpha + \epsilon_t)}{2} \in \{0, 1\}$$

Factors

1. market
2. Fama-French 3: market, size and value

Explanatory factors+target

Yearly,

1. **ESG:** Resource Use, Emissions, Innovation, Workforce, Human Rights, Community, Product Responsibility, Management, Shareholders, CSR Strategy + aggregated Controversy.
2. **non-ESG:** market capitalization, country, and Refinitiv Business Classification levels 1, 2, 3

Machine learning → non-linear relationship F

$$Y_t = F(ESG_t, fundamentals_t) + \dots$$

Machine learning problem

- For each company i and time t , build a vector of predictors

$$X_t^{(i)} = (ESG_{1,t}^{(i)}, \dots, ESG_{K,t}^{(i)}, \dots)$$

- Stack the vectors into a matrix

$$X^{(i)} = \begin{pmatrix} ESG_{1,1}^{(i)}, \dots, ESG_{K,1}^{(i)}, \dots \\ \vdots \\ ESG_{1,T}^{(i)}, \dots, ESG_{K,T}^{(i)}, \dots \end{pmatrix}$$

- Stack the matrices $X^{(i)}$ into a single matrix

$$X = \begin{pmatrix} X^{(1)} \\ \vdots \\ X^{(N)} \end{pmatrix}$$

Machine learning problem

- Compute the signs $Y_t^{(i)} \rightarrow$ vector $Y^{(i)}$

$$Y = \begin{pmatrix} Y^{(1)} \\ \vdots \\ Y^{(N)} \end{pmatrix}$$

- Train (line-by-line) model F

$$Y \sim F(X)$$

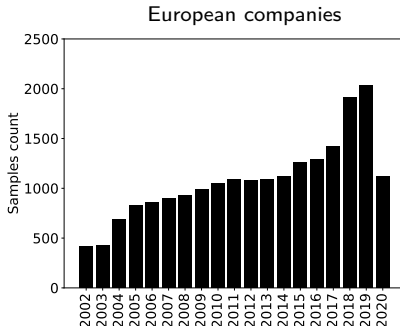
- Trained model output: estimate

$$F(ESG_{1,t'}^{(j)}, \dots, ESG_{t',1}^{(j)}, \dots) = \hat{Y}_{j,t'} \in [0, 1]$$

Challenges

1. Dataset with constant ESG factor methodology (human intervention)
→ Refinitiv

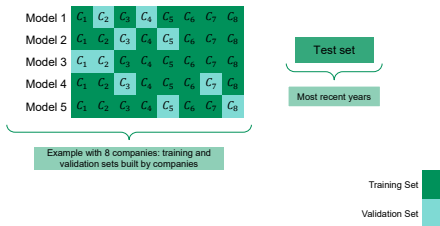
2. Quantitative growth



3. Qualitative growth

Robustness precautions

1. Rolling 5-year calibration windows, 1-year test window
2. Company-wise cross-validation

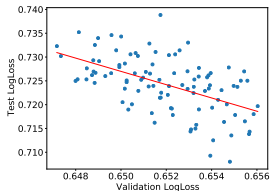


→ train and validate on most recent data

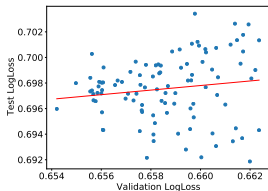
3. Hyperparameter search: 180 models
4. Compare performance in validation vs test sets

Result I: persistence of performance

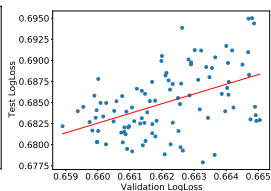
2016



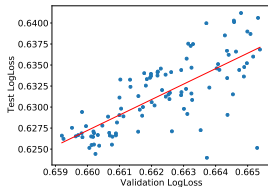
2017



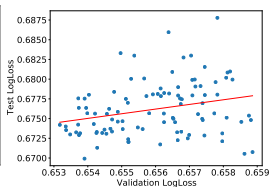
2018



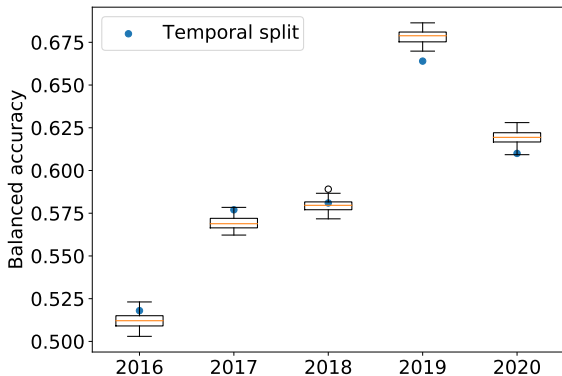
2019



2020

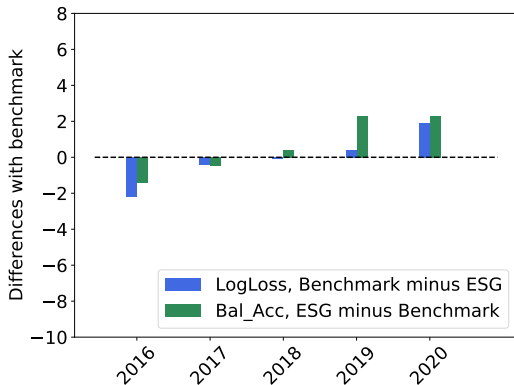


Result I: prediction accuracy vs time



balanced accuracy = (sensitivity+specificity)/2

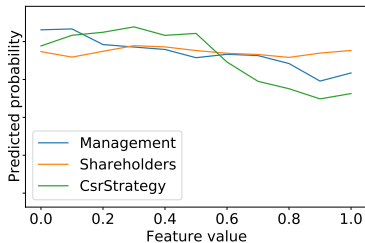
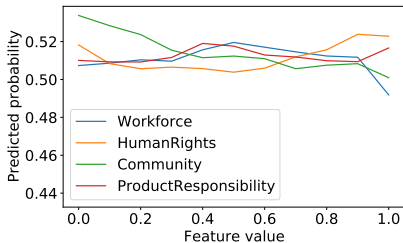
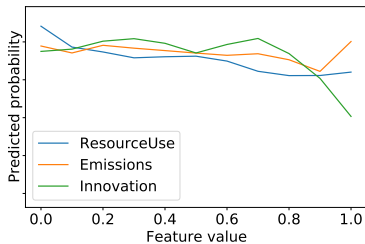
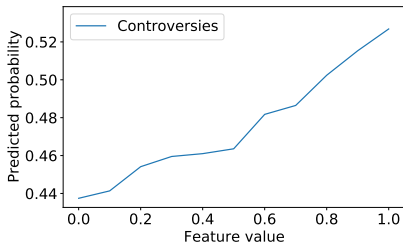
Result II: ESG's increasing importance



predictors:

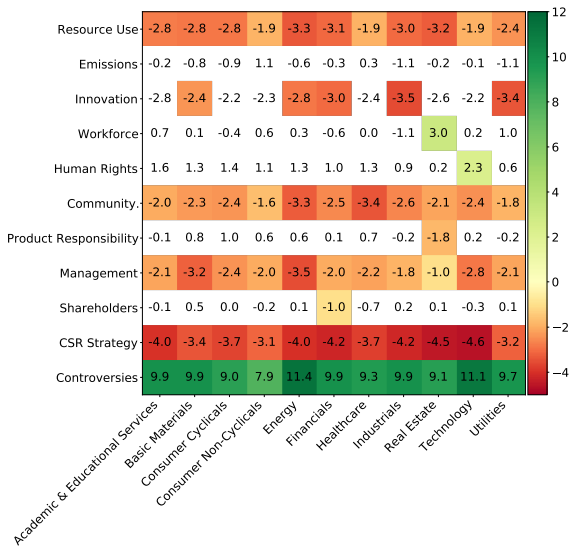
$X = (\text{ESG} + \text{fundamentals})$ vs $X_{\text{benchmark}} = (\text{fundamentals})$

Result III: predicted positive return probability vs ESG



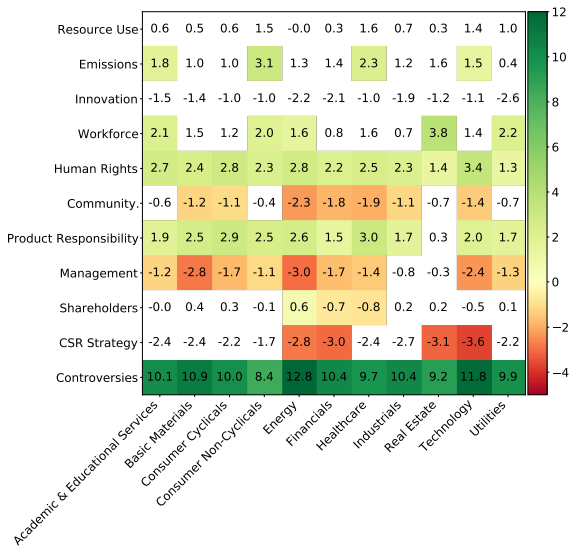
Materiality matrices

Slope of marginal effect. False Discovery Rate=0.05



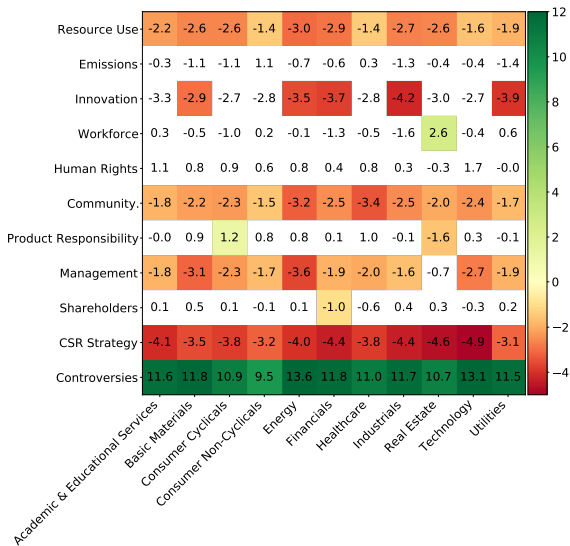
Materiality matrices: large caps

Slope of marginal effect. False Discovery Rate=0.05



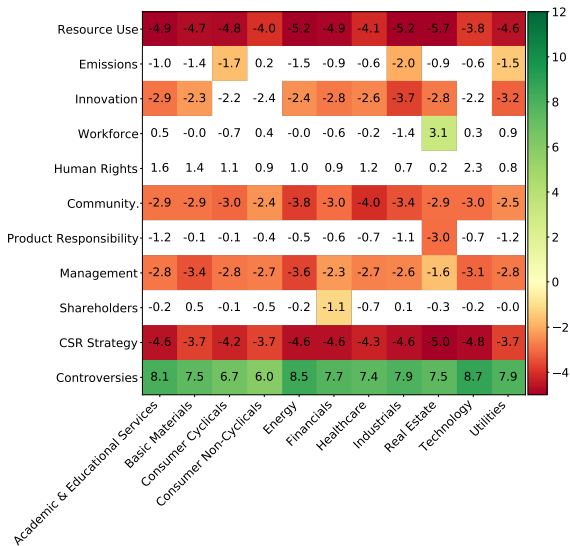
Materiality matrices: mid-cap

Slope of marginal effect. False Discovery Rate=0.05



Materiality matrices: small-cap

Slope of marginal effect. False Discovery Rate=0.05



Conclusions

1. How much do ESG factors explain?

at least one bit

2. Do ESG factor explain more than fundamentals?

yes, more and more

3. Doing better by doing good?

yes, for large caps.

→ avoid controversies