ESG factors explain one bit of price returns

Jérémi Assael$^{1,2}$, Laurent Carlier$^2$, Damien Challet$^1$,

$^1$CentraleSupélec
$^2$BNP Paribas

2022-03-21
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

\[ r_t = r_{f,t} + \sum_k w_k F_{k,t} + \alpha + \epsilon_t \]

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,


2. **non-ESG**: market capitalization, country, and Refinitiv Business Classification levels 1, 2, 3

Machine learning $\rightarrow$ non-linear relationship $F$

$$Y_t = F(ESG_t, fundamentals_t) + ...$$
Machine learning problem

- For each company $i$ and time $t$, build a vector of predictors
  \[ X_{t}^{(i)} = (ESG_{1,t}^{(i)}, \ldots, ESG_{K,t}^{(i)}, \ldots) \]

- Stack the vectors into a matrix
  \[ X^{(i)} = \begin{pmatrix} ESG_{1,1}^{(i)}, & \ldots, & ESG_{K,1}^{(i)} \\ \vdots \\ ESG_{1,T}^{(i)}, & \ldots, & ESG_{K,T}^{(i)} \end{pmatrix} \]

- 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

$$F(ESG_{1,t'}, \cdots , ESG_{t',1}, \cdots ) = \hat{Y}_{j,t'} \in [0, 1]$$
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 1: prediction accuracy vs time

balanced accuracy = (sensitivity + specificity) / 2
Result II: ESG’s increasing importance

predictors:

\[ X = (\text{ESG} + \text{fundamentals}) \text{ vs } X_{\text{benchmark}} = (\text{fundamentals}) \]
Result III: predicted positive return probability vs ESG
Materiality matrices

Slope of marginal effect. False Discovery Rate=0.05

<table>
<thead>
<tr>
<th>Resource Use</th>
<th>-2.8</th>
<th>-2.8</th>
<th>-2.8</th>
<th>-1.9</th>
<th>-3.3</th>
<th>-3.1</th>
<th>-1.9</th>
<th>-3.0</th>
<th>-3.2</th>
<th>-1.9</th>
<th>-2.4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emissions</td>
<td>-0.2</td>
<td>-0.8</td>
<td>-0.9</td>
<td>1.1</td>
<td>-0.6</td>
<td>-0.3</td>
<td>0.3</td>
<td>-1.1</td>
<td>-0.2</td>
<td>-0.1</td>
<td>-1.0</td>
</tr>
<tr>
<td>Innovation</td>
<td>-2.8</td>
<td>-2.4</td>
<td>-2.2</td>
<td>-2.3</td>
<td>-2.8</td>
<td>-3.0</td>
<td>-2.4</td>
<td>-3.5</td>
<td>-2.6</td>
<td>-2.2</td>
<td>-3.4</td>
</tr>
<tr>
<td>Workforce</td>
<td>0.7</td>
<td>0.1</td>
<td>-0.4</td>
<td>0.6</td>
<td>0.3</td>
<td>-0.6</td>
<td>0.0</td>
<td>-1.1</td>
<td>3.0</td>
<td>0.2</td>
<td>1.0</td>
</tr>
<tr>
<td>Human Rights</td>
<td>1.6</td>
<td>1.3</td>
<td>1.4</td>
<td>1.1</td>
<td>1.3</td>
<td>1.0</td>
<td>1.3</td>
<td>0.9</td>
<td>0.2</td>
<td>2.3</td>
<td>0.6</td>
</tr>
<tr>
<td>Community</td>
<td>-2.0</td>
<td>-2.3</td>
<td>-2.4</td>
<td>-1.6</td>
<td>-3.3</td>
<td>-2.5</td>
<td>-3.4</td>
<td>-2.6</td>
<td>-2.1</td>
<td>-2.4</td>
<td>-1.8</td>
</tr>
<tr>
<td>Product Responsibility</td>
<td>-0.1</td>
<td>0.8</td>
<td>1.0</td>
<td>0.6</td>
<td>0.6</td>
<td>0.1</td>
<td>0.7</td>
<td>-0.2</td>
<td>-1.8</td>
<td>0.2</td>
<td>-0.2</td>
</tr>
<tr>
<td>Management</td>
<td>-2.1</td>
<td>-3.2</td>
<td>-2.4</td>
<td>-2.0</td>
<td>-3.5</td>
<td>-2.0</td>
<td>-2.2</td>
<td>-1.8</td>
<td>-1.0</td>
<td>-2.8</td>
<td>-2.1</td>
</tr>
<tr>
<td>Shareholders</td>
<td>-0.1</td>
<td>0.5</td>
<td>0.0</td>
<td>-0.2</td>
<td>0.1</td>
<td>-1.0</td>
<td>-0.7</td>
<td>0.2</td>
<td>0.1</td>
<td>-0.3</td>
<td>0.1</td>
</tr>
<tr>
<td>CSR Strategy</td>
<td>-4.0</td>
<td>-3.4</td>
<td>-3.7</td>
<td>-3.1</td>
<td>-4.0</td>
<td>-4.2</td>
<td>-3.7</td>
<td>-4.2</td>
<td>-4.5</td>
<td>-4.6</td>
<td>-3.2</td>
</tr>
<tr>
<td>Controversies</td>
<td>9.9</td>
<td>9.9</td>
<td>9.0</td>
<td>7.9</td>
<td>11.4</td>
<td>9.9</td>
<td>9.3</td>
<td>9.9</td>
<td>9.1</td>
<td>11.1</td>
<td>9.7</td>
</tr>
</tbody>
</table>
Materiality matrices: mid-cap

Slope of marginal effect. False Discovery Rate=0.05

<table>
<thead>
<tr>
<th>Resource Use</th>
<th>-2.2</th>
<th>-2.6</th>
<th>-2.6</th>
<th>-1.4</th>
<th>-3.0</th>
<th>-2.9</th>
<th>-1.4</th>
<th>-2.7</th>
<th>-2.6</th>
<th>-1.6</th>
<th>-1.9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emissions</td>
<td>-0.3</td>
<td>-1.1</td>
<td>-1.1</td>
<td>1.1</td>
<td>-0.7</td>
<td>-0.6</td>
<td>0.3</td>
<td>-1.3</td>
<td>-0.4</td>
<td>-0.4</td>
<td>-1.4</td>
</tr>
<tr>
<td>Innovation</td>
<td>-3.3</td>
<td>-2.9</td>
<td>-2.7</td>
<td>-2.8</td>
<td>-3.5</td>
<td>-3.7</td>
<td>-2.8</td>
<td>-4.2</td>
<td>-3.0</td>
<td>-2.7</td>
<td>-3.9</td>
</tr>
<tr>
<td>Workforce</td>
<td>0.3</td>
<td>-0.5</td>
<td>-1.0</td>
<td>0.2</td>
<td>-0.1</td>
<td>-1.3</td>
<td>-0.5</td>
<td>-1.6</td>
<td>2.6</td>
<td>-0.4</td>
<td>0.6</td>
</tr>
<tr>
<td>Human Rights</td>
<td>1.1</td>
<td>0.8</td>
<td>0.9</td>
<td>0.6</td>
<td>0.8</td>
<td>0.4</td>
<td>0.8</td>
<td>0.3</td>
<td>-0.3</td>
<td>1.7</td>
<td>-0.0</td>
</tr>
<tr>
<td>Community</td>
<td>-1.8</td>
<td>-2.2</td>
<td>-2.3</td>
<td>-1.5</td>
<td>-3.2</td>
<td>-2.5</td>
<td>-3.4</td>
<td>-2.5</td>
<td>-2.0</td>
<td>-2.4</td>
<td>-1.7</td>
</tr>
<tr>
<td>Product</td>
<td>-0.0</td>
<td>0.9</td>
<td>1.2</td>
<td>0.8</td>
<td>0.8</td>
<td>0.1</td>
<td>1.0</td>
<td>-0.1</td>
<td>-1.6</td>
<td>0.3</td>
<td>-0.1</td>
</tr>
<tr>
<td>Responsibility</td>
<td>-1.8</td>
<td>-3.1</td>
<td>-2.3</td>
<td>-1.7</td>
<td>-3.6</td>
<td>-1.9</td>
<td>-2.0</td>
<td>-1.6</td>
<td>-0.7</td>
<td>-2.7</td>
<td>-1.9</td>
</tr>
<tr>
<td>Management</td>
<td>0.1</td>
<td>0.5</td>
<td>0.1</td>
<td>-0.1</td>
<td>0.1</td>
<td>-1.0</td>
<td>-0.6</td>
<td>0.4</td>
<td>0.3</td>
<td>-0.3</td>
<td>0.2</td>
</tr>
<tr>
<td>Shareholders</td>
<td>-4.1</td>
<td>-3.5</td>
<td>-3.8</td>
<td>-3.2</td>
<td>-4.0</td>
<td>-4.4</td>
<td>-3.8</td>
<td>-4.4</td>
<td>-4.6</td>
<td>-4.9</td>
<td>-3.1</td>
</tr>
<tr>
<td>Controversies</td>
<td>11.6</td>
<td>11.8</td>
<td>10.9</td>
<td>9.5</td>
<td>13.6</td>
<td>11.8</td>
<td>11.0</td>
<td>11.7</td>
<td>10.7</td>
<td>13.1</td>
<td>11.5</td>
</tr>
</tbody>
</table>
Materiality matrices: small-cap

Slope of marginal effect. False Discovery Rate=0.05
Conclusions

1. How much do ESG factors explain?  
\[\textit{at least one bit}\]

2. Do ESG factors explain more than fundamentals?  
\[\textit{yes, more and more}\]

3. Doing better by doing good?  
\[\textit{yes, for large caps.}\]

\[\rightarrow \textit{avoid controversies}\]