ESG rating and ambiguity

An informative and distorted signal based approach

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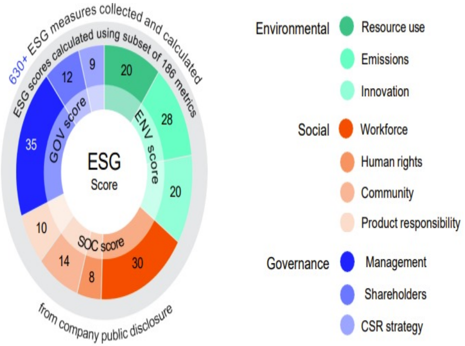
3rd December 2024

2nd workshop on sustainable finance , Venice

Today's agenda

ESG scores

The ESG scores are evaluations of companies' performances relative to the Environmental, Social and Governance (ESG) Issues. They are expressed as a number between 0 and 100, and they can refer to the overall company's performance or to one of the ESG pillars.



[0] The image is taken from "Enviromental, social and governance scores from LSEG" (2023)

Fallacies of the ESG score

At the moment the ESG scores are the most comprehensive and used measure of sustainability, but they are **far from perfect**. During the years different issues linked to the ESG scores were reported in the literature, such as [1]:

- lack of comparability for firms across different sectors;
- tendency to be rewritten ex-post;
- discordance among scores of different rating agencies for the same company;
- unclear regulatory framework.

[1]See Berg, Fabisik, and Sautner (2020) and Berg, Koelbel, and Rigobon (2019) for a deepen discussion

An ambiguous and Information-based model

Inspired by the concept of **ambiguous preferences**, we propose an ambiguous version of the ESG rating that accounts for varying levels of information and subjective preferences.
In particular, we proposed a discrete-state model that allows for a stress analysis of policy shocks under different degrees of **informativiness** and **ambiguity**.

DM utility

The Klibanoff, Marinacci, and Mukerji 2005 representation of smooth preferences takes the form:

$$V(f) = \int_{\Delta} \phi \left(\int_{S} u(f(s)) d\pi \right) d\mu \equiv \mathbb{E}_{\mu}\phi(\mathbb{E}_{\pi} u \circ f), \qquad (1)$$

where $\phi(.)$ is a continuous and strictly increasing function[2] $\phi : \mathcal{U} \to \mathbb{R}$ and $u(.)$ is a von Neumann-Morgenstern utility that represents the preferences of the DM in the state space S. The set Δ denotes the set of all possible distribution over the states while μ is a subjective second-order probability measure over the first-order probabilities $\pi \in \Delta$.

[2] The domain $\mathcal{U}$ is considered to be the space of expected utilities, objectively determined under the real probability measure.

Information distortion

To define the subjective information setup, we represent the dependence structure between π and μ in terms of a *deformation density*.

Therefore, in line with Blackwell 1953 and Blackwell and Girshick 1979, we note the copula function[3] between π and μ as :

$$C_{\pi,\mu}(\delta, s) = \mu(\delta|s)\pi(s), \delta \in \Delta, s \in S,$$

where s represents the signal, π the prior distribution over the states, and μ represents the conditional distribution, or second-order probability, that reflects the decision-maker's updated beliefs after receiving a signal.

[3] The marginals being the cumulative distribution functions of the prior and updated beliefs.

Preferences' under distortion

The preferences' representation affected by a distortion leads to a new version of equation (1), i.e.

$$\hat{V}(f) = \int_{\Delta \times S} u(f(s))\phi(d\pi)\, d\hat{\mu} = \int_{\Delta \times S} u(f(s))d\hat{C}_{\pi,\mu}(\delta, s), \quad (2)$$

where $\hat{C}$ denotes the dependence structure affected by a distortion of μ, i.e. $\hat{\mu}$, including the attitude to ambiguity of the DM. Therefore we can identify the following special cases:

- in case of *full information*, i.e. identity information density and fully trusting on the signals we have no bias
- in case of *full information*, i.e. identity information density and *ambiguity-neutral* DM, who does not trust the signal, the same probabilities are assigned to every state in the world.

Discrete state world

Therefore we assume finite states world and the signals the DM receives, we use a distortion matrix to represent the ambiguity impact on a probability set.
The proposed model is well defined by an information and a garbling matrix, whose product will be a distortion matrix, i.e.

$$\boldsymbol{D} = \boldsymbol{G} \times \boldsymbol{\Pi}$$

We define the signal set as composed by ten different signals. Consequently, we specify both the information and the garbling matrix, whose dimension is 10×10.

Informative set and signal's distortion

The implemented information matrices are:

- **Π1** Identity matrix: all signals are perceived.
- **Π2** Sup matrix: no signal on the highest spectrum.
- **Π3** Inf matrix: no information on lower spectrum.

The garbling matrices taken into account are :

- ***G*1** Identity matrix.
- ***G*2** Ambiguity Neutral matrix: each weight is equal.
- ***G*3** Ambiguous matrix: the weights is based on the reliability of the ESG score.

Ambiguity garbling matrix

To asses the level of ambiguity of the agents for $\boldsymbol{G3}$,it is computed the distance of the Refinitiv ESG scores to a benchmark based on the SASB criteria for each company in the sample.
Then we compute for each sector the average standardized difference (Z_k), and we define as implicit level of ambiguity for the sector k (α_k), as :

$$\alpha_k = P(|Z| > |z_k|) = \Phi(-|z_k|) + (1 - \Phi(|z_k|)),$$

where Z is a standard normal random variable.

Finally for each sector K we have a garbling matrices $\boldsymbol{G3}_k$, such that for each element of the matrix is assumed to be beta distributed, i.e. :

$$X_{p,l} \sim \mathcal{B}(e^{\alpha_k}, e^{1-\alpha_k}),$$

Distorted ESG score

In the last step, the new ESG rate is calculated for each company

$$E\hat{S}G = \sum_{i=1}^{3} \sum_{j=1}^{n_i} \hat{w}_{ij} P_{ij},$$

where P_{ij} represents the score assigned by Refinitiv to the j-th factor of the i-th pillar for the company under consideration. On the other hand, $\hat{w}_{ij}$ is the new distorted weight of the j-th factor of the i-th pillar induced by $\boldsymbol{D}_k$, where k identifies the sector to which the considered company belongs.
The new distorted weights are evaluated assuming that the weight's increment is **constant** for each sector.

Scenario description

To assesses the resilience of the ESG scores to policy shocks, we perform an analysis, for which:

- we consider 3 baseline scenarios, concerning 3 different changes in rating structure. We generate 10000 observations for each scenario.
- for each observation we evaluate for each ambiguity level the perturbed ESG scores.
- we retrieve the transition matrix and the average sectorial variation of the ESG score.

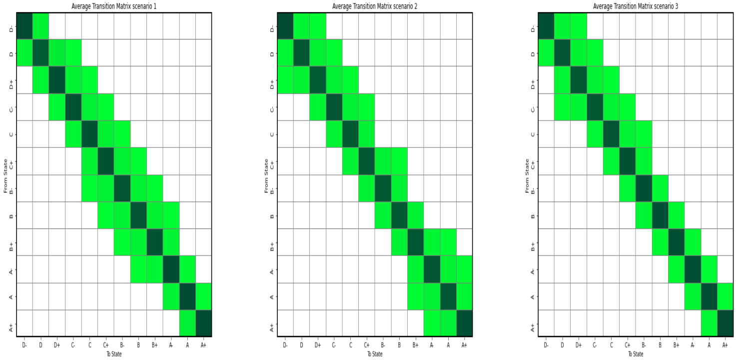
Scenarios' description

- Scenario 1: **Environmental** factors dominance.
  Focuses on environmental factors as the primary driver of sustainability assessments, reflecting the urgency of climate change and resource management. Companies face increasing pressure to adopt sustainable practices, influencing their competitive standing and reputation.
- Scenario 2:**Social** factors dominance.
  Emphasizes social issues such as equity, labor rights, and community well-being as key determinants of corporate success. Companies are compelled to engage in ethical practices and social responsibility, responding to heightened societal awareness and demand for accountability.
- Scenario 2: **Sustainability** factors dominance. Highlights the interplay between environmental and CSR initiatives amid growing regulatory pressures. Companies are expected to integrate both pillars into their strategies, balancing environmental responsibility with social contributions to meet stakeholder expectations.

Scenario' Description: dependence among shocks

- Scenario 1: Extreme positive changes in environmental and social responsibility factors are likely to occur **together**, while less extreme changes show weaker dependence. We model this through a Gumbel copula ($\theta = 2.5$), which captures moderate dependence with a focus on right-tail dependence.
- Scenario 2: Expected changes in social and environmental factors are strongly linked but moderate in magnitude, and do not exhibit extreme fluctuations. For this scenario, we use a Frank copula ($\theta = 8$), highlighting a strong dependence between the two factors.
- Scenario 3: Companies face increased scrutiny and regulatory requirements related to sustainability, denoting right-tail dependence among environmental factors and CSR. We use a Gumbel copula ($\theta = 4.5$).

Transition matrices



(a) 1st Base Scenario (b) 2nd Base Scenario (c) 3rd Base Scenario

Figure: Mean Transition Matrices across all ambiguity levels.

Sectorial Analysis

Overall tougher environmental policies tend to reduce scores, signaling that current sustainability measures are widely seen as inadequate. Instead, social initiatives, enhance perceptions of the industries' sustainability.

- **Scenario 1**: On average, scores decreased by 0.26 when stricter environmental and product responsibility standards were applied. Environmentally intensive industries generally faced a drop in evaluation, whereas service-oriented sectors like freight and logistics saw improvements.
- **Scenario 2**:An average increase of 0.85 points was observed. Most industries benefited from this shift, with 34 out of 51 showing positive changes, indicating that enhancing social factors can boost ESG scores.
- **Scenario 3**:Stricter environmental and disclosure standards led to an average decline of 2.14 points, highlighting the broad vulnerability of industries to heightened climate policies

An ambiguous and information-based model

The proposed model infers a distortion on the ESG rating which is valuable because:

- it has a forecasting power if the calibrated ambiguity is assumed to be representative of the market sentiment;
- it is a useful tool for policy-makers, able to identify ESG-under/overestimated sectors based on a forward-looking perspective;
- it allows to make clear the sensitivity of the official ESG rating to the information signal, hence showing its level of robustness to the singular pillars.

The 2023 Refinitiv-ESG scores reveal that, overall, the E pillar tends to be slightly undervalued for most types of market agents. Significant positive impacts on scoring result from variations in the weight of the S pillar, especially notable for industries with high environmental intensity. Conversely, governance factors, along with environmental considerations, are currently undervalued, consistently yielding negative impacts across almost all sectors and levels of ambiguity.

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Scenarios' description

Scenario	First Scenario	Second Scenario	Third Scenario
Affected Factors	E-S	E-S	E-G
Affected categories	E: all/S: only the fourth	E: all/S: all	E: all/G: only the second
$P_1 = E$	$w_{E1} = \sum_{j=1}^{3} \Delta w_{E,j} \sim N(0.10, 12.25 * 10^{-2})$	$w_{E2} = \sum_{j=1}^{3} \Delta w_{1,j} \sim N(0.04, 12.25 * 10^{-2})$	$w_{E3} = \sum_{j=1}^{3} \Delta w_{1,j}(0.15, 9 * 10^{-5})$
$P_2 = S$	$w_{S1} = \Delta w_{2,4} \sim N(0.02, 0.01)$	$w_{S2} = \sum_{j=1}^{4} \Delta w_{2,j} \sim N(0.15, 0.04)$	-
$P_3 = G$	-	-	$w_{G3} = \Delta w_{3,2} \sim N(0.004, 2 * 10^{-5})$
Dependence Structure	Gumbel	Frank	Gumbel
Dependence Parameter	$\theta_1 = 2.5$	$\theta_2 = 8$	$\theta_3 = 4.5$