Technical Methodology

ESG Index 2021
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The ESG Index (Environmental, Social and Governance Index) or ESGI is a composite measure offering a classification of exogenous risks by country with regards to the environment, human rights and health & safety. This index was built in the framework of a more general risk mitigation plan, compliant with international recommendations and current binding legal requirements, such as the French law “Devoir de Vigilance”.
This technical methodology is meant to provide all necessary information for understanding the variables used and their respective impact in rankings.

1- Indicators and Data Overview

The ESGI is based on 65 variables that are exclusively borrowed from internationally recognized entities. The ESGI is divided into 3 independent sub-indexes as presented below.

The Environment sub-index covers 191 countries and displays two indicators:

- (1) Air and Climate
- (2) Ecosystem Health

The Human Rights sub-index covers 182 countries and comprises 4 indicators:

- (1) Ratification Status of Conventions
- (2) Social Rights
- (3) Civil and Political Rights
- (4) Collective Rights.

The last sub-index focuses on Health & Safety and provides a result for 185 countries. It is divided into 3 indicators:

- (1) Health
- (2) Safety
- (3) Inequality by Residential Area

1779 countries and territories are scored in all three sub-indexes and are therefore included in the global scoring of the ESG Index

Table 1 Levels of aggregation

Variable Ref.	Weight	Indicator	Weight	Indicator	Weight	Indicator	Weight	Sub-index	Weight	Index
V1	0.75	Six Main Pollutants	0.5	Air Pollution	0.5	Air and Climate	0.7	Environment	0.3	ESG Index
V2	0.05									
V3	0.05									
V4	0.05									
V5	0.05									
V6	0.05									
V7	0.3	Air Pollution DALYs	0.5							
V8	0.7									
V9	0.35	Climate Change Trends	0.7	Climate Change	0.5					
V10	0.075									
V11	0.075									
V12	0.5									
V13	0.45	Climate Change Indicators	0.3							
V14	0.45									
V15	0.1									
V16	0.85	Biodiversity			0.5	Ecosystem Health	0.3			
V17	0.05									
V18	0.05									
V19	0.05									
V20	0.5	Land Ecosystem	0.5	Ecosystem	0.5					
V21	0.5									
V22	0.25	Sea Ecosystem	0.5							
V23	0.25									
V24	0.25									
V25	0.25									
V26	0.55	Ratified treaties, reporting compliance and standing invitations					0.25	Human Rights	0.5	
V27	0.15									
V28	0.15									
V29	0.15									
V30	0.1	Labor Rights			0.5	Social Rights	0.35			
V31	0.15									
V32	0.1									
V33	0.2									
V34	0.2									
V35	0.1									
V36	0.15									
V37	0.7	Education			0.15					
V38	0.3									
V39	0.5	Housing			0.15					
V40	0.5									
V41	/	Gender Equality			0.2					
V42	/	Public Affairs Investment			0.1	Civil and Political Rights	0.25			
V43	/	Press Freedom			0.1					
V44	/	Factionalized Elites	0.3	Prohibition of Discrimination & Minority Rights	0.3					
V45	/	Group Grievance	0.3							
V46	/	Freedom to Make Life Choices	0.4							
V47	/	Personal Freedom			0.2					
V48	/	Political Rights and Civil Liberties Index			0.3					
V49	/	Gobal Peace Index			0.7	Collective Rights	0.15			
V50	0.3	Right to Self Determination			0.3					
V51	0.7									
V52	0.35	Medical Care			0.35	Health Indicators	0.4	Health & Safety	0.2	
V53	0.35									
V54	0.3									
V55	0.4	Life Expectancy			0.25					
V56	0.6									
V57	0.6	Access to Food and Drinking Water			0.4					
V58	0.2									
V59	0.2									
V60	/	Safety at Work			0.5	Safety Indicators	0.4			
V61	/	Social health Protection Coverage	0.4	Social Security	0.5					
V62	/	Unemployment Benefits	0.3							
V63	0.5	Protection of Vulnerable Persons	0.3							
V64	0.5									
V65	/	Inequality by Residential Area					0.2			

The following table lists the data variables used to calculate the ESGI, together with their respective variable code.

Table 2 Data Overview

Sub-index	Ref.	Variable
Environment	V1	Exposure to Fine Particules (PM2.5)
	V2	Ozone Mortality
	V3	Lead Mortality
	V4	CO Emissions per 100'000 Inhabitants
	V5	N2O Emissions per 100'000 Inhabitants
	V6	SO2 Emissions per 100'000 Inhabitants
	V7	Household Air Pollution in DALYs
	V8	Ambient Air Pollution in DALYs
	V9	CO2 Emissions Growth Rate
	V10	CH4 Emissions Growth Rate
	V11	N2O Emissions Growth Rate
	V12	Greenhouse Gases Emissions Growth Rate
	V13	CO2 Emissions per 100'000 Inhabitants
	V14	Greenhouse Gas Emissions per 100'000 Inhabitants
	V15	Share of CO2 Emissions embedded in Trade
	V16	Biodiversity Intactness Index
	V17	Threatened Fish Species Ratio
	V18	Treatened Birds Species Ratio
	V19	Threatened Plants Species Ratio
	V20	Net Forest Change
	V21	Fertilizer Consumption per hectare
	V22	IUU Fishing Index
	V23	Carbon Storage
	V24	Clean Water
	V25	Ocean Biodiversity
Human Rights	V26	Ratification Status of 18 Human Rights Treaties
	V27	Overdue Reports (total)
	V28	5+ Years Overdue Reports
	V29	Standing Invitations
	V30	Income Inequality
	V31	Working Poverty Rate
	V32	Vulnerable Employment
	V33	Child Labour
	V34	Prohibition of Slavery
	V35	Human Trafficking Minimum Standards
	V36	Collective Rights at Work
	V37	Access to Education
	V38	Pupil-teacher ratio
	V39	Access to Electricity
	V40	Sanitation Services
	V41	Gender Inequality Index
	V42	Share of Seats in Parliament held by Women
	V43	Press Freedom
	V44	Factionalized Elites
	V45	Group Grievance
	V46	Freedom to Make Life Choices
	V47	Personal Freedom
	V48	Political Rights and Civil Liberties
	V49	Global Peace
	V50	Number of Conflicts for Autonomy and / or Secession
	V51	Intensity of Conflicts for Autonomy and / or Secession
Health & Safety	V52	Mortality Rate of Children
	V53	Maternity Mortality Ratio
	V54	Unintentional Poisoning Mortality
	V55	Healthy Life Expectancy
	V56	Inequality Adjusted Life Expectancy
	V57	Undernourishment
	V58	Safely Managed Water
	V59	Sanitation
	V60	Injuries at Work
	V61	Social Health Protection Coverage
	V62	Unemployment Benefits
	V63	Population Above Statutory Pensionable Age Receiving Age Pension
	V64	Mandatory Paid Maternity Leave
	V65	Inequality by Residential Area of Maternal Mortality Ratio

A number of criteria were considered during the selection process:

- All data variables are linked to the measures of environment, human rights and health & safety, either directly or indirectly.

- In order to ensure cross-country comparability, no country specific information is considered. Such data would generate valuations relying on different bases / concepts, which is unsuitable for rankings

- Data sources with limited coverage are set aside, except in the case of a high explanation power. In this context and in the absence of other similar measures, variables are kept in the analysis.

- Although some variables have wider coverage than others, none of them are limited to a specific cluster of countries. This decision is meant to guarantee that each variable offers a data set with scattered points across the full spectrum of possibilities

- During the selection process, preference is given to quantitative type of data. Qualitative information is also considered if and only if the transitivity axiom is ultimately satisfied

2- Missing Data

Several methods exist to deal with missing values, which can be grouped into two types of treatments: deletion - such as listwise deletion (complete-case analysis) and simple case deletion - or imputation.
Considering that most of our missing data is either of type MAR (Missing at Random) or MNAR (Missing not at Random), deletion is hardly appropriate and would lead to biased estimates.

The processing of missing data is thus handled on a case-by-case basis depending on the structure of the datasets.

2.1- Imputation

First, in the case of time series datasets with visible trends, we proceed with a linear extrapolation from the five last available years. This method allows to estimating parameters based on real past values.

The second approach used is the method of the Last Observation Carried Forward (LOCF), which is a common statistical approach for time series data that consists in imputing the last available observation. Similar to the first method, only the last five available years are considered.

The two above-mentioned methods are selected to be based on known values that are specific to the countries, and consequently true at a point in time. In most cases, such methods can't be applied because no current nor past value is available. In these cases, we consider a third imputation method: Predictive Mean Matching (PMM) with multiple imputation.

Single imputation provides only one parameter estimate for each missing value and omits possible alternatives. It therefore tends to underestimate the standard errors and consequently overestimate the validity of the estimated scoring. As opposed to single imputation, multiple imputation provides *n* different possibilities for each missing value. These *n* possibilities allow for two desirable outputs:

- First, each imputed value results from the pooling of the *n* parameter estimates, thus providing a better approximation of the true value
- Second and more importantly, multiple imputation allows for measures of uncertainty, by sampling *n* times from the posterior predictive distribution.

As previously mentioned, the selected method of multiple imputations is that of Predictive Mean Matching (PMM). This approach allows us to preserve the distributions in the data and ensures that imputed values are plausible as it fills in values from real observations (Vink et al., 2014[1]). PMM provides a random value from a donor, based on the closeness of the regression-predicted values of the donor $\hat{\beta}$, with that of the recipient β^*. This implies that

[1] Vink, G., Frank, L. E., Pannekoek, J., and van Buuren, S. (2014). Predictive mean matching imputation of semicontinuous variables. Statistica Neerlandica. 68(1). 61-90

linear regressions are not used to generate imputed values but rather to determine the donor (Schenker, N. & Taylor, J.M.G., 1996[2]).

The process by which PMM is performed is as follows (Vink et al., 2014[3]):

1. First, an Ordinary Least Squares (OLS) linear regression of γ given the selected predictors χ is performed to obtain the parameter estimates $\hat{\beta}$, $\hat{\sigma}^2$ and $\hat{\varepsilon}$, respectively the regression coefficient, the variance and the random error
2. In a second step, random draws of σ^{2*} and β^* are performed based on the posterior predictive distributions to provide new sets of coefficients. These draws allow for the calculation of $\hat{\gamma}_{missing}$
3. Predicted values are then generated by calculating $\hat{\gamma}$ for both cases with values (potential donors) and missing values (recipients), using the parameter estimates $\hat{\beta}$ and β^* respectively
4. The closeness of predicted values between donors and recipients is evaluated, so as to identify the three cases which minimizes $|\hat{\gamma}_{observed} - \hat{\gamma}_{missing}|$
5. Missing values are substituted from a random donor among those that satisfy the minimization criteria of the previous step.
6. Considering this index uses PMM for multiple imputation, the process starting from the random draws of σ^{2*} and β^* to the final imputation is repeated *n* times, in order to provide *n* complete datasets with *n* possible values for each missing case

[2] Schenker, N., & Taylor, J. M. G. (1996). Partially parametric techniques for multiple imputation. Computational Statistics & Data Analysis, 22(4), 425–446

[3] Vink, G., Frank, L. E., Pannekoek, J., and van Buuren, S. (2014). Predictive mean matching imputation of semicontinuous variables. Statistica Neerlandica. 68(1). 61-90

2.2- Case Deletion

For some variables, no PMM imputation was performed and only true values were considered in the analysis. This is due to the structure of the data and the absence of correlation with other variables. In the case of a missing value, the algorithm proportionally redistributes the according weight to variables measuring the same indicator.

3- Standardization

Aside from binary variables, all datasets were tested for skewness, then transformed and recoded if necessary. The mean and standard deviation is calculated and all variables are then standardized, to allow for a proper aggregation in the global scoring. Several normalization methods exist. The one used here is that of z-scores, which converts datasets to a common scale with a mean of zero and a standard deviation of one, as follows:

$$I_{i,c} = \frac{X_{i,c} - X_{i,\bar{c}}}{\sigma_{\bar{c}}}$$

with:

ι = *variable*

c = country

$\bar{c}$ = *reference country*

σ = *standard deviation*

4- Aggregation

The aggregation process converts all data points to a scale of 0-100, where 0 represents the lowest risk, and 100 corresponds to the highest risk. Country scores are then calculated for each sub-index (Environment, Human Rights and Health & Safety) using an arithmetic mean and following the weights previously presented (table 1).
In order to provide a unique risk score encompassing all three measures, scores by sub-index are eventually aggregated using a weighted geometric mean.

5- Measure of Uncertainty

Based on the *n* datasets obtained from the multiple imputation process, a standard error and a 90 percent confidence interval are calculated for each dataset to reflect the variance around the different scores.

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