ARE ESG FACTORS STRUCTURAL DETERMINANTS OF ECONOMIES?

BEYOND RATINGS

standards for positive finance

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ESG FACTORS IN A NUTSHELL

1. WHERE ARE WE GOING?

Given the ESG impact on sustainable development and the increased interested of the financial market on these factors in the investment decision, we offer to use a:

1. Quantitative analysis to classify countries according to their ESG performance and to identify the existence of long-term relationship between ESG factors and sovereign risk (retrospective analysis).
2. Qualitative analysis to predict a very long-term risk taking into account not only economic and finance risk but also ESG related risk (prospective analysis).

1.1 HOW ABOUT SUSTAINABLE DEVELOPMENT

Sustainable Development Goals (SDGs)

- 17 Sustainable Development Goals (SDGs) to accomplish by 2030.
- Three dimensions: economic, social and environmental.
- Keys issues: sustainable energy, eradicating extreme poverty, gender inequality, climate change and environmental degradation.
- SDGs and the Paris Climate Agreement (2016): two key international tools to re-think sustainable development.

Task Force on Climate-Related Financial Disclosures (TCFD)

- Established by the Financial Stability Board, intends to tackle the issue of how the financial sector can address climate-related risks through better disclosure, and to support a more appropriate allocation of capital in the global economy.

Credit Ratings Agencies (CRAs)

- High-Level Expert Group (HLEG): identifies the importance for credit ratings agencies (CRAs) to take a long-term ESG credit risk approach in credit risk analysis and claims that the CRAs currently fail to adequately incorporate long-term risks, including ESG impacts on risk analysis.
- HLEG highly criticizes the short-term perspective CRAs use in their credit risk and propose a longer horizon to consider more long-term factors which may not be evident in the short-term but could increase risks in a broader view.

1.2 HOW ABOUT (VERY) LONG-TERM SOVEREIGN RISK?

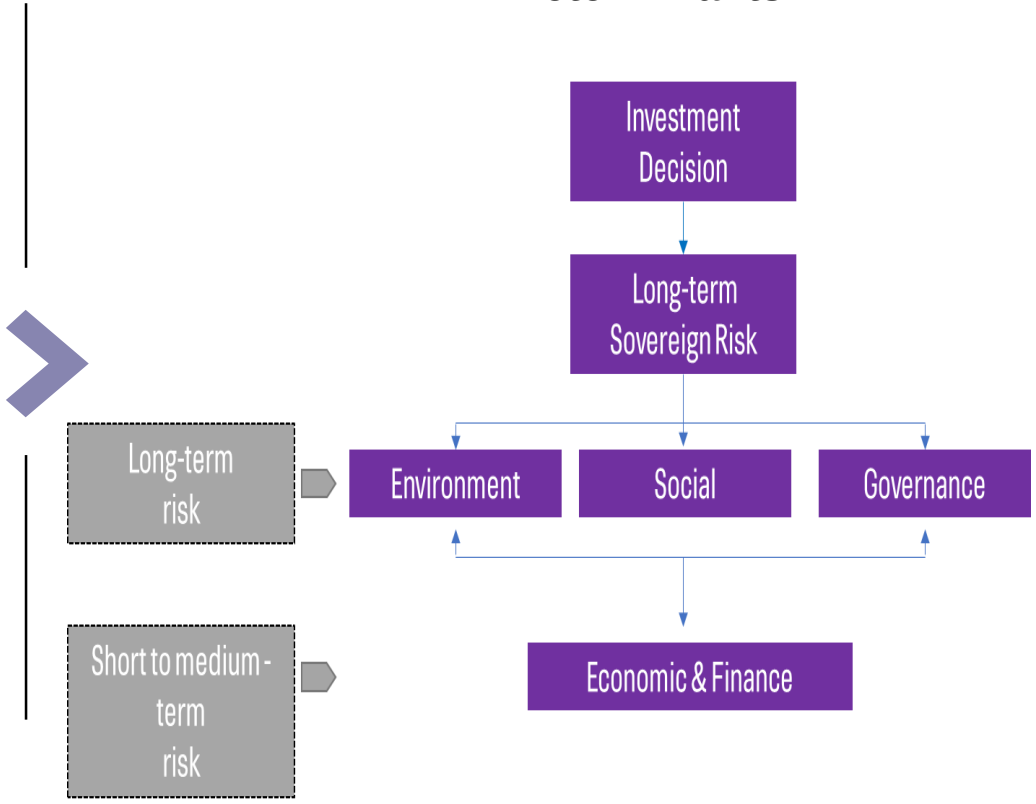
Towards to a very long-term sovereign risk

- BR believes that it is now very important to assess ESG performance in sovereign risk analysis and offers answers to the following question:
- How do ESG factors affect the long-term structure of economies?

Fundamentals

- In this framework, very long-term sovereign risk (10 – 15 years) could be defined as a function of three main fundamentals: environmental, social and governance performance. These fundamentals also explain how economies could perform and react to shocks in the short- to medium-term.

Figure 1. Sovereign Risk Determinants

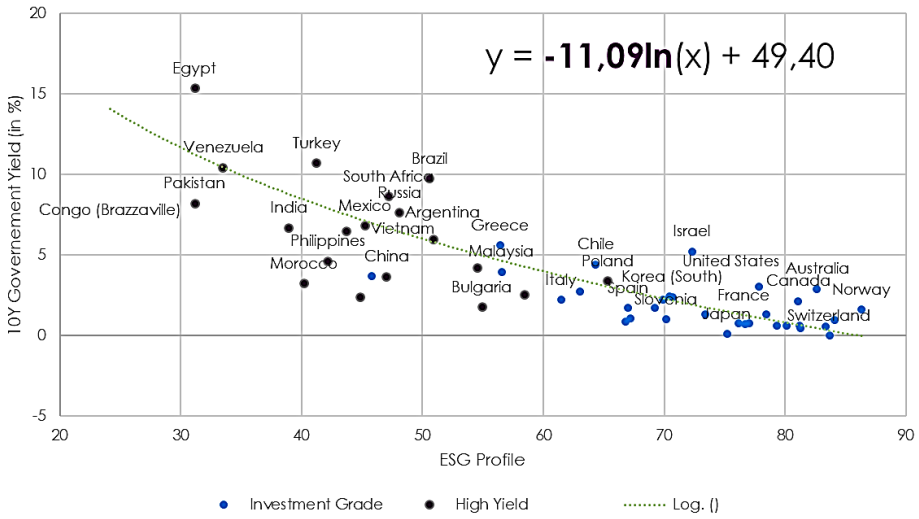


1.3 ESG PERFORMANCE CAN HELP EXPLAIN SOVEREIGN RISK

There is a negative relationship between countries' ESG profile and long-term sovereign yields

- Governments with weak ESG profiles present a higher risk of sovereign default, and vice-versa
  - Governance performance has immediate credit implications and policy issues with long-term economic and investment impact.
  - Countries with weak social performance are often more prone to shocks from social events, leading to a greater sovereign risk.

Figure 2. ESG profile vs 10y Government yield (Q4 2017)



1.4 HOW ABOUT BEYOND RATINGS ESG PROFILE?

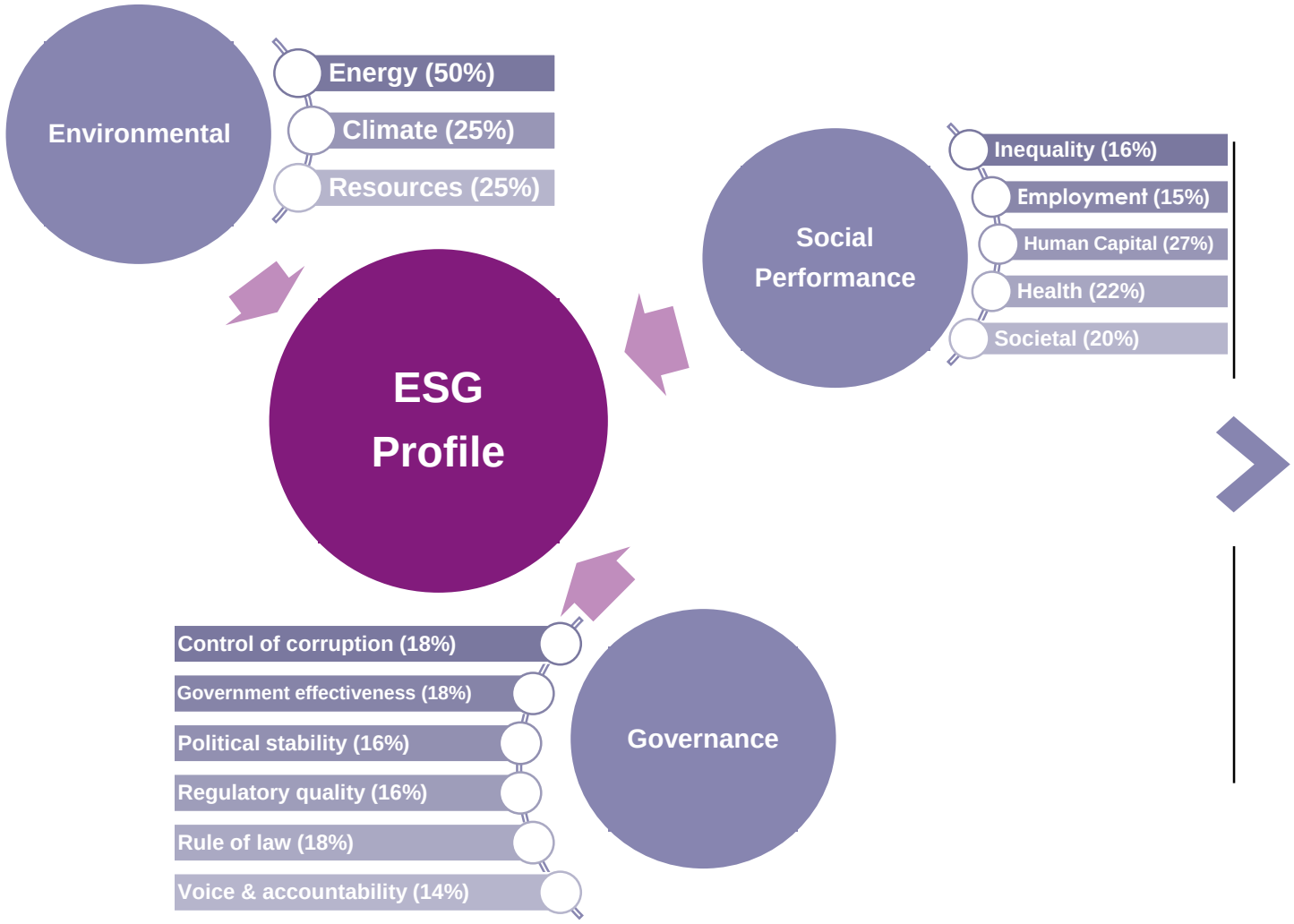
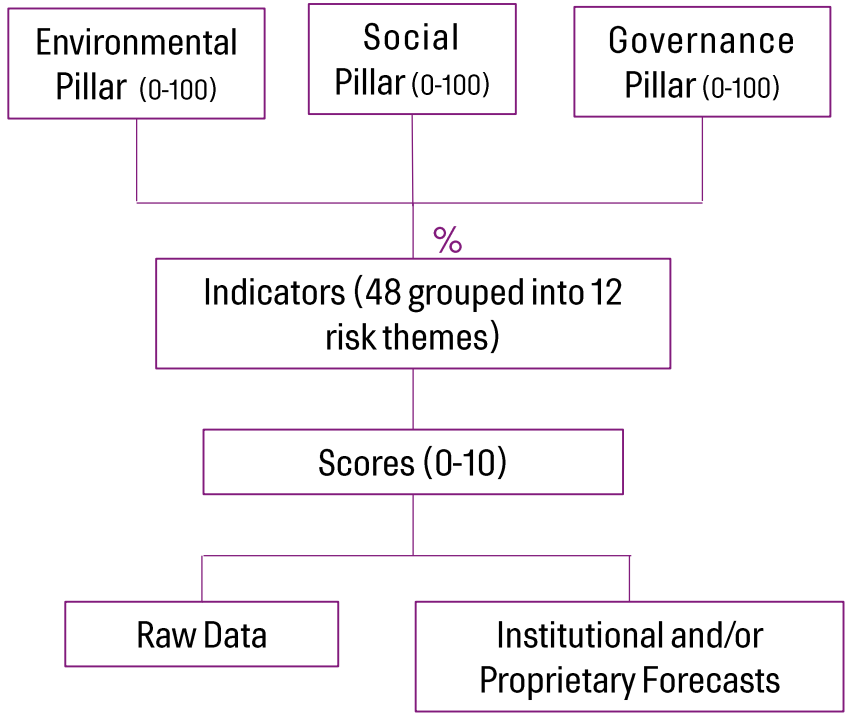


Figure 3. Bottom-Up model for ESG Sovereign Rating Methodology



2

AN INNOVATIVE COUNTRY CLUSTERING BASED ON ESG BEHAVIOR OF COUNTRIES

2.1 ESG COUNTRY CLUSTERING

Hierarchical Ascendant Classification (HAC)

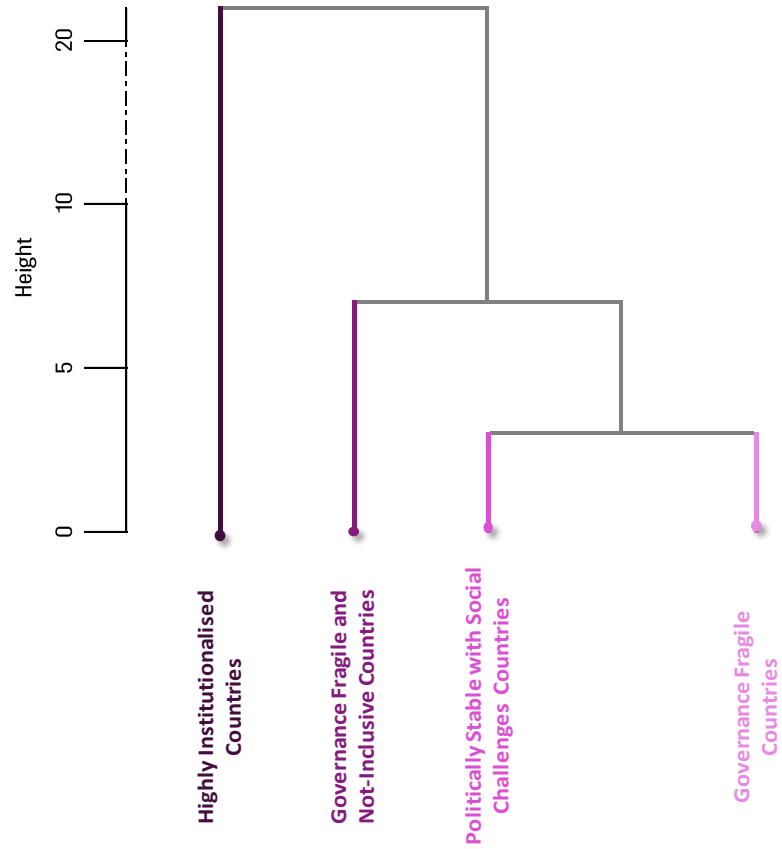
- This methodology is useful to identify clusters.
- In our case, observations (x_{it}) are scores that belong to a country i in a period t.
- Distances are measured according to the Ward methodology which minimize the distance between two clusters in each iteration.
- Ward's method defines the distance between cluster (K) and cluster (L) as follows:

$$D_{kl} = \frac{\|\bar{x}_K - \bar{x}_L\|^2}{\frac{1}{N_K} + \frac{1}{N_L}}$$

- Consequently, and after to identify the optimum number of cluster, we apply K-means algorithm to allocate each observation into the nearest cluster.
- The algorithm starts with initial estimates for the K centroids and then assign data to the nearest centroid based on the squared of the Euclidean distance:

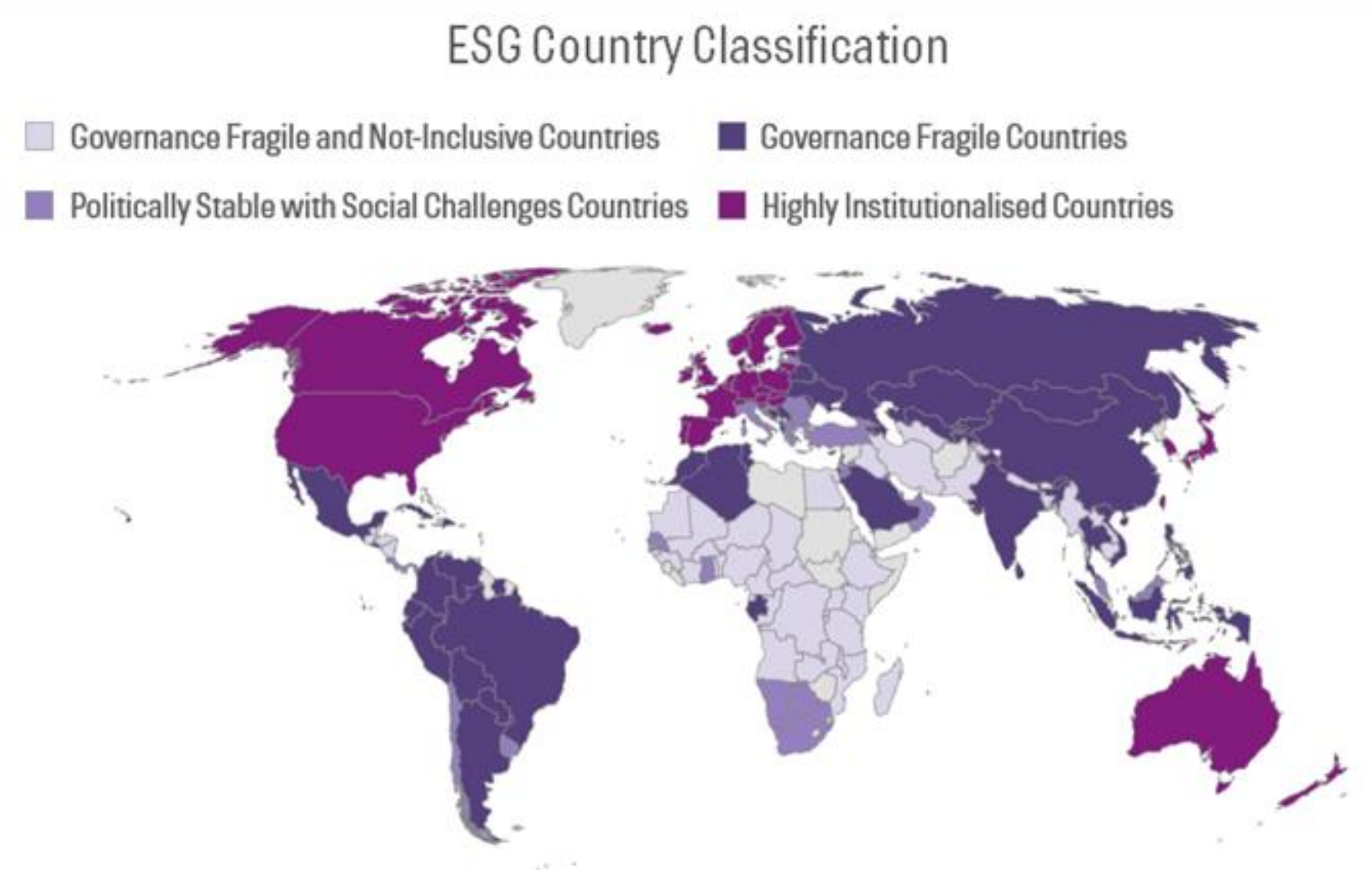
$$arg \min_{c_i \in C} dist\ (c_i, x)^2$$

Figure 4. ESG Clustering Results for 146 Countries



Note: Height is captured by the total within-cluster sum of squares error (SSE) in the original dendrogram.

2.1.1 ESG COUNTRY CLUSTERING IDENTIFICATION



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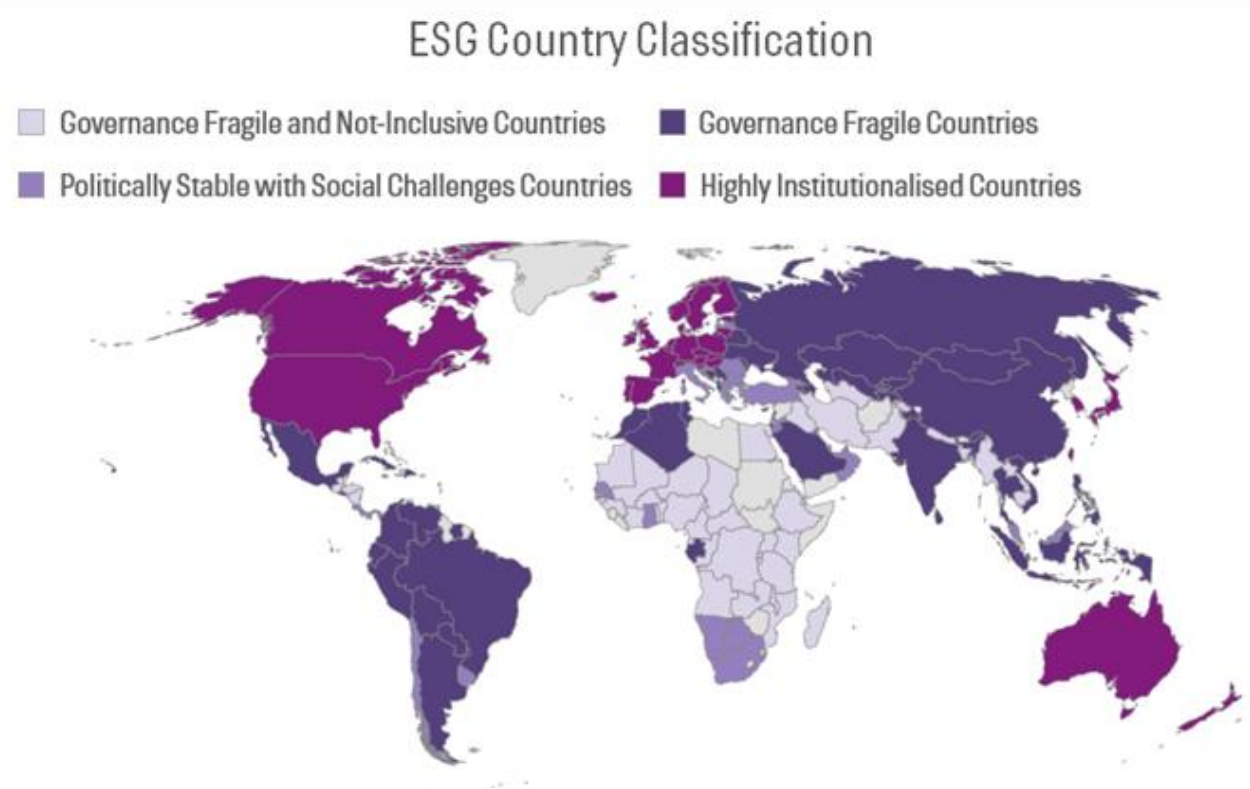
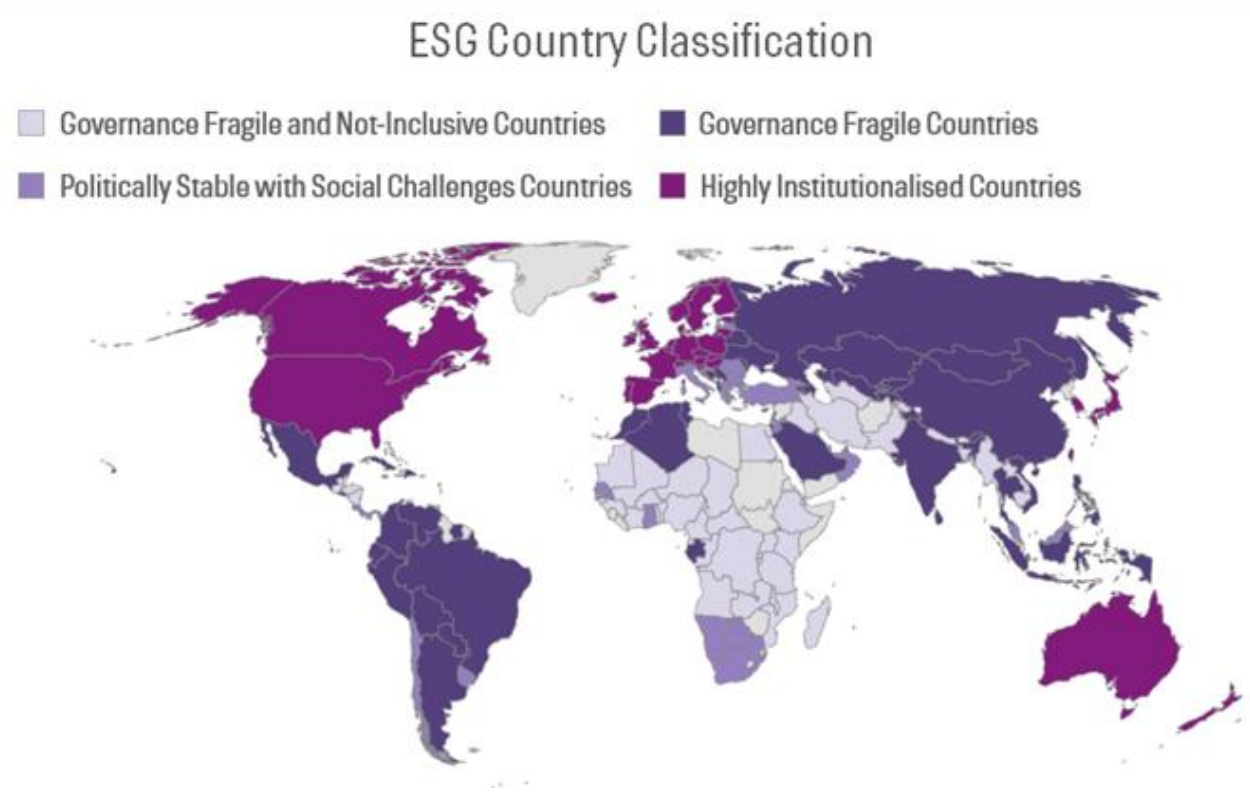


Governance Fragile and Not-Inclusive Countries

- This group is composed of 39 countries and it is characterized by its lowest governance and social performance. Nevertheless, the heterogeneity in the governance score seems to be important.
- Eleven outstanding countries can be identified in this group. These countries are characterized to be more politically stable and they perform better in terms of governance measures.
- Furthermore, social performance features considering inequality and employment are discriminant within this group. The clustering analysis into social components differentiates this cluster into 2 sub-groups .
- Finally, countries in this group are the most exposed to climate risk, including precipitation and temperature trends. In fact, many countries from Sub Saharan Africa are included in this group, this being one of the most vulnerable regions in the world in that respect

2.1.2 COUNTRY CLUSTERING IDENTIFICATION



Governance Fragile Countries

- It includes 42 countries.
- The second-stage HAC applied to the governance aggregated score cuts this group into three sub-groups.
- The first one embodies the least performant countries in terms of rule of law. Countries which have centralized political administration are present in this cluster.
- The second sub-group is the most exposed to political risk.
- Finally, the third sub-group is composed of countries that struggle with control of corruption but are relatively well positioned in terms of political stability, explaining their position in a separate group.
- Social risk is also highly important. The main concern comes from human capital and societal. Inequality is still a risk in a sub-group of 30 countries, as this component is relatively high in 12 of them.
- Environmental performance is pushed up by energy policy (energy independency and low fossil fuel risk). The least performant environmental component is natural resources.

2.1.3 COUNTRY CLUSTERING IDENTIFICATION

Politically Stable with Social Challenges Countries

- Some OECD countries are found here, as for example, Chile, Greece, Italy, Latvia and Turkey. However, a deep analysis into governance components is useful to distinguish a sub-group of 11 countries that are less governance performant, especially in terms of control of corruption.
- Governance does not represent a risk for this group as it could for social performance. Human capital, measured as the efforts a state makes in education and R&D and health care provision, is still low, especially in 19 countries.
- Finally, environment performance is still good. Energy risk is controlled for some countries that do not have oil fossil fuels. Also, the climate risk is controlled as the natural resource risk is.

2.1.4 COUNTRY CLUSTERING IDENTIFICATION

Highly Institutionalized Countries

- This country group (35) is characterized by a high governance score followed by a high social performance.
- Environmental performance is enhanced by their better practices in managing their natural resources (high water productivity and low levels of air pollution).
- Furthermore, these countries are not so exposed to climate risk (physical and transitional) given their outstanding infrastructure and environmental policies. Nevertheless, energy policy – measured as their energy independence – is not significant, meaning that they must be more efficient or move faster to renewable energies.

3

A GENUINE LINK BETWEEN ESG FACTORS AND SOVEREIGN RISK

3.1 DETERMINING LONG TERM RELATIONSHIP

Methodology

- To measure the long-term relationship we use an Auto Regressive Distributed Lag (ARDL). This model is appropriate to identify the long-term relationship between a set of explicative variables and a dependent variable, when both follows a non-conventional cointegration form (See Appendix 3 for more detail).

- It is called Auto regressive model since the dependent variable follows an autoregressive process, meaning that one part of its future value will depend on its own past values. It is called Distributed Lag because it includes not only explanatory variables in levels but also its lagged values.

- A simple way to represent an ARDL(p,q):

$$Y_t = f(X_t, Y_{t-p}, X_{t-q}) \qquad (1a)$$

$$Y_t = \varphi + \sum_{i=1}^{p} \alpha_i Y_{t-i} + \sum_{j=0}^{q} b_j X_{t-j} + e_t \quad \text{where: } e_t \sim iid\ (0, \sigma) \qquad (1b)$$

- The short-term effect is measured by (b_0), and the long-term effect could be calculated by ϕ if we consider the next long-term relationship :

$$Y_t = \kappa + \phi X_t + u \qquad (2)$$

$$\phi = \frac{\sum b_j}{(1 - \sum \alpha_I)} \qquad (3)$$

3.1.1 DETERMINING LONG TERM RELATIONSHIP

Times Series specification Model

- At first step we used three case study to test ARDL model: Germany, United States and Italy.

- We use the 10 years nominal yield as a proxy of long-term sovereign risk. As a control variable we use the monetary rate. Explanatories variables are the ESG performance.

- ARDL specification (Table 1) shows the lagged values of the dependent variable and the regressors.

- Cointegration bounding test was used to identify long-relationship between the analyzed variables.

- Residuals and coefficients diagnostic, and model specification test were used to test the robustness of the model.

- The overall model was compared with the real data to know if the forecast predicted is correct according to the data

Table 1 . ARDL (p_y,q_{env},q_{soc},q_{gov}) model lags specification

Country	Nominal Yield	Environment	Social	Governance
Germany	1	7	1	4
United States of America	2	0	0	2
Italy	1	0	0	0

Table 2. Levels Equation and Cointegration coefficient

Country		Coefficient
Germany	Cointegration	-0.5808***
	Environment performance	0.0436***
	Social performance	-0.4002***
	Governance risk	0.3236***
United States of America	Cointegration	-0.6030***
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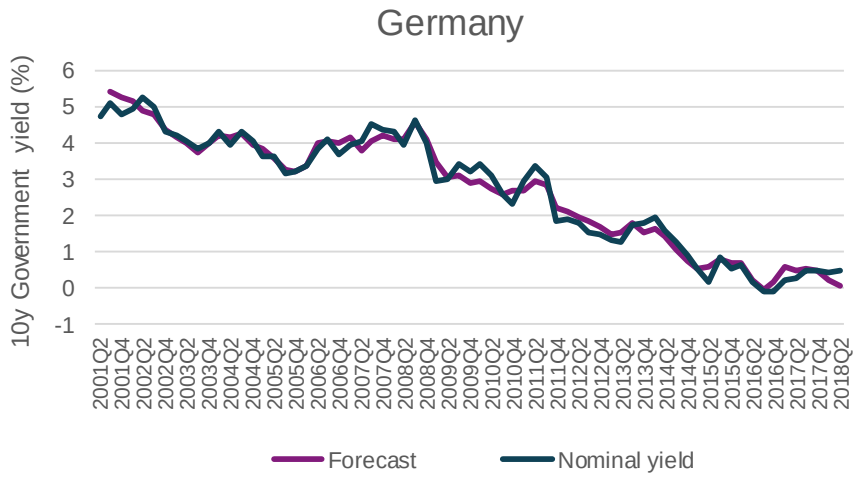
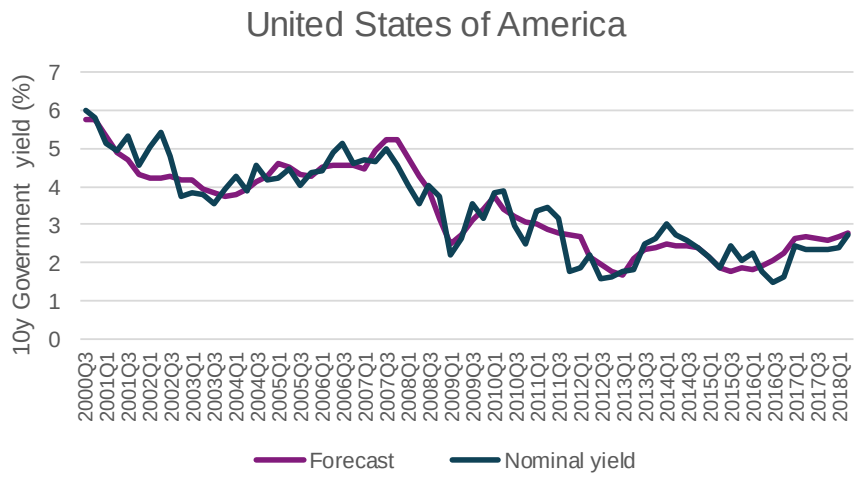
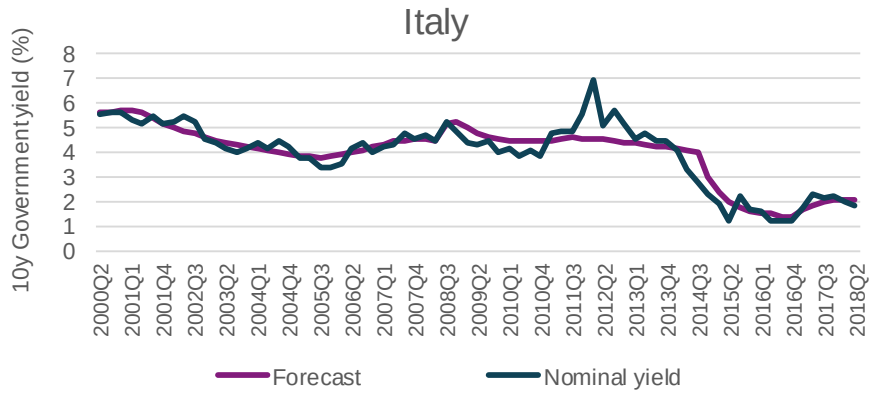
	Social performance	0.0803
	Governance risk	0.0686
Italy	Cointegration	-0.4051***
	Environment performance	0.0147
	Social performance	-0.0905
	Governance risk	0.0928

1/ Levin, Lin and Chu statistic (LLC) and Im, Pesaran, Shin (IPS) statistic of unit root

3.1.2 CASE STUDY RESULTS







3.1.1 DETERMINING LONG TERM RELATIONSHIP

Panel Specification Model (in progress)

- One advantage to use panel data is that it captures more information than a solely country times series analysis.

- ESG Country HAC classification was used to form four short panel data sets with *N* countries in *T* periods. By doing this, we solved in a large extend problems related with heterogenous panel.

- We use the 10 years nominal yield as a proxy of long-term sovereign risk. As a control variable we use the monetary rate. Explanatories variables are the ESG performance

$$Y_{it} = \varphi + \sum_{J=1}^{p} \alpha_i Y_{it-j} + \sum_{l=0}^{q} b_j X_{it-l} + e_{it} \qquad (4)$$

- Where Y_{it} is the 10y nominal yield, matrix X includes the environmental risk (E_{it}), social performance (S_{it}) and governance performance (G_{it}).

Short panel data composition and Co-integration analysis

Panel	Issuer countries over total	Periods (Quarterly)
Highly institutionalized countries	34/35	68
Governance fragile and not-inclusive countries	7/39	68
Politically stable with social challenges countries	10/30	68
Governance fragile countries	14/42	68

[1/] Levin, Lin and Chu statistic (LLC) and Im, Pesaran, Shin (IPS) statistic of unit root

4

CONCLUSION

4.1 CONCLUSION AND FURTHER DEVELOPMENTS

Main results

- BR proposes four country groups according to their environmental, social and governance performance, and are characterized as: (i) Highly Institutionalized, (ii) Governance Fragile and Not-Inclusive, (iii) Politically Stable with Social Challenges and (iv) Governance Fragile countries.
- Governance and social performance are highly important discriminant factors that determine these clusters. However, environmental performance, analyzed by its components, gives important additional information, but is not as discriminating as the two previous factors.
- This result could be given by the triple target of this feature: risks related to natural resources, energy policy risks and climate change risks. On one hand, countries with relatively good institutions and social performance will better manage their natural resources and thus will be less vulnerable to climate change risk. However, energy policy risk (included better use of renewable resource) is still a challenge.
- The first econometrics results show that there is exist a long-term relationship between the 10y government yield and the ESG performance.

Further developments

- Measure the long-term relationship taking into account country group classification to better understand the importance of ESG.
- Pass from a retrospective analysis to a predictive score analysis.

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APPENDICES

Technical References

A.1 APPENDIX 1: SOVEREIGN RATING METHODOLOGY

Z-scores

- For each variable $X_{t,i}$ with t period time and i country, the z-score is denoted as:

$$z\text{-}score_{X_{t,i}} = \frac{X_{t,i} - \overline{X_t}}{\sigma_{X_t}}$$

- Z-score allows us to compare a specific country with respect to others by giving a value between 0 to 10 to a specific variable after a normal distribution transformation.
- Three forms of distribution are used, where the optimum is: i) the maximum value, ii) the minimum value, iii) average value.

Indicators to pillars

- As some variables are correlated, we use Partial Least Squares (PLS) regressions. This econometric framework (Wold,1960) allows the construction of predictive models in the presence of many correlated independent variables.

$$Y = \alpha + \sum_{j=1}^{N} \beta_j X_j + \epsilon$$

- To find the optimal weights of each indicator we use the Variable Importance in Projection (VIP) score, which is the summary of the importance of each indicator in finding the components of the X matrix.

A.2 APPENDIX 2: PANEL UNIT ROOT ANALYSIS

Levin, Lin and Chu (LLC) panel unit root (common UR)

- Levin *et al* (2002) test depends on the pooled data

$$y_{it} = \rho_i y_{i,t-1} + z'_{it}\gamma + u_{it}$$

- Where z_{it} is the deterministic component and u_{it} is the error term which follows a stationary process and $u_{it} \sim iid\ (0, \sigma^2)$; Coefficient $\rho_i = \rho$ for all values of *i*.
- The null hypothesis is $H_o: \rho_i = 1$ meaning that all series have UR. In contrast, $H_1: \rho_i < 1$ means that all series are stationary.

Im, Pesaran,Shin (IPS) panel unit root (individual UR)

- Im *et al* (2003) test takes the average of individual unit root ADF statistics. It is similar to test UR for all cross-section units and it allows for heterogeneity both in intercept and slope terms in cross- section.

$$y_{it} = \rho_i y_{i,t-1} + \sum_{j=1}^{\rho_I} \phi_{IJ}\, \Delta y_{i,t-1} + z'_{it}\gamma + \varepsilon_{it}$$

- The null hypothesis is $H_o: \rho_i = 1$ meaning that all series have UR. In contrast, $H_1: \rho_i < 1$ means that all series are stationary.
- It is possible that panel data has not pooled UR but individual UR in the presence of cross-section dependence problems (regional and macroeconomic links, unobserved common factors, externalities).
- When results are not conclusive about the presence of UR between different variables, it is not possible to follow a standard OLS model. One appropriate methodology that tackled this issue is panel ARDL models.

A.2 APPENDIX 2: PANEL UNIT ROOT ANALYSIS

Stationarity test by country group

- Five panel UR test in EVIEWS10 were used: Levin, Lin and Chu (LLC), Breitung t-stat, Im, Pesaran, Shin W-stat (IPS), ADF-Fisher Chi-square and PP-Fisher Chi-square. The most used test in the literature are LLC and IPS.
- Table 1 shows that some variables are I(0) meaning that they are stationary at levels while other variables are I(1) meaning that they are stationary of order one.

Table A1. Panel Unit Root Results

Variables	HIGHLY INSTITUTIONALISED				GOVERNANCE FRAGILE AND NOT-INCLUSIVE COUNTRIES				POLITICALLY STABLE WITH SOCIAL CHALLENGES COUNTRIES				GOVERNANCE FRAGILE COUNTRIES			
	Individual Intercept		Individual effects & linear trends		Individual Intercept		Individual effects & linear trends		Individual Intercept		Individual effects & linear trends		Individual Intercept		Individual effects & linear trends	
UR Statistic ->	LLC	IPS	LLC	IPS	LLC	IPS	LLC	IPS	LLC	IPS	LLC	IPS	LLC	IPS	LLC	IPS
Nominal Yield	I(0)	**I(1)**	I(0)	I(0)	**I(1)**	I(0)	**I(1)**	**I(1)**	**I(1)**	**I(1)**	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)
Environment	I(0)	I(0)	I(0)	I(0)	**I(1)**	**I(1)**	**I(1)**	I(0)	I(0)	I(0)	I(0)	I(0)	**I(1)**	I(0)	**I(1)**	I(0)
Social	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	**I(1)**	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)
Governance	I(0)	I(0)	I(0)	I(0)	**I(1)**	**I(1)**	**I(1)**	I(0)	I(0)	I(0)	**I(1)**	I(0)	I(0)	I(0)	I(0)	I(0)
Monetary rate	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	**I(1)**	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	**I(1)**	I(0)

No conclusive results for unit root test. OLS are not appropriate.

A3. APPENDIX 3: TIME SERIES AUTOREGRESSIVE DISTRIBUTED LAG (ARDL)

Times series UR analysis with breaking points – Germany, United States of America and Italy

Three countries were selected to analyze the possibility of structural change in all variables to confirm if the conventional UR analysis is not biased (Table A2).

Since the current test of UR with breaking points (BUR) allows us to determine the initial point of the structural change but not give us the duration period, we use sub-sample to test BUR in order to know if breaking points stay until the last analyzed period.

ARDL specification

After BUR test and the identification of the structural change periods for each variable, we introduce a set of dummy for each breaking point in order to better specify the ARDL model.

Monetary rate and break dummies were introduced as fixed regressors (control variables).

We use the Schwarz criteria to specified the number of lags of the dependent variable and regressors (Table A3).

Table A2. UR results with breaking points

Variables	Germany	United States of America	Italy
Nominal Yield	-4.4726	-4.2273	-4.0633
Environment	-3.8062	-4.6788	-3.6534
Social	-3.7704	-5.3920	-4.8117
Governance	-6.9937	-4.7474	-3.0375
Monetary rate	-4.3165	-5.8224	-4.3165

Significance	1%	5%	10%
ADF - statistic	-5.3476	-4.8598	-4.6073

Null hypothesis: Series has unit root.
Values bigger than critical values reject the null hypothesis

Table A3. ARDL model specification

Country	Nominal Yield	Environment	Social	Governance
Germany	1	7	1	4
United States of America	2	0	0	2
Italy	1	0	0	0

Note: Lags selection depends on Schwarz information criterion (SIC) after to analyze 13310 models

A3. APPENDIX 3: TIME SERIES AUTOREGRESSIVE DISTRIBUTED LAG (ARDL)

Residual Analysis

- In order to test for no-serial correlation, we analyze the Q-statistics for autocorrelation and partial autocorrelation and we apply LM test for no-serial correlation. If error terms are correlated, then the we cannot test the long-term relationship between variables.

- Furthermore, in order to identify no heteroskedasticity residuals, we applied the Breusch-Pagan-Godfrey test.

- We conclude that there is no serial correlation and no heteroskedasticity in the residuals.

Cointegration Test: Bound Test

- Pesaran et al (2001) propose a new approach to test the existence of the relationship between variables in levels that could be applied whether the regressors are purely I(0), purely I(1) or mutually cointegrated.

- Table 5 shows that results of the *F*-statistics applied to the correspondent ARDL model are greater than those of the critical values (Table 6) meaning that variables are cointegrated and **a long-term relationship exists between 10y yield and the regressor: environmental performance, social performance and governance risk.**

Table A4. Residuals Diagnostic

Country	Serial Correlation LM Test[1/]	*p*-values	Heteroskedasticity Test [2/]	*p*-values
Germany	1.629766	0.2073	1.080422	0.3999
United States of America	0.922183	0.4033	1.136603	0.3502
Italy	0.630284	0.5359	1.449471	0.1805

1/ Breusch-Godfrey. Null hypothesis of no serial correlation
2/ Breusch-Pagan-Godfrey. Null hypothesis of no heteroskedasticity
P-values less than (0,05) reject the null hypothesis

Table A5. Bound test coefficients

Country	F-statistic	T - statistic
Germany	12.97	-6.19
United States of America	9.13	-5.65
Italy	4,98	-4.13

Table A6. Critical Values

Significance	10%	5%	3%	1%
I(0) F-statistic	2.01	2.45	2.87	3.42
I(1) F-statistic	3.10	3.63	4.16	4.84
I(0) t-statistic	-1.62	-1.95	-2.24	-2.58
I(1) t-statistic	-3.00	-3.33	-3.64	-3.97

Pesaran et el. 2001. Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*

A3. APPENDIX 3: TIME SERIES AUTOREGRESSIVE DISTRIBUTED LAG (ARDL)

Long-Term Relationship (Conditional Error Correction Model)

- Given a long-term relationship in levels we analyze the cointegration coefficient and the level relationship between variables for each country study.

- Cointegration coefficients are negative and they are significantly at 1% meaning that there is a significant long-term relationship.

- Levels equation coefficient for environmental performance, social performance and governance risk are significant for Germany. In the case of United States of America, only environmental performance is significant and for Italy, any coefficient is significant.

- ECM are projected after this analysis.

Table A7. Levels Equation and Cointegration coefficient

Country		Coefficient	Significance
Germany	Cointegration	-0.5808	***
	Environment performance	0.0436	***
	Social performance	-0.4002	***
	Governance risk	0.3236	***
United States of America	Cointegration	-0.6030	***
	Environment performance	-0.1884	***
	Social performance	0.0803	
	Governance risk	0.0686	
Italy	Cointegration	-0.4051	***
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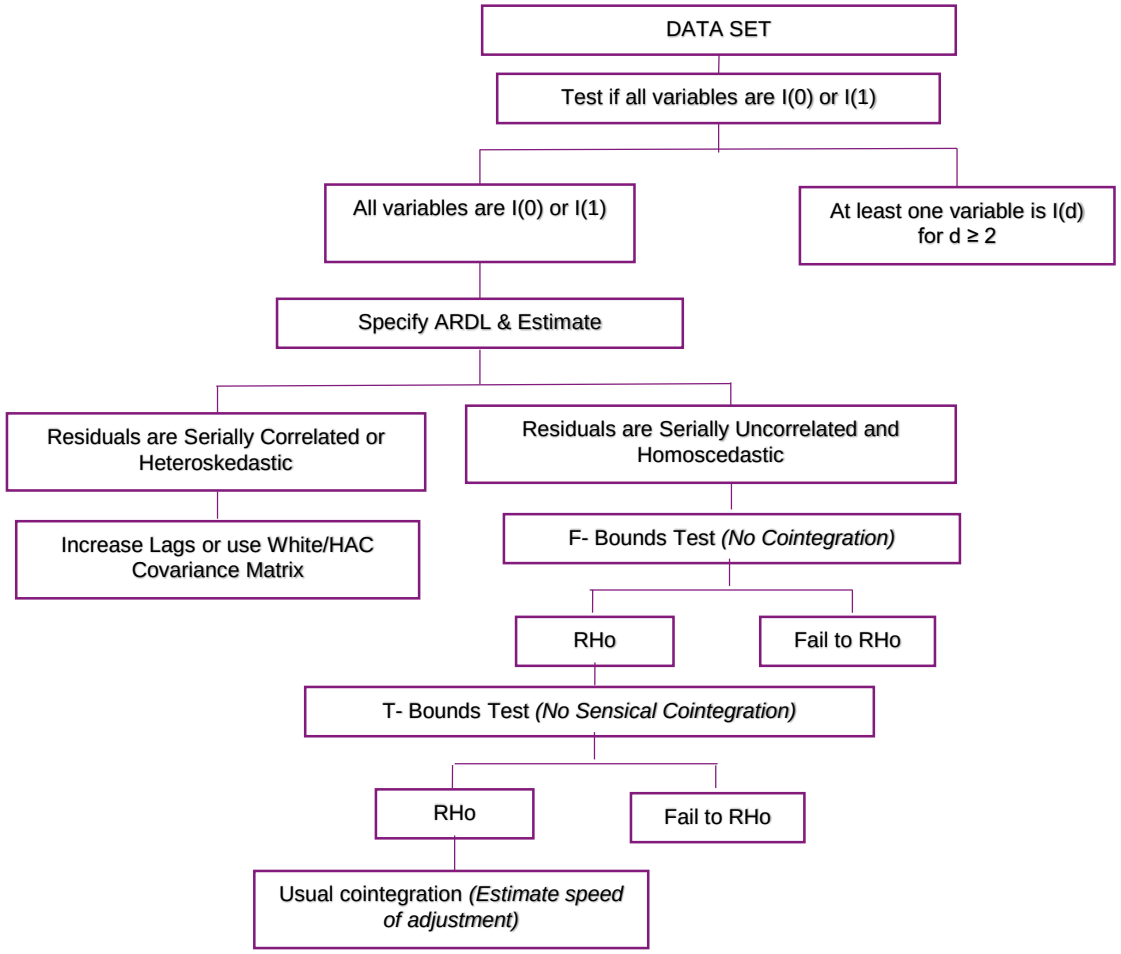
A3. APPENDIX 3: AUTOREGRESSIVE DISTRIBUTED LAG (ARDL)



Methodology [1/]

- Get a feel for the nature of the data.
- Ensure all variables are integrated of order I*(d)* where *(d)* is less than one.
- Specify how deterministic enter the ARDL model.
- Determine the appropriate lag structure of the model selected.
- Estimate the model using Ordinary Least Squares (OLS).
- Ensure residuals are serially uncorrelated and homoscedastic.
- Perform the Bounds Test.
- Estimate speed of adjustment.

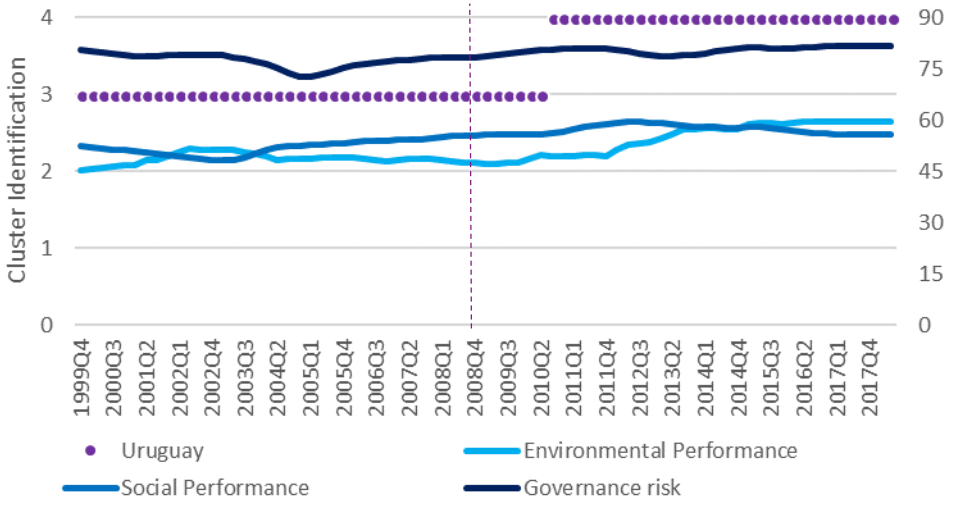
[1/] Source: www.eviews.com

A.4 APPENDIX 4: HIERARCHICAL ASCENDANT CLASSIFICATION

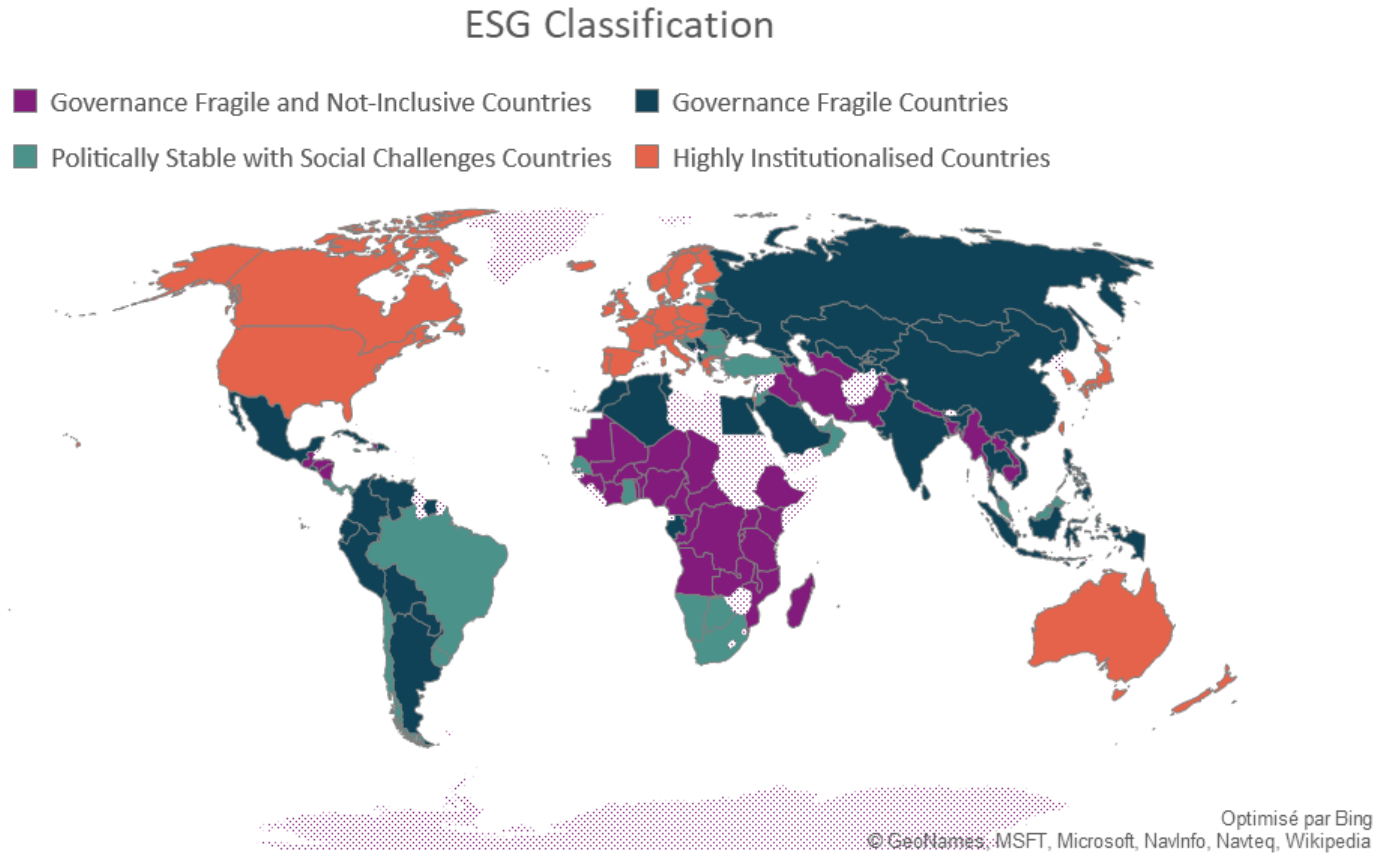
- Uruguay has substantially performed its ESG indicators in the last years. To classify countries which have moved from one cluster to other, we use a weight average value to have the last classification.

4	Highly Institutionalized Countries
3	Politically Stable with Social Challenges Countries
2	Governance Fragile Countries
1	Governance Fragile and Not-Inclusive Countries

Figure A1. Uruguay: Politically Stable with Social Challenges Countries



A.4 APPENDIX 4: HIERARCHICAL ASCENDANT CLASSIFICATION



Note: This classification takes into account the median of the cluster belonging among the period analyzed.

HAC classification changes if we use the median value