Methodology

Sustainable Sovereign Risk Methodology

v1.1

October 2024

Contents

ESG integration into sovereign risk analysis

1. Introduction

The Sustainable Sovereign Risk Methodology (2SRM) has been built on the Sovereign Risk Monitor (SRM)[1] to respond to increasing market maturity, customer needs and the World Bank and International Monetary Fund recommendations[2].

2SRM is a quantitative, relative and systematic approach, based on 36 indicators for 151 countries, divided into three pillars of sustainable sovereign risk assessment.

LSEG calculates a score on a quarterly basis for each indicator, starting from 1999 until the end of the latest quarter. Each of the 36 indicators is the outcome of numerous adjustments – systematic to a large extent – based on public, private and proprietary data.

All indicators are combined at (i) a risk theme level and (ii) a pillar level to obtain an aggregated score, which is derived from advanced statistical and econometric techniques.

Finally, the scores are aggregated from each pillar to obtain an aggregated ESG score.

2SRM focuses on financially material ESG metrics. It is thus best adapted for use as an input[3] and as a complement to traditional macroeconomic and financial analysis to quantify and better assess portfolio risk-return profiles.

1.1 The scoring framework

2SRM relies on the quantitative assessment of Environmental (E), Social (S) and Governance (G) pillars which characterise sovereign creditworthiness. Each pillar is structured around sub-pillars, which consist of several risk themes that include several indicators (see Figure 1).

The Environmental Pillar, for example, is represented by three sub-pillars: Energy, Climate and Natural Capital. The Energy sub-pillar is consequently made up of three risk themes: Energy Policy, Low-Carbon Energy and Energy Independence. The Energy Policy risk theme is composed of two indicators: Electricity Access and Energy Consumption. The quantity of indicators varies from one risk theme to another, but on average, they range between two and four.[4]

[1] For more details, refer to the Sovereign Risk Monitor Methodology.

[2] For more details on World Bank and International Monetary Fund recommendations, please refer to Demystifying Sovereign ESG and Sovereign Environmental, Social, and Governance (ESG) Investing: Chasing Elusive Sustainability.

[3] For more details on a recommended framework for Sovereign ESG investing, refer to Beyond risk management: can Sovereign ESG data drive impact investing?

[4] Please see Appendix 1 for the detailed list of the raw data used.

Figure 1. The 2SRM framework

Source: LSEG Sovereign Sustainability.

1.2 The relative and systematic quantitative framework

1.2.1 Assembling raw data

The 2SRM ingests data from several sources. These include proprietary data and public data[5]. Both sets of data are handled by a data manager, who specialises in receiving, validating and storing all raw data. The data manager keeps a schedule of when all raw inputs are updated and when they should be validated. In this way, it is assured that each update of 2SRM has the latest available data. The 2SRM inputs are gathered every January, April, July and October for the model's quarterly updates.

When datasets are updated, the manager goes through a validation process. They verify that all previously available data points are available or not, as for some countries or time periods, some data points are lost or added. This also includes the verification of null values. Along with this, the manager will verify how values have evolved. Using quantitative rules, maximum thresholds for change will be calculated for each indicator type and these will be used to accept or reject new values.

When a value is not accepted, be it because its change goes beyond the maximum threshold or because the evolution seems erroneous, the value will be flagged, and the subject-matter-experts (SMEs) will be made aware

[5] For all sources, please refer to Appendix 1.

to review the data point. In these cases, the raw data values may be either overruled, whereby the new value will be replaced by its previous one, or it may be accepted, and the new value will be integrated in the database. All changes to raw data points are very carefully analysed and documented by both the manager and the SMEs, keeping in mind the impact these may have on final scores and its users. These processes also apply to LSEG's proprietary data, where the inputs and outputs of intermediary models are validated equally (see Appendix 2 for further details).

The final check, before being ingested by the 2SRM model, includes a verification that all the necessary data for the 151 countries, years (since 1999) and 36 total indicators concerned is available.

1.2.2 From raw data to indicators

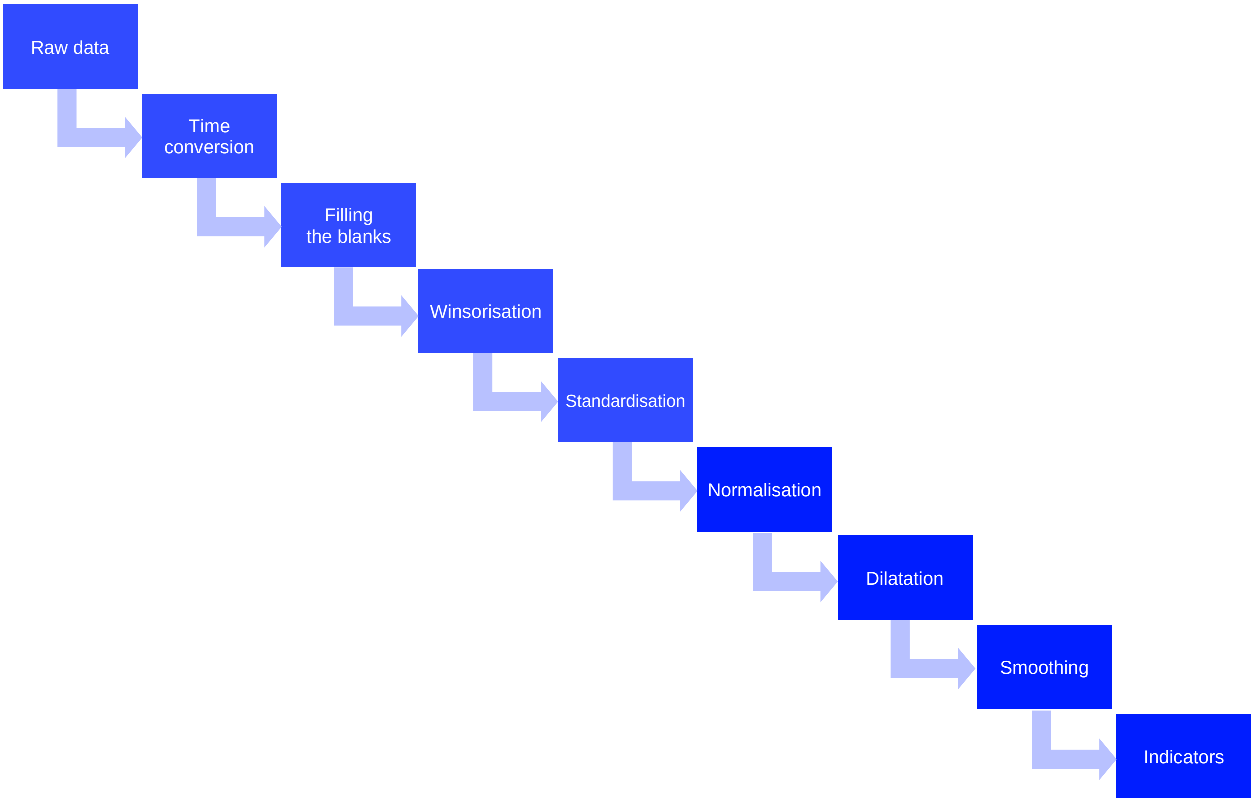
Figure 2 illustrates the general framework through which LSEG Sovereign Sustainability transform raw data into indicators.

Time conversion

Raw datasets are received on an annual basis. As 2SRM provides scores on a quarterly basis, annual values will be attributed to the fourth quarter of a given year, which is followed by a linear interpolation between every current fourth quarter and the fourth quarter of the previous year. When the data gap is larger than the difference between two consecutive fourth quarters, the linear interpolation will only be performed for the first, second and third quarter of the given year and the fourth of the previous year. Remaining gaps will not be filled at this stage.[6]

[6] The Implied Temperature Rise (ITR) indicator will, however, be backward filled for the whole time series of every country as it is a forward-looking indicator which is not recorded historically.

Figure 2. From raw data to indicators



Source: LSEG Sovereign Sustainability.

Filling the blanks

All indicators have different levels of coverage. For some indicators, data may be widely available across all countries for which a country score is produced, but not necessarily over the entire data set since 1999. In instances where an indicator is unavailable, the following approach is followed:

i. In the event that an indicator value is missing at the beginning of the time series, the value is populated with the first available value. When values are missing at the end of the time series, values are populated with the last available value.

ii. In the event that an indicator value is missing at some point in time during the history of the time series (encircled by available values), a linear interpolation is used to derive the missing values.

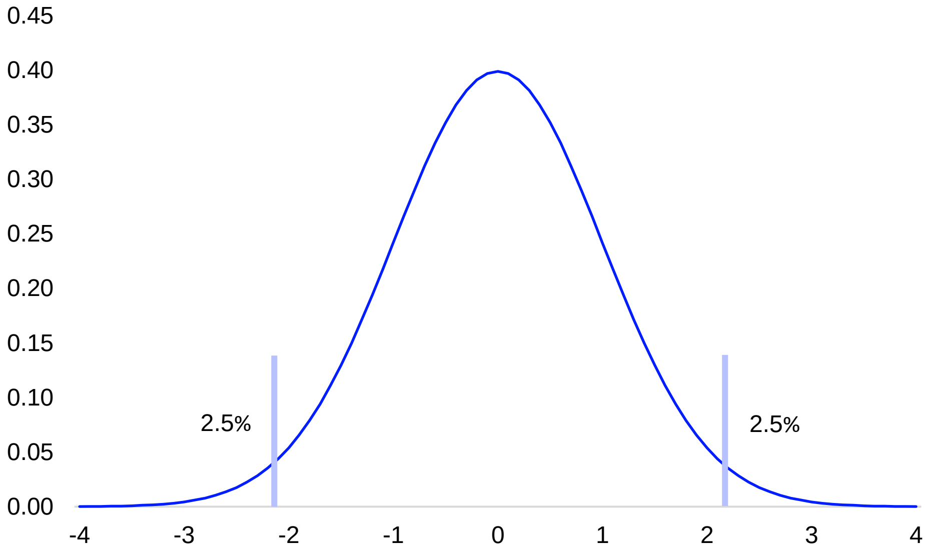
iii. In the event that an indicator is missing for the entire time series for a given country, the World Bank group average value will be attributed: for each year and KPI, the average value by country income groups, according to the World Bank Income Group's country classification[7], is calculated. World Bank Income Groups are defined as: low income, lower-middle income, upper-middle income, and high income countries. In the event that a change of income group occurs, the average of this new income group is taken from the year of the change of group.

Winsorisation

To minimise the impact of potential outliers, all indicators are corrected for extreme values that are higher than the 97.5th percentile or lower than the 2.5th percentile of the distribution (see Figure 3).

[7] For more details on the World Bank country and lending groups using the World Bank Atlas method, please see World Bank Country and Lending Groups – World Bank Data Help Desk.

Figure 3. Standard distribution curve: Winsorisation process



Source: LSEG Sovereign Sustainability.

Standardisation

With the exception of the indicators noted below, indicators are transformed into z-scores[8] for each country, by year and quarter. This allows to assess the relative risk linked to the initial data and corrects for data scaling.

There are four indicators or families of indicators that are not winsorised and standardised – the World Governance Indicators produced by the World Bank, the Red List Index provided by the Sustainable Development Goals Database, the Physical Risk indicators and the Implied Temperature Rise indicator developed by LSEG Sovereign Sustainability – these indicators go through a standardisation process during production.

Normalisation

The z-scores are transformed into continuous scores on an interval, ranging from 0 to 1[9] in accordance with the cumulated distribution of a standard normal distribution – where 0 represents the worst score and 1 the best score.

Two different cases provide the framework for these additional adjustments:

i. When the optimum is a maximum, the higher the value for the data, the higher the value of the corresponding z-score, and the higher the indicator (see Figure 4 on the left-hand side).
ii. When the optimum is a minimum, the lower the value for the data, the lower the value of the corresponding z-score, and the higher the indicator (see Figure 4 on the right-hand side).

Dilatation

In order to maximise the discriminating power between sovereigns, a linear dilation is performed on all scores to ensure they range from 0 to 100[10]. This third phase allows to calculate scores (*i.e.*, indicators).

Smoothing

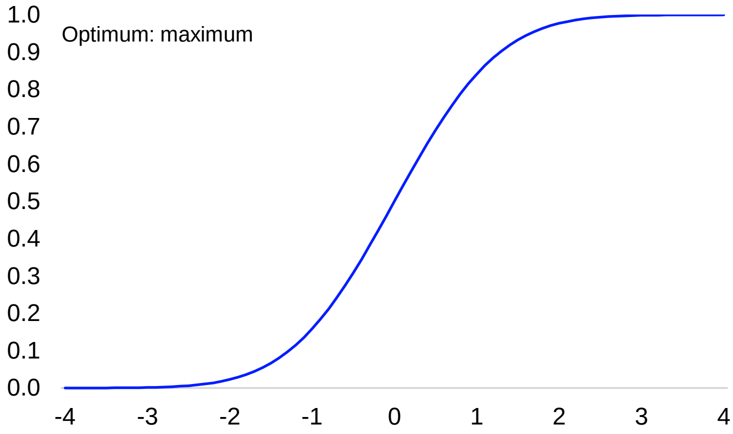
Finally, for every quarterly value for a given indicator and country, a smoothing process is applied. Following an exponential rule, different weights are applied to values in t, t-1, t-2 and t-3, with t being assigned the heavier weight and t-3 the lowest. This method accounts for fluctuations over the last four quarters and smoothing of potential one-off effects or erratic data.

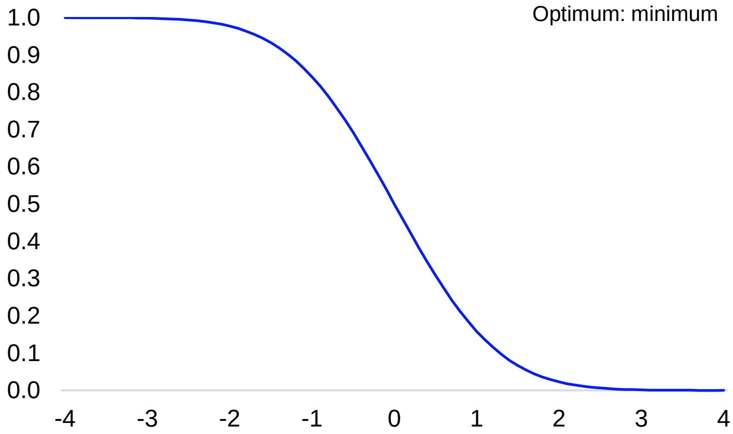
[8] For a raw datum denoted $X_{t,i}$ with t the date and i the country, $z\text{-}score_{X_{t,i}} = \frac{X_{t,i} - \overline{X_t}}{\sigma_{X_t}}$ with $\overline{X_t} = n^{-1} \sum_{j=1}^{n} X_t$ and $\sigma_{X_t} = \sqrt{(n-1)^{-1} \sum_{j=1}^{n} \left(X_j - \overline{X_t}\right)^2}$.

[9] The cumulated distribution of a standard normal distribution provides a value between 0 and 1 for a given z-score. This value is then multiplied by 100 for the needs of the model.

[10] The linear dilation formula is the following: $\hat{X}_{t,i} = \frac{X_{t,i} - \min_X X_t}{\max_X X_t - \min_X X_t}$.

Figure 4. Standard Normal Cumulative Distribution Function (x axis: z-scores; y axis: scores)





Source: LSEG Sovereign Sustainability.

1.2.3 Aggregation – From indicators to pillars

Figure 5 illustrates the systematic approach to assigning a score to a pillar based on its underlying indicators. The chart shows how the six indicators in the Governance pillar are aggregated to provide the Governance Pillar score, representing an approach that allows to derive a score in the form of a weighted average.

Accounting for the level of development

The relevance of each indicator in predicting the probability of default will depend on the level of economic development for every country. As a result, Advanced Economies (AEs), Emerging Markets and Developing Economies (EMDEs) are split, as defined by the International Monetary Fund's dynamic country classification,[11] to derive an indicator's weight for each group of countries. This means that indicators such as Poverty will be assigned a weight of 24.8% for AEs and 33.1% for EMDEs.

[11] The main criteria used by the IMF to classify the world into advanced economies and emerging market and developing economies are (i) per capita income level, (ii) export diversification (excludes resource-based economies, which hold high GDP per capita due to oil or gas rents) and (iii) degree of integration into the global financial system. This classification is updated once a year. Further information on https://www.imf.org/external/pubs/ft/weo/2020/02/weodata/groups.htm.

Figure 5. From indicators to pillars: example

	Control of Corruption	Government Effectiveness	Regulatory Quality	Rule of Law	Political Stability & Absence of Violence	Voice & Accountability
Advanced Economies	18.8%	18.6%	20.2%	19.4%	11.9%	11.1%
Emerging Markets & Developing Economies	15.5%	18.3%	18.1%	16.7%	12.1%	19.2%

Source: LSEG Sovereign Sustainability.

Calibration process

The weights of each indicator for each pillar, *i.e.*, intra-pillar weights, are calibrated using the econometric modelling framework called Partial Least Squares (PLS), with an added Variable Importance in Projection (VIP) score (see Appendix 3 for further details).

This type of econometric modelling aims to be more robust than a simple linear model of the Ordinary Least Squares (OLS) type.[12] The PLS econometric model with an added VIP score allows consideration of potential issues linked to collinearity between each indicator and ranking of the information value contained in each indicator within a pillar to estimate an aggregated measure of sovereign risk.

The aggregated sovereign risk measure[13] is the endogenous variable. It is calculated as the average of the non-linear numerical adjustment of the empirical default probabilities derived from the financial credit ratings of the three main credit rating agencies.[14] This aggregate measure of sovereign risk is therefore considered to calibrate the intra- and inter-pillar[15] weights of 2SRM.

Once the coefficients for each indicator within each pillar are estimated, the scores are normalised under a significance constraint[16] to obtain a weighting set with a 100% sum for each pillar.

The results derived from this advanced econometric framework are calibrated on a data sample from Q4 1999 to Q4 2020.[17]

Exceptions

The weights of some indicators cannot be exclusively decided using an econometric framework, but rather through the support of multidisciplinary research. This is especially the case for Physical Risk, Transition Risk, Air Pollution, Water Stress, Biodiversity and Food Security indicators.

Even if such indicators do not show a direct theoretical link to sovereign credit risk, they quantify the degree of exposure and vulnerability of countries' populations, infrastructure and ecosystems to environmental degradation, which can help predict the severity of economic impact in the short, medium and long term.

[12] The OLS econometric modelling does not take into account the potential issues linked to collinearity between each indicator. Indeed, it is obvious that some indicators are strongly correlated with others, e.g., a country's general government overall balance is *de facto* strongly correlated with the general government primary balance of this same country. Therefore, the coefficients estimated through OLS are biased.

[13] This aggregated sovereign risk measure is a good proxy of a default probability.

[14] Standard & Poor's, Moody's Investors Service and Fitch Ratings, as publicly disclosed on their websites.

[15] Intra-pillar means within each pillar (e.g., within the Social risk pillar) while inter-pillar means between each pillar (e.g., between the three pillars E, S and G).

[16] In order to not underestimate too much the weight of some indicators in the modelling, a minimum value is assigned ($Minimum\ Weight = 1/2N$ with N the number of indicators constituting the pillar) below which no weight can be. If some indicators are assigned that minimum weight, all the other weights are once again normalised in order to obtain weightings set the sum of which is 100% for each pillar.

[17] The calibration period runs from Q4 1999 to Q4 2020. The choice of this period was motivated by data availability constraints and the date at which we carried out this calibration. Regarding the former, to ensure the outputs are based on a large enough sample, we focused on a sample that was sufficiently complete across geography and in frequency. Regarding the latter, the calibration was carried out in 2022 meaning that the data was relatively incomplete between 2020 and 2022. However, it is key to note that the results of the first calibration process, which was first carried out in 2016 using the same methodology, resulted in almost identical outputs.

In such cases, and within the scope of this model, the indicators have been attributed equal weights to represent their equal importance, irrespective of countries' level of economic development.

1.2.4 From pillars to an aggregated ESG risk score

The E, S and G pillars are equally weighted to provide the ESG risk score. This is to mitigate the risk that empirical econometric analysis tends to reduce the importance of the Environmental pillar. Environmental indicators are a priority for some investors, and are increasingly relevant for sovereign risk in areas of the world more exposed to physical and/or transition risks due to climate change. Moreover, overall resource depletion ought to be accounted for as a set of weak signals, which are precursors for potential second-round effects in geopolitical and economic terms.

1.2.5 Validation of final scores

In addition to the input validation process, we carry out a validation process of the outputs of the 2SRM model. This helps us ensure that the scores reflect the reality presented by the data points and that these are free of methodological or human error.

The process is done by comparing the latest time series (e.g., Q2 2024) from the newly produced outputs of the current quarter update with the latest time series produced by the outputs of previous quarter update (i.e. Q1 2024). Countries are flagged when their E, S and G pillar scores experience changes above 3 points or below -3 points. For those countries, we will identify which indicator is leading the shift. Flagged changes in the E, S and G pillars are usually due to absolute changes of at least 8 points at the indicator level.

Once the indicator is identified, we will compare the current quarter and previous quarter raw data. In most cases, changes are caused by updates or revisions of the raw data, carried out by the data provider. Otherwise, distributional changes can also influence final scores. All discrepancies and their justification are written up in quarterly reports for documentation and reference purposes.

Key features of 2SRM

2. Income-adjusted scores: an ex-post approach to tackle the income bias

2.1 Addressing the income bias

The integration of ESG criteria in sovereign credit risk analysis results in the *Ingrained Income Bias*. High-income countries (i.e., AEs) tend to have higher ESG scores, whereas low- and middle-income countries (i.e., EMDEs) tend to have lower ESG scores. Social and Governance scores drive this bias due to the inherent correlation with economies' level of development, while Environmental scores are less correlated due to topic diversity and divergence in assessment frameworks.

As 2SRM distinguishes between AEs and EMDEs, it allows the model to account for some of the income bias *ex ante*. However, to correct for the persisting income bias, LSEG Sovereign Sustainability uses an *ex-post* approach[18] to generate separate income-adjusted E, S and G scores.

2.2 Income adjustment methodology

LSEG Sovereign Sustainability uses a simple econometric framework to construct income-adjusted sovereign ESG scores. To neutralise the information related to income bias from 2SRM's E, S and G scores, a univariate pooled ordinary least square (POLS) regression for 149 economies is used, on a quarterly basis, between Q4 1999 and Q4 2020.

2.3 Empirical linkages between GNI per capita and ESG scores

The Environmental, Social and Governance scores from 2SRM are regressed on the explanatory variable that is the natural logarithm of the gross national income (GNI) per capita (at purchasing power parity in constant USD) for each economy and quarter.

	Environmental	Social	Governance
α	38.33*** (5.94)	-69.67*** (6.30)	-100.45*** (9.81)
β	1.90*** (0.69)	12.71*** (0.70)	16.12*** (1.11)
# Observations	12,495	12,495	12,495
R-squared	0.06	0.67	0.56

Source: LSEG Sovereign Sustainability.
Notes: The table presents the coefficient of the POLS $E_{it} = \alpha_E + \beta_E * LN(GNI\ per\ capita_{it}) + e_{it}$ for Environmental Risk pillar, $S_{it} = \alpha_S + \beta_S * LN(GNI\ per\ capita_{it}) + s_{it}$ for Social Risk pillar and $G_{it} = \alpha_G + \beta_G * LN(GNI\ per\ capita_{it}) + g_{it}$ for Governance Risk pillar. Standard errors are in parentheses. *, ** and *** denote statistical significance at the 10%, 5% and 1% level of confidence, respectively.

2.4 Beyond the GNI per capita

The residuals from these three regressions are then retrieved (which represent the share of the initial E, S, and G scores that is not explained by the income level) to calculate the income-adjusted sovereign E, S and G scores.

To do these calculations, these residuals are transformed into z-scores for each score and economy on a quarterly basis. Then, the z-scores are transformed into continuous scores based on an interval, ranging from 0 to 100, in accordance with the cumulative distribution function of a standard normal distribution – where 0 represents the worst score and 100 the best score. Finally, the E, S, and G scores are aggregated to calculate overall income-adjusted sovereign ESG scores.

[18] For more details, refer to the Dealing with income bias in sovereign ESG scores – Sovereign ESG revisited.

Appendices

Appendix 1: Breakdown of raw data used within the 2SRM framework

Pillar	Sub-pillar	Theme	Indicator	Definition	Source
Environmental Risk	Energy Risk	Energy Policy	Electricity Access	The electricity access measures the percentage of population with largely uninterrupted access to decentralised or grid power. Electricity access gives a strong indication of a country's energy poverty status and the degree of constraint exerted by energy, as a production factor, on the whole economic system, and as such is a governmental priority. Electricity access data are collected from international sources, industry and national surveys.	World Bank
			Energy Consumption	The energy consumption measures the degree of energy over- or under- consumption against a standard determined by the country's level of income based on an extensive geographical coverage of about 200 countries. It captures various drivers, from structural (climate conditions, population density, population concentration), to cyclical (economic cycles) and to technological (energy and overall efficiencies). The standard level is econometrically estimated, based on the whole sample of countries over the period starting from 2000. Each country is then attributed a ranking depending on its performance relative to the GDP per capita level.	LSEG
		Low Carbon Energy	Brown Proxy	The brown proxy indicator measures the percentage of fossil fuels in primary energy consumption. These include oil, gas, and coal.	LSEG
			Green Proxy	The green proxy indicator measures the percentage of low-carbon energy sources used in primary energy consumption. These include hydropower, wind, solar, geothermal, tidal, and nuclear energy.	LSEG
		Energy Independence	Total Energy Independence	The energy independence indicator is calculated using primary energy consumption and production metrics. This indicator provides a more global view of the resources directly available to a country's energy system.	LSEG
	Climate Risk	Physical Risk	Historical Physical Risk	Six climate hazards are considered in the building of physical risks scores: heatwaves, droughts, water stress, intense precipitations, riverine floods, and coastal floods. For each hazard, raw climate data is used to calculate specific indicators that will describe a hazard's frequency and/or intensity. Past exposures are computed from the absolute values of climate indicators (e.g., the frequency of warm days). Then, given that the potential impact on a given sector of the economy depends on this sector's vulnerability to the hazard, the hazard scores are combined with the sectoral vulnerability scores. Following so, the sectoral risk scores are linked to the sectoral Gross Domestic Product (GDP) breakdown, using a weighted average to obtain each hazard's risk scores for each country. Finally, a single, multi-hazard score is created that summarises the overall	LSEG

Pillar	Sub-pillar	Theme	Indicator	Definition	Source
				physical climate risk level of the country. This synthetic score is calculated from the average of the three highest hazard specific scores for each country.	
			2050 Physical Risk	Seven climate hazards are considered in the building of physical risks scores: heatwaves, droughts, water stress, intense precipitations, riverine floods, coastal floods and increase in average temperature. For each hazard, raw climate data is used to calculate specific indicators that will describe a hazard's frequency and/or intensity. Forward-looking exposure is defined by the change in climate conditions, calculating the difference between future and past climate indicators (e.g., additional warm days). Forward-looking data is based on the IPCC SSP5-8.5 climate scenario, following a 'hope for the best, plan for the worst' type of approach. Then, given that the potential impact on a given sector of the economy depends on this sector's vulnerability to the hazard, the hazard scores are combined with the sectoral vulnerability scores. Following so, the sectoral risk scores are linked to the sectoral Gross Domestic Product (GDP) breakdown, using a weighted average to obtain each hazard's risk scores for each country. Finally, a single, multi-hazard score is created that summarises the overall physical climate risk level of the country. This synthetic score is calculated from the average of the three highest hazard-specific scores for each country.	LSEG
		Transition Risk	GHG to GDP Performance	This indicator measures the deviation of consumed GHG emissions from the standard defined by the country's level of income. Consumed GHG emissions includes territorial and imported emissions but excludes exported emissions. This indicator captures key drivers: (i) Structural (climate conditions, population density, population concentration, GDP structure); (ii) Cyclical (economic cycles); (iii) Energy (energy balance structure, energy domestic prices); (iv) Technological (energy and overall efficiency). The standard level is econometrically estimated, based on a sub-sample of 130 countries over the period starting from 2000. Each country is then attributed a ranking depending on its relative performance.	LSEG
			NDC Implied Temperature Rise	The Implied temperature Rise (ITR) is an indicator providing an approximation of the global warming level (in 2100) if the whole world had the same carbon budget overshoot than a specific country. This overshoot of a country is defined as the gap between its 1.5°C-consistent carbon budget and the carbon budget induced by its emission target (formalised in its Nationally Determined Contributions – NDC). The country for whom the 'NDC-based' projected emissions are below its 1.5°C-carbon budget is called 'undershoot', whereas it is called an 'overshoot' if its projected emissions are above its Paris-aligned carbon budget. To define the countries' carbon budget consistent with a 1.5°C objective (or 2°C), LSEG D&A developed the CLAIM methodology. It relies on a statistical approach that remains as neutral as possible, because the way to share the global carbon budget is a politically sensitive issue.. CLAIM takes into account a lot of parameters that can be considered to reflect the climate profile of a country relatively to the other countries in this sharing perspective, such as the GDP, the energy intensity of the GDP, the carbon intensity of the energy mix, the past emissions, etc.	LSEG
	Natural Capital Risk	Air Pollution	Air Pollution	Population-weighted exposure to ambient PM2.5 pollution is defined as the average level of exposure of a nation's population to concentrations of suspended particles measuring less than 2.5 microns in aerodynamic diameter, which are capable of penetrating deep into the respiratory tract and causing severe health damage. Exposure is calculated by weighting mean annual concentrations of PM2.5 by population in both urban and rural	World Bank

Pillar	Sub-pillar	Theme	Indicator	Definition	Source
				areas.	
		Water Management	Water Stress	The level of water stress indicator measures freshwater withdrawal as a proportion of available freshwater resources. It calculates the ratio between total freshwater withdrawn by all major sectors and total renewable freshwater resources, after taking into account environmental water requirements. Main sectors, as defined by ISIC standards, include agriculture; forestry and fishing; manufacturing; electricity industry; and services. This indicator is also known as water withdrawal intensity.	World Bank
		Biodiversity	Red List Index	The Red List Index, used to track the Sustainable Development Goal of Life on Land (Goal 15), measures the change in aggregate extinction risk across groups of species. It is based on genuine changes in the number of species in each category of extinction risk on The IUCN Red List of Threatened Species (IUCN 2015). It is expressed as changes in an index ranging from 0 to 1. Governments use the index to track their progress towards targets for reducing biodiversity loss.	UN SDG Database
		Food Security	Prevalence of Undernourishment	The prevalence of undernourishment is the percentage of the population whose habitual food consumption is insufficient to provide the dietary energy levels that are required to maintain a normal active and healthy life. This indicator serves as a proxy for the prevalence of moderate or severe food insecurity in the World Bank's population indicator (PFI) as its geographical and historical coverage is limited.	World Bank
Social Risk	Human Capital and Innovation		R&D Expenditures	Expenditures for research and development are current and capital expenditures (both public and private) on creative work undertaken systematically to increase knowledge, culture, and society improvement, and the use of knowledge for new applications. R&D covers basic research, applied research, and experimental development. It is expressed as a share of GDP.	World Bank
			High-Tech Exports	High-technology exports are products with high R&D intensity, such as in aerospace, computers, pharmaceuticals, scientific instruments, and electrical machinery. Expressed as share of manufactured exports.	World Bank
			Education Expenditures	General government expenditures on education (current, capital, and transfers) are expressed as a percentage of GDP. It includes expenditures funded by transfers from international sources to government. General government refers to local, regional, and central governments.	World Bank
	Health		Health Expenditures	Total health expenditure is the sum of public and private health expenditure. It covers the provision of health services (preventive and curative), family planning activities, nutrition activities, and emergency aid designated for health but does not include provision of water and sanitation.	World Bank
			Hospital Beds	Hospital beds include in-patient beds available in public, private, general, and specialised hospitals and rehabilitation centres. In most cases beds for both acute and chronic care are included.	World Bank
			Physicians	Physicians include generalist and specialist medical practitioners. It is expressed per 1,000 people.	World Bank
			Life Expectancy	Life expectancy at birth indicates the number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life.	World Bank

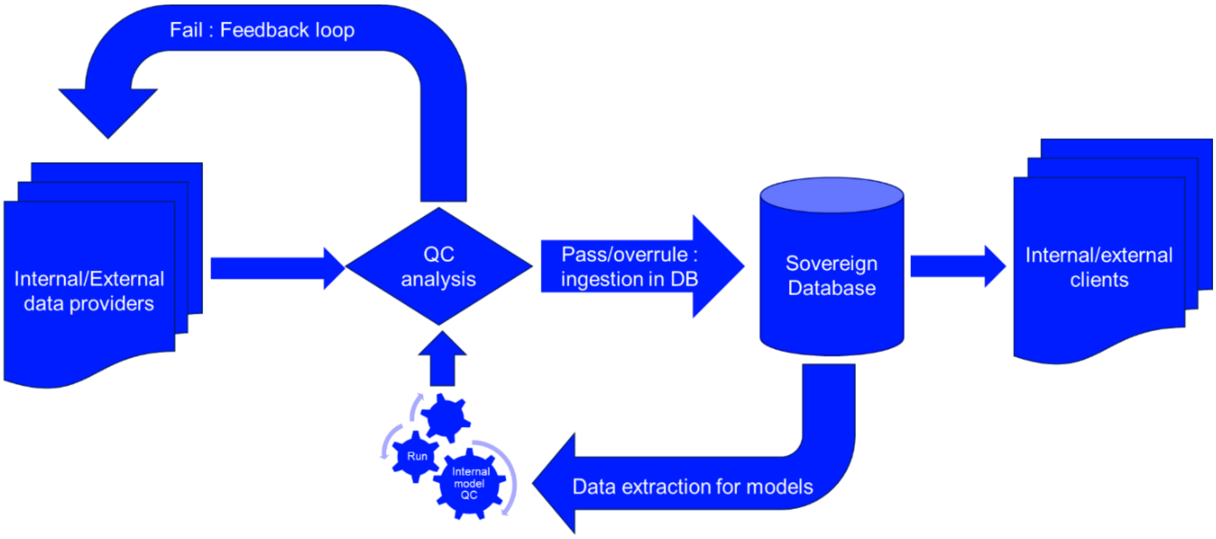
Pillar	Sub-pillar	Theme	Indicator	Definition	Source
	Societal Wellbeing		Female Labour Participation Rate	The female to male labour force participation rate (from national sources) is a good proxy of the place of women in the society. Labour force participation rate is the proportion of the population aged 15 and older that is economically active: all people who supply labour for the production of goods and services during a specified period.	World Bank
			Internet Access	Internet users are individuals who have used the Internet (from any location) in the last 12 months. Internet can be used via a computer, mobile phone, personal digital assistant, games machine, digital TV etc. It is expressed per 1,000 people.	World Bank
			Urbanisation Rate	Urban population refers to people living in urban areas as defined by national statistical offices. The data are collected and smoothed by the United Nations Population Division.	World Bank
	Inequality		GINI Index	Gini index measures the extent to which the distribution of income (or, in some cases, consumption expenditure) among individuals or households within an economy deviates from a perfectly equal distribution. A Lorenz curve plots the cumulative percentages of total income received against the cumulative number of recipients, starting with the poorest individual or household. The Gini index measures the area between the Lorenz curve and a hypothetical line of absolute equality, expressed as a percentage of the maximum area under the line. Thus, a Gini index of 0 represents perfect equality, while an index of 100 implies perfect inequality.	World Bank
			Income Distortion Index	The income distortion index corresponds to the share of income held by the top 10% richest households in a country.	World Bank
			Social Contributions	Social contributions include social security contributions by employees, employers, and self-employed individuals. They also include actual or imputed contributions to social insurance schemes operated by governments. It is expressed as a share of government revenue.	World Bank
			Poverty Rate	Poverty headcount ratio at USD 1.90 a day is the percentage of the population living on less than USD 1.90 a day at 2011 international prices.	World Bank
	Employment		Labour Participation Rate	The labour force participation rate is the proportion of the population ages 15 and older that is economically active: all people who supply labour for the production of goods and services during a specified period.	World Bank
			Unemployment Rate	The unemployment rate is calculated as the number of persons who are unemployed during the reference period given as a percent of the total number of employed and unemployed persons (i.e., the labour force) in the same reference period.	World Bank
			Youth Unemployment Rate	The youth unemployment rate refers to the share of the labour force ages between 15 and 24 without work but available for and seeking employment.	World Bank
Governance Risk	Control of Corruption			Control of corruption captures the extent to which public power is not exercised for private gain, including both petty and grand forms of corruption, as well as avoiding the "capture" of the state by elites and vested interests. The more corruption there is in the country, the weaker the indicator.	World Bank
	Government Effectiveness			Government effectiveness captures the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to	World Bank

Pillar	Sub-pillar	Theme	Indicator	Definition	Source
				such policies.	
	Political Stability & Absence of Violence			Political stability & absence of violence captures the likelihood that the government will be destabilised or overthrown by unconstitutional or violent means. The more the political power is unstable and the more violence there is in the country, the weaker the indicator.	World Bank
	Regulatory Quality			Regulatory quality captures the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development and limit negative externalities from commerce.	World Bank
	Rule of Law			Rule of law captures the extent to which agents have confidence in and abide by the rules of society, and in particular the ability to enforce property rights, the quality of the police and the courts, as well as the level of crime and violence.	World Bank
	Voice & Accountability			Voice & accountability captures the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media.	World Bank

Source: LSEG Sovereign Sustainability.

Appendix 2: Generic QC flow for sovereign datasets

Figure 1. Validation flow chart for sovereign datasets



Source: LSEG Sovereign Sustainability.
Notes: Run refers to the regular updating of methodologies.

Data validation is a process that encompasses all activities aimed at identifying, processing, and, if necessary, correcting data entering the Sustainable Finance (SFI) information systems. The importance of this process lies in the fact that the data is later used by internal or external clients. This process is centralized upstream of the Sovereign Database (DB), which is the master database for sovereign SFI data. It consists of two parts:

1. **Metadata checks:**
   a) Comparisons between countries from the newly imported "golden" data (i.e., data already stored and used for different products) and the country reference table. First check revises if all countries codes are in the reference table and if codes are identical.
   After checks, discrepancies can:
      i. Either be ignored if it does not impact downstream flow
      ii. Or lead to an update in the reference table before further ingestion (add missed countries, for example).
   b) Comparisons between indicators metadata details:
      i. check if a golden data point is missing;
      ii. check if the unit of a newly imported indicator is the same as the one described in metadata table.

2. **Comparison between data points from the 2 latest updates allows the flagging of suspicious datapoints:**
   i. check if the imported dataset contains data for all the countries previously imported or if some countries are missing or have been added;
   ii. check if both new and old values are null;
   iii. list all data points which match with abs(new value/old value-1) > 0.3;
      - for indicators with a percentage unit, only those with abs(old_val -new_val)>5 are flagged
      - for indicators with constant prices and a deflator, calculate the ratio of value_n - 1/value n for each year and check if this ratio is constant.
   iv. list all data points where the new value is missing but not in the previous instance;
   v. list all data points where the old value is missing and not the new value;
   vi. list all data points where the new value < average-3*std deviation;
   vii. list all data points where the new value > average+3*std deviation;
   viii. list indicators with unique value in time series;
   ix. list indicators where the unit have changed between the previous delivery and the new update;
   x. list indicators where unit is missing but not the value;
   xi. list missing or added indicators between the 2 updates;

xii. list of overruled data on the previous update, the value overruled and the new value.

Once all these checks files are validated, data are recorded in the final table which contains all data points (raw data and computed data). For suspicious datapoints, other sources are considered that might lead to an overrule. If no decision is made, questions are raised back to the provider for further investigation and justification.

Appendix 3: Partial Least Squares (PLS) regression and Variable Importance in Projection (VIP) score

The Sovereign Risk Monitor aims to produce a comprehensive and relevant assessment of sovereign risk. To design such a framework, a statistical and econometric methodology capable of analysing multiple indicators and extracting valuable sovereign risk-related information has been developed.

Sovereign risk is often influenced by numerous indicators, covering topics as wide-ranging and as different as economic performance, public finances, social features, etc. but also exposure to climate change or the quality of governance. Some indicators that make up these topics are uncorrelated, while others show a strong correlation. Therefore, extracting precise and specific sovereign risk-related information cannot be undertaken by using simple regression techniques as the results would be biased. To circumvent this issue, specific regression techniques are used to estimate the weight of each indicator in predicting an aggregated sovereign risk measure. The following model is used:

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

where:

- Y is the aggregated sovereign risk measure with $Y = (Y_1, \dots, Y_n)^t$, t the number of quarters and n the number of countries;
- For $j = 1, \dots, J$, X_j is the j-th explicative indicator X matrix and J the number of indicators;
- β_j is the j-th coefficient. As already stated, it cannot be estimated by a simple Ordinary Least Squares regression as this estimator would be biased.

These indicators can present strong correlations (*e.g.*, between Social Risk and Governance Risk indicators), hence, to consider this specificity of the selected data, Partial Least Squares (PLS) regressions are used. That econometric framework, developed by Wold[19] in the 1960s, enables the construction of predictive models in the presence of many correlated independent variables. It finds orthogonal components – thus eliminating the multicollinearity issue – of the X matrix that explain as much as possible the covariance between X and Y. Then, this breakdown of X is used in the regression to predict Y.[20] More precisely, the PLS regressions follow several steps:

i. The PLS regressions produce a matrix W such as $T = XW$, where T is the factor score matrix and W is estimated such as to minimise collinearity and maximise the covariance between the explanatory and endogenous variables;
ii. estimate the matrix Q so that $Y = TQ + E$;
iii. estimate the matrix P so that $X = TP + E'$;
iv. compute $\beta = WQ$.

To estimate the T matrix, the standard algorithm for computing PLS components is used, *i.e.*, Nonlinear Iterative Partial Least Squares (NIPALS) algorithm. It uses all the matrices defined above to estimate W and then compute T.

The aim is not to predict directly Y but rather to find the optimal weights of each indicator in SRM. So, the β coefficient is not used directly in the regressions. Instead, the Variable Importance in Projection (VIP) score is used. It represents the summary of the importance of each indicator in finding the components of the X matrix[21] during the first step of the PLS regressions. Formally, it is the weighted sum of squares of the PLS weights (the W matrix), which considers the explained variance of each dimension. It is used to select relevant predictors according to their value. In the academic literature, the VIP score is statistically significant if it based above a given threshold ranging from 0.8 to 1.[22] However, in order not to exclude too many indicators, the VIP scores are used directly to calculate the weights. This approach remains relevant because VIP scores higher than 0.8 account for more than 80% of SRM indicators. The last 20% are rarely below 0.5.

[19] Wold, H., 1966, “Estimation of principal components and related models by iterative least squares”, in P.R. Krishnaiaah (Ed.), *Multivariate analysis*, pp.391-420.

[20] Abdi, H., 2003, “Partial Least Squares (PLS) Regression”, The University of Texas at Dallas.

[21] Palermo, G., P. Piraino, and H.-D. Zucht, 2009, “Performance of PLS regression coefficients in selecting variables for each response of a multivariate PLS for omics-type data”, *Advances and Applications in Bioinformatics and Chemistry: AABC*, *2*, pp. 57–70.

[22] Chong, I.G., and C.H. Jun, 2005, “Performance of some variable selection methods when multicollinearity is present”, *Chemometrics and Intelligent Laboratory Systems 78*, pp. 103–112.

Appendix 4: Governance & COI management

Governance of methodologies

Prior to launch, the Sustainable Finance & Investment (SFI) products are submitted to a Products and Commercials Board which considers, among other aspects, the risks associated with new products. The underlying models and methodologies are validated by LSEG Model Risk Management team before submission.

SFI products methodologies are subject to regular review to ensure they reflect the purpose for which they have been created. Criteria for datapoints inclusion or changes in methodologies are considered by LSEG D&A SFI Regulatory Governance Committee (SRGC) which oversees methodologies' compliance with regulations and codes of conduct. The data metrics and methodology used for products is periodically evaluated to ensure its relevance and accuracy. Similarly, when new logic is developed, or existing logic modified, impact analysis is performed to understand the potential effects on the product and its outputs. This analysis helps in identifying any potential limitations, biases, or unintended consequences that may arise from the changes. Changes, enhancements and impact analysis is thoroughly documented to maintain transparency and accountability.

Conflicts of Interest management

LSEG D&A SFI business has processes in place to identify, assess and manage potential conflicts of interest (COI). Any conflicts of interest are recorded in a conflicts of interest register and reviewed periodically in line with our governance framework.

Conflicts of interest may arise in areas including:

- organisational ownership;
- product design and management;
- clients, partners or suppliers;
- individual employees/directors.

These COI management processes are subject to review by the LSEG D&A SRGC on an annual basis, or more frequently if the possibility of a conflict arises.

Following a conflict being identified, management and Compliance assess the nature of the conflict and determine what controls may be put in place to manage the conflict adequately, and any disclosure that may be required. In the event that satisfactory controls cannot be established the activity will be declined or discontinued.

The range of mitigating processes, controls and governance put in place to manage the potential conflicts identified as part of the framework, aims to remove any residual material conflicts.

ABOUT LSEG

LSEG is one of the world's leading providers of financial markets infrastructure and delivers financial data, analytics, news and index products to more than 40,000 customers in over 170 countries.

We help organisations fund innovation, manage risk and create jobs by partnering with customers at every point in the trade lifecycle: from informing their pre-trade decisions and executing trades to raising capital, clearing and optimisation.

Backed by more than three centuries of experience, innovative technologies and a team of 25,000 people in over 60 countries, we are driving financial stability, empowering economies and enabling you to grow sustainably.

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