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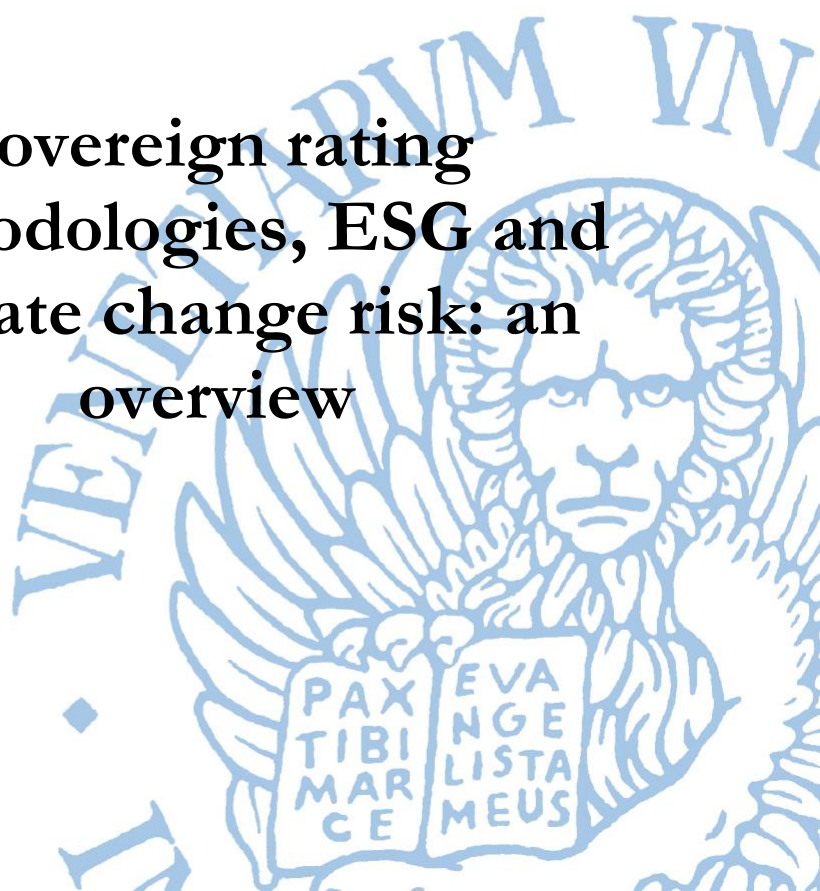
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Sovereign rating methodologies, ESG and climate change risk: an overview

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Abstract

We review the sovereign credit rating methodologies of three credit rating agencies (Moody's, S&P and Fitch) and analyze how they currently accommodate climate change risk and ESG considerations. We elaborate on the differences between the three rating methodologies and critically evaluate their suitability and limitations. We propose lines of improvement with respect to the indicator selection, normalization, aggregation and weighting procedures as well as the use of the sovereign rating indicator in connection with climate change scenarios.

Keywords

Climate risk, sovereign risk, sovereign credit, rating agency

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1. Introduction

Climate change and the associated risk affect social-economic outcomes profoundly (European Central Bank, 2020, p. 10). Where mitigation of climate change effects is not possible, as it indeed occurs especially in the medium term due to climatic inertias, social-economic systems have to adapt to that risk. Adaptation can be planned, when there is an active engagement by the public sector, or autonomous. The latter encompasses all measures put in place by the private sector including autonomous market adjustments.

A prerequisite of effective adaptation, either public or private, is an appropriate and “operational” knowledge of climate change risk. Climate change risks and the related adaptation options can vary widely, due to spatial/temporal characteristics of the impacts and of the targets of the impacts (EU Commission, 2021). Environmental risk can be classified according the two broad categories of physical and transactional (Task Force on Climate-related Financial Disclosures, 2017, p. 5), (European Central Bank, 2020, p. 10). The former includes the direct financial and operational implications for companies or countries from climate stressors, be they associated with “extremes” like natural catastrophes, or with long-term slow onset climate changes (ibid.). The latter includes all the policy, legal, technological, and reputational challenges from the transition to a low-carbon economy, and their associated costs (ibid.). This paper focuses on sovereign risk, defined as the possible effect of climate change on credit worthiness of countries, on the stability of public budgets, and on its measurement.

Climate change risk affects the ability of a country to repay debts (Klusak et al., 2021). Identifying standardized procedures for embedding climate change risk into the sovereign risk definition and assessment is of relevance firstly for national decision makers that we identify in the “highest tier” of government in a country. Especially highly indebted countries need comprehensive and timely information to anticipate stress on public finances and debt position coming from climate risks of both physical and transitional nature to then plan appropriate fiscal and monetary policies. It is also of great interest for private investors that will benefit from a richer representation of the broader “country risk” and get a more informative picture of the risk-return profile of their portfolios. Aware of the increasing importance of climate change as a macro trend for sovereign risk, major rating agencies, such as Moody’s, Standard and Poor and Fitch, are including through standardized procedures climate change risk indicators in their process to rate country sovereign risk. In parallel, they constantly develop research for a better characterization of climate change risk.

Against this background, an early contribution by Standard and Poor (2014) establishes climate change as one of the global mega-trends that will influence sovereign creditworthiness in the decades to come (S&P Global Ratings, 2014). The study provides an estimate of climate vulnerability by constructing an indicator based on the share of population living in coastal areas below five meters, the share of agriculture in national GDP and the vulnerability index provided by Notre Dame University Global Adaptation Index (ND-GAIN), which quantifies a country’s vulnerability to climate change (Chen et al., 2015). The study emphasizes an inverse relation between climate change risk and prosperity and shows that lower rate sovereigns are more vulnerable to climate change.

A similar, indicator-based approach is adopted by Moody’s (2016) to build a climate change country susceptibility index evaluating the two components “exposure” and “resilience” (Moody’s Investors Service, 2016). The former is assumed to be a function of economic diversification and geographic location, the latter depends on the development level, fiscal flexibility and governmental policies. A third indicator-based approach, a recent contribution by Four Twenty Seven Inc. (427), an initiative that informs Moody’s Investors Service on physical climate risk, attempts to assess sovereign physical climate risk exposure based on the population, the PPP-adjusted Gross Domestic Product and the agricultural area exposed to extreme climatic events (427, 2020a), (427, 2020b). The 427 contribution relies on overlaying climate data with population and PPP-adjusted GDP at a high spatial resolution in a manner consistent with a S&P comment on the potential of climate data to provide a foundation for better understanding physical climate risks (S&P Global Ratings, 2020). Improved data availability also enables econometric estimations of the financial impacts of climate-related hazards into credit quality as the recent firm-level analysis by Moody’s (Moody’s Analytics, 2020).

S&P (2015) addresses the relationship between climate change and sovereign credit ratings, yet it is limited by its exclusive focus on natural disasters (Standard and Poor's Rating Services, 2013). Other simulation studies by Moody's considers a variety of channels in quantifying the economic costs of climate change (Moody's Analytics, 2019, 2021). Their use of a global macroeconomic model demonstrates the necessity for harmonized scenarios for impact assessment. The scenario issue is also highlighted by two Fitch contributions (Fitch Ratings, 2020a; Parker, 2020). The basic premises of climate scenario analysis are outlined in a recent contribution by 427 (427, 2019).

The first goal of this paper is to describe how climate change risk is currently, explicitly or implicitly, accounted for in the sovereign credit rating methodologies of Moody's, S&P and Fitch. The specific focus is on climate change physical risk. We build on the work of Volz et al. by describing the rating methodologies, but also exploring in depth the treatment of environmental, social and governance (ESG) risks in the sovereign rating methodologies (Volz et al., 2020). The second goal is to understand how these methodologies can be improved upon in view of their strengths and weaknesses. In what follows, section 2 revises rating methodologies by the three rating agencies, section 3 provides a critical discussion and suggests improvements, section 4 concludes.

2. Rating agencies and their rating methodologies

2.1. Moody's

Moody's rates sovereigns by applying a scorecard methodology to four rating factors describing the economy: (i) economic strength, (ii) institutions and governance strength, (iii) fiscal strength and (iv) susceptibility to event risk (Moody's Investors Service, 2019, p. 3). The factors are operationalized by the set of qualitative and quantitative indicators enumerated in Table 1 in the Appendix. The first three of the four factors are determined by aggregating the sub-sub-factors using a system of fixed weights indicated in Table 1. The factor "Susceptibility to event risk" is measured using a minimum function. The factor scores are not rigid, they can be adjusted within ranges as indicated in Table 1. Furthermore, adjustments based on characteristics not reflected in the scorecard overview are possible at factor and sometimes subfactor levels.

Economic Strength is indicative of the resilience of a sovereign to diverse shocks (Moody's Investors Service, 2019, p. 5). It comprises the sub-factors: growth dynamics, scale of the economy and national income (ibid.). The metrics used to measure economic strength are average real GDP growth and GDP growth volatility, nominal GDP and GDP per capita (Moody's Investors Service, 2019, p. 4). Average real GDP growth draws on predictions five years into the future as well as historical observations. Adjustments of the factor score of up to nine notches are possible (ibid.).

Institutions and Governance Strength captures the presence of a stable and from an investor's perspective predictable institutional setting (Moody's Investors Service, 2019, p. 11). The factor is operationalized by two subfactors: Quality of Institutions and Policy Effectiveness (Moody's Investors Service, 2019, p. 4). The Quality of Institutions is measured by Quality of Executive and Legislative Institutions and by Strength of the Civil Society and the Judiciary, while Policy Effectiveness is measured by the Fiscal Policy Effectiveness and the Monetary and Macroeconomic Policy Effectiveness. Adjustments to the factor score are possible based on the Government Default History and the Track Record of Arrears (ibid.). Additional adjustments of the factor score of up to three notches are possible (ibid.).

Fiscal Strength results from the Debt Burden and Debt Affordability of a sovereign which are indicative of the vulnerability to financial shocks and the possibility of a default on financial obligations (Moody's Investors Service, 2019, p. 23). The debt burden is measured by means of two ratios: General Government Debt to nominal GDP and General Government Debt to General Government Revenues. Debt affordability puts the General Government Interest Payments in relation to both GDP and Government Revenues (Moody's Investors Service, 2019, p. 4). Adjustments of the factor score up to six notches are possible according to the Debt Trend and three ratios: General Government Foreign Currency Debt to General Government Debt, Other Non-Financial Public Sector Debt to GDP, and Public Sector Financial Assets and Sovereign Wealth Funds to General Government Debt (ibid.). The metric Debt Trend uses both observed and predicted values

(ibid.). Other considerations could also lead to an adjustment of the factor score amounting to three notches (ibid.).

Susceptibility to Event Risk is determined as the minimum of the subfactors Political Risk, Government Liquidity Risk, Banking Sector Risk and External Vulnerability Risk (Moody's Investors Service, 2019, p. 32). Political Risk is substantiated by Domestic, Political, and Geopolitical Risk (Moody's Investors Service, 2019, p. 4). The Government Liquidity Risk depends upon Ease of Access to Funding and can be adjusted at subfactor level by two categories (ibid.). The Banking Sector Risk is determined compounding the Risk of Banking Sector Credit Event and the ratio of Total Domestic Bank Assets to GDP (ibid.). Both the Banking Sector Risk and the External Vulnerability Risk can be adjusted by two categories at a subfactor level (ibid.). Overall, the factor Susceptibility to Event Risk can be adjusted by two scores to accommodate additional analyst judgement (ibid.).

All quantitative and qualitative indicators are associated to a numeric score in two steps. Firstly, they are attributed to an alphanumeric category and secondly associated to a numerical score via linear interpolation (Moody's Investors Service, 2019, p. 53). Table 2 in the Appendix exemplifies the conversion into an alphanumeric category of the sub-factors composing the Economic Strength indicator (Average Real GDP Growth, Volatility in GDP Growth, Nominal GDP and GDP per capita). For instance, a sovereign exhibiting an annual percentage growth in real GDP of 3.1 percent would thereby be assigned to the alphanumeric category baa1.

Subsequently, alphanumeric categories are converted to a numeric score following a linear interpolation as illustrated in Table 3 in the Appendix (Moody's Investors Service, 2019, p. 53). The sovereign exhibiting an annual percentage growth in real GDP of 3.1 percent assigned to the alphanumeric category baa1 would thereby have a numeric score close to 7.5, while another hypothetical sovereign with percentage growth in real GDP of 3.3 percent, that would also be assigned to the category baa1, would have a numerical score of 8.5. Metric-specific cutoff points on the linear conversion scale between alphanumeric and numeric scores are also introduced. These are reported in Table 4. For instance, a sovereign with an average real GDP growth of 15% or more would be classified as aaa, while a sovereign with zero growth would be classified as belonging to the ca category.

The conversion of qualitative indicators to alphanumeric category uses predefined structural characteristics of a sovereign. An example of the conversion for a qualitative factor is displayed in Table 5 in the Appendix for the sub-sub-factor Strength of the Civil Society and the Judiciary. The alphanumeric scores of the qualitative indicators are converted to numeric scores using the scale in Table 6 in the Appendix. A sovereign that belongs to the aa category based on the indicator Strength of Civil Society and the Judiciary will be assigned a numeric score of 3.

Once the qualitative and quantitative indicators are converted to a numeric score the upper-level factor scores are calculated with the help of the sub-sub-factor weights displayed in Table 1 (Moody's Investors Service, 2019, p. 53). For instance, if the numerical score of the four sub-sub-factors of Economic Strength in Table 1 are denoted by x_i and the corresponding weights in Table 1 are denoted by w_i for $i = 1, \dots, 4$, then the factor score y is computed as

$$y = \sum_1^4 x_i w_i \quad (1)$$

The sum of the products is rounded to the nearest integer and converted to a broad alphanumeric score using the scale in Table 3 (ibid.). Adjustments to the upper-level factors scores are possible at this stage to incorporate additional analyst judgement (ibid.) The factor scores are combined stepwise following the framework depicted in Figure 1.

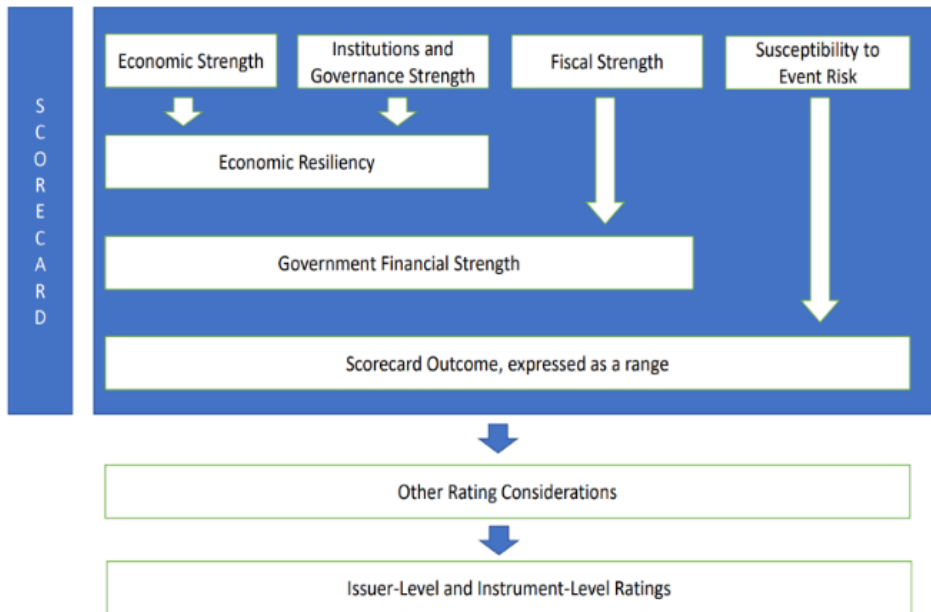


Figure 1 Moody's rating methodology. **Source:** Moody's Investors Service, 2019, p. 3.

Economic Strength and Institutions and Governance Strength are combined into the Economic Resiliency Outcome by attaching equal weights to the factor scores (Moody's Investors Service, 2019, p. 23). The Economic Resiliency Outcome and the Fiscal Strength Factor combined according to the decision matrix as described in Figure 2 determine the Government Financial Strength Outcome (Moody's Investors Service, 2019, p. 31).

EXHIBIT 7

Government Financial Strength

		Fiscal Strength																					
		aaa	aa1	aa2	aa3	a1	a2	a3	baa1	baa2	baa3	ba1	ba2	ba3	b1	b2	b3	caa1	caa2	caa3	ca		
Economic Resiliency	aaa	aaa	aaa	aaa	aaa	aaa	aa1	aa1	aa1	aa1	aa1	aa1	aa1	aa2	aa2	aa2	aa2	aa2	aa2	aa2	aa3	aa3	
	aa1	aa1	aa1	aa1	aa1	aa1	aa1	aa1	aa2	aa2	aa2	aa2	aa2	aa2	aa2	aa2	aa3	aa3	aa3	aa3	aa3	aa3	aa3
	aa2	aa1	aa1	aa2	aa2	aa2	aa2	aa2	aa2	aa2	aa3	aa3	aa3	aa3	aa3	aa3	aa3	aa3	a1	a1	a1	a1	a1
	aa3	aa2	aa2	aa2	aa2	aa3	aa3	aa3	aa3	aa3	aa3	aa3	a1	a1	a1	a1	a1	a1	a1	a1	a1	a2	a2
	a1	aa2	aa2	aa3	aa3	aa3	aa3	a1	a1	a1	a1	a2	a2	a2	a2	a3	a3	a3	a3	a3	a3	baa1	baa1
	a2	aa3	aa3	aa3	a1	a1	a1	a2	a2	a2	a2	a2	a3	a3	a3	a3	a3	baa1	baa1	baa1	baa1	baa1	baa2
	a3	aa3	a1	a1	a1	a1	a2	a2	a2	a2	a3	a3	a3	a3	a3	baa1	baa1	baa1	baa1	baa1	baa2	baa2	baa2
	baa1	a1	a1	a2	a2	a2	a2	a3	a3	a3	a3	baa1	baa1	baa1	baa1	baa2	baa2	baa2	baa2	baa2	baa2	baa3	baa3
	baa2	a1	a1	a2	a2	a2	a3	a3	a3	baa1	baa1	baa1	baa2	baa2	baa2	baa2	baa3	baa3	baa3	baa3	baa3	baa3	baa3
	baa3	a1	a2	a2	a2	a3	a3	a3	baa1	baa1	baa1	baa2	baa2	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3
	ba1	a2	a2	a3	a3	a3	baa1	baa1	baa1	baa1	baa2	baa2	baa2	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3
	ba2	a2	a3	a3	a3	baa1	baa1	baa1	baa2	baa2	baa2	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3
	ba3	baa1	baa1	baa2	baa2	baa2	baa2	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3
	b1	baa2	baa2	baa2	baa2	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3
	b2	baa2	baa2	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3
	b3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3	baa3
caa1	ba2	ba2	ba2	ba2	ba3	ba3	ba3	ba3	ba3	ba3	ba3	ba3	ba3	ba3	ba3	ba3	ba3	ba3	ba3	ba3	ba3	ba3	
caa2	ba3	ba3	ba3	ba3	ba3	ba3	ba3	ba3	ba3	ba3	ba3	ba3	ba3	ba3	ba3	ba3	ba3	ba3	ba3	ba3	ba3	ba3	
caa3	ba3	b1	b1	b1	b1	b1	b1	b1	b1	b2	b2	b2	b2	b2	b2	b2	b2	b2	b2	b2	b2	b2	
ca	b1	b1	b1	b2	b2	b2	b2	b2	b2	b2	b2	b2	b2	b2	b2	b2	b2	b2	b2	b2	b2	b2	

Source: Moody's Investors Service

Figure 2: The aggregation of the factors economic resiliency and fiscal strength.

Source: Moody's Investors Service, 2019, p. 31.

Similarly, the Government Financial Strength Outcome is combined in a matrix framework with the Susceptibility to Event Risk to calculate the Scorecard Indicated Outcome, which is then combined with other rating considerations to get to the "issuer-level" and "instrument-level" ratings as illustrated in Figure 3 (Moody's Investors Service, 2019, p. 32).

EXHIBIT 8

Combining Government Financial Strength and Susceptibility to Event Risk*

		Government Financial Strength																
		aaa	aa1	aa2	aa3	a1	a2	a3	baa1	baa2	baa3	ba1	ba2	ba3	b1	b2	b3	caa1
Susceptibility to Event Risk	aaa	Aaa	Aa1	Aa2	Aa3	A1	A2	A3	Baa1	Baa2	Baa3	Ba1	Ba2	Ba3	B1	B2	B3	Caa1
	aa	Aaa	Aa1	Aa2	Aa3	A1	A2	A3	Baa1	Baa2	Baa3	Ba1	Ba2	Ba3	B1	B2	B3	Caa1
	a	Aaa	Aa1	Aa2	Aa3	A1	A2	A3	Baa2	Baa3	Ba1	Ba2	Ba3	B2	B3	Caa1	Caa2	Caa3
	baa	Aaa	Aa1	Aa2	Aa3	A2	A3	Baa1	Baa2	Ba1	Ba2	Ba3	B1	B3	Caa1	Caa2	Caa3	Ca
	ba	Aa1	Aa2	Aa3	A1	A2	Baa1	Baa2	Baa3	Ba2	Ba3	B1	B2	B3	Caa1	Caa2	Caa3	Ca
	b	Aa2	Aa3	A1	A2	A3	Baa2	Ba1	Ba2	Ba3	B1	B2	B3	Caa1	Caa2	Caa3	Caa3	Ca
	caa	Aa3	A1	A2	A3	Baa1	Baa3	Ba1	Ba2	B1	B2	B3	Caa1	Caa2	Caa3	Caa3	Caa3	Ca
	ca	A1	A2	A3	Baa1	Baa2	Ba1	Ba2	Ba3	B1	B2	B3	Caa1	Caa2	Caa3	Caa3	Caa3	Ca

Source: Moody's Investors Service

Figure 3 The aggregation of the factors government financial strength and susceptibility to events risk. Source: Moody's Investors Service, 2019, p. 32.

Climate risk in Moody's rating methodology

Elements of climate risk are included in Moody's methodology as part of Environmental, Social and Governance (ESG) factors. ESG risks need to be seen as "material" as evaluated on a five-point absolute scale (Moody's Investors Service, 2020, p. 2). The concept of materiality of risks plays a prominent role in the methodology when evaluating the relative risk of default of a sovereign regardless of the time horizon (Moody's Investors Service, 2020, p. 5).

Climate risks are explicitly captured by the Carbon Transition and the Physical Climate Risk indicators part of the environmental component (Moody's Investors Service, 2020, p. 13). For completeness, other domains of environmental risks accounted for are water management, waste and pollution and natural capital (Moody's Investors Service, 2020, p. 13). Social risk factors relate to demographic factors, labor and income, education, housing, health and safety and the access to basic services (Moody's Investors Service, 2020, p. 15). Governance risks encompass institutional structure, policy credibility and effectiveness, transparency and disclosure and budget management (Moody's Investors Service, 2020, p. 17). Specific examples for each of the three risk categories are given in Table 7, Table 8 and Table 9 in the Appendix.

The potential impact of ESG considerations, and therefore also of climate risk, is qualitatively assessed in a forward-looking fashion with regards to the central credit related characteristics of the sovereign, albeit the relevant time horizon remains somewhat obscured (Moody's Investors Service, 2020, p. 4). In fact, Moody's acknowledge that the time horizon of ESG risks vary widely (ibid.). Once established that ESG risks are material, their impact on the rating factors in the methodology scorecard is determined qualitatively (ibid.). The qualitative assessment involves assessing the influence of a specific ESG risk source that qualifies as material on the rating factors.

The ESG considerations can correct both individual factor scores in the scorecard and the scorecard outcome expressed as a range (Moody's Investors Service, 2020, p. 4). In practice, environmental risks are mostly influential for the scorecard pillars Economic Strength and Fiscal Strength, while governance risks are pivotal for the rating factor Institutions and Governance Strength (Moody's Investors Service, 2020, p. 33). The influence of social considerations spreads across all credit relevant categories, from institutional strength to economic and fiscal indicators and susceptibility to domestic and geopolitical risks (Moody's Investors Service, 2020, p. 14 - 15). If no direct impact on the rating factors can be established, the rating is adjusted in the final step outside the scorecard methodology, as Figure 1 illustrates (Moody's Investors Service, 2020, p. 4).

Eventually, Moody's establishes an issuers profile to capture the immediate exposure of a sovereign to ESG risks. A sovereign-specific "credit impact score" reflects the qualitative assessment of the relative weight of

ESG considerations in a specific sovereign rating with scores on a five-point scale ranging from the very highly negative to the positive (Moody’s Investors Service, 2020, p. 27). The Moody’s evaluation reflects with scores on a five-point qualitative scale ranging from the very highly negative to the positive “the extent, if any, to which the rating of an issuer or transaction is different than it would have been in the absence of exposure to risks related to the issuer’s ESG characteristics” (Moody’s Investors Service, 2020, p. 28).

The credit impact of the ESG risks varies across category as illustrated in Figure 4. Environmental factors are mostly assessed as having moderately negative, and neutral at best, impact on credit scores, while the social factors mostly have a moderately to highly negative impact. Governance factors have a positive impact on credit scores for most advanced economies, with varying results for emerging economies.

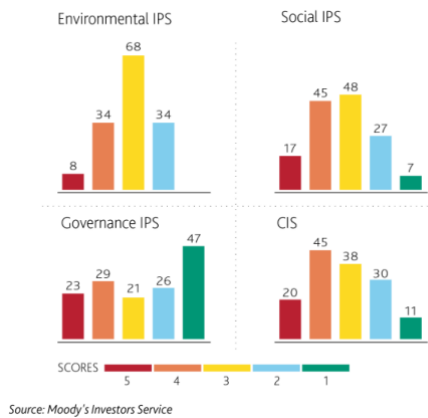


Figure 4 The distribution of the Issuer profile scores (IPS) and Credit impact scores (CIS). Issuer profile scores measure the exposure of an issuer to environmental, social and governance risks respectively. Credit impact scores gauge the extent to which ESG factors influence the credit quality of an issuer. The possible categories are: ‘5’ (“Very Highly Negative”), ‘4’ (“Highly Negative”), ‘3’ (“Moderately Negative”), ‘2’ (“Neutral to Low”), ‘1’ (“Positive”)

Source: Moody’s Investors Service, 2021, p. 3.

Box 1: Moody's ESG metrics and data sources.

Source: (Moody's Investors Service, 2020, p. 30- 34)

The principal metrics used to measure carbon transition risk include indicators of the hydrocarbon sector as a share of GDP, government revenue and exports. The data sources include the International Energy Agency and Rystad Energy. Moody's uses scenario analysis to assess the implications of a carbon transition for hydrocarbon-producing sovereigns' revenues, exports and economic activity. The main metrics used to measure the physical climate risks are indicators of relative exposure to heat stress, water stress, flooding and extreme precipitation, hurricanes and typhoons, sea level rise such as provided by 427. Estimates provided by the Notre Dame Global Adaptation Initiative or other sources might also be used. Water management is assessed using the annual freshwater withdrawal as a percentage of total available freshwater and the share of population exposed to unsafe drinking water. Vigeo Eiris and the World Bank are the respective data sources. The metrics used in the assessment of waste and pollution include the population-adjusted mean levels of fine particulate matter (PM2.5) in cities and annual municipal solid waste production per capita. Again, the data sources are Vigeo Eiris and the World Bank respectively. Natural capital is assessed using indicators of the share of a country's terrestrial and marine areas and forest area that are protected; and the share of the country's land area covered by forests. The data is provided by the World Bank.

The social risk categories covered by Moody's include demographics, labor and income, education, housing, health and safety and access to basic services. The principal metrics used for the demographic assessment include the dependency ratio, the working age population growth, the share of the immigrant population in the country's total population and an index of gender inequality. The source of the data is the United Nations and the World Bank. The metrics used for the labor and income risk include the youth unemployment rate, share of population living under certain income levels (e.g., \$5.50 per person per day). The data sources are the World Bank and the United Nations Development Programme's inequality-adjusted income index. Principal metrics for education are governments' expenditure on education as a percentage of GDP, governments' expenditure on secondary education per student as a percentage of GDP per capita, secondary school enrollment rates and inequality-adjusted education outcomes. The data are provided by the World Bank and the United Nations. The Legatum Institute's housing deprivation indicator is the metric used to assess housing. Health and safety are measured by the level of healthcare spending per capita (adjusted for differences in living costs), the intentional homicide rate, the under-five mortality rate, the prevalence of undernourishment, and life expectancy at birth. The data source is the World Bank. The metrics used to assess the access to basic services include measures of access to a range of services including electricity, safe drinking water, sanitation services and mobile cellular service subscriptions. The origin of the data is the World Bank.

The metrics used for the governance risk categories are often mapped from the related factors of the sovereign rating methodology. The institutional structure score is mapped from the Quality of Institutions sub-factor of the Institutions and Governance Strength factor, while the policy credibility and effectiveness category score is mapped from the Policy Effectiveness subfactor of the Institutions and Governance Strength factor. The assessment of the transparency and disclosure category is qualitative and based on various indices assessing transparency of fiscal reporting, e.g., the Open Budget Index is based on certain dimensions of the World Bank's Country Policy and Institutional Assessment, and the IMF assessment on the adequacy of data. The budget management category score is taken from the Fiscal Policy Effectiveness sub-sub-factor of the Institutions and Governance Strength factor.

2.2. S&P

S&P’s methodology for sovereign risk evaluates the five credit-relevant factors shown in Figure 4, namely the institutional, economic, monetary, external and fiscal factors (S&P Global Ratings, 2017, p. 2). They are assessed on a six-point numerical scale from '1' being the strongest to '6' being the weakest, with the scale benchmarking being “target-based” rather than relative (S&P Global Ratings, 2017, p. 3). For instance, the economic assessment of sovereigns compares them to a “wealthy, diversified, resilient, market-oriented, and adaptable economy ... with a track record of sustained economic growth” (S&P Global Ratings, 2017, p. 9). The assessments are forward-looking and based on both qualitative and quantitative information (S&P Global Ratings, 2017, p. 3). The relevant time horizon for environmental factors affecting sovereign ratings is assumed to be five to ten years (S&P Global Ratings, 2017a, p. 3). The relevant time frame for social and governance factors is not precisely specified.

The Institutional and Economic factors are aggregated with equal weights within the Institutional and Economic profile of a country (S&P Global Ratings, 2017, p. 3). Low values are consistent with a resilient economy, strong and stable institutional setting, and predictable and effective policy making. The External, Fiscal and Monetary factors are combined with equal weights into the sovereign’s Flexibility and Performance profile, which summarizes the sovereign’s fiscal and monetary circumstances in the context of its external finances (S&P Global Ratings, 2017, p. 4). The five pillars of credit rating determination shown in Figure 5 are measured by several subfactors and quantitative metrics, which are listed in Table 10.

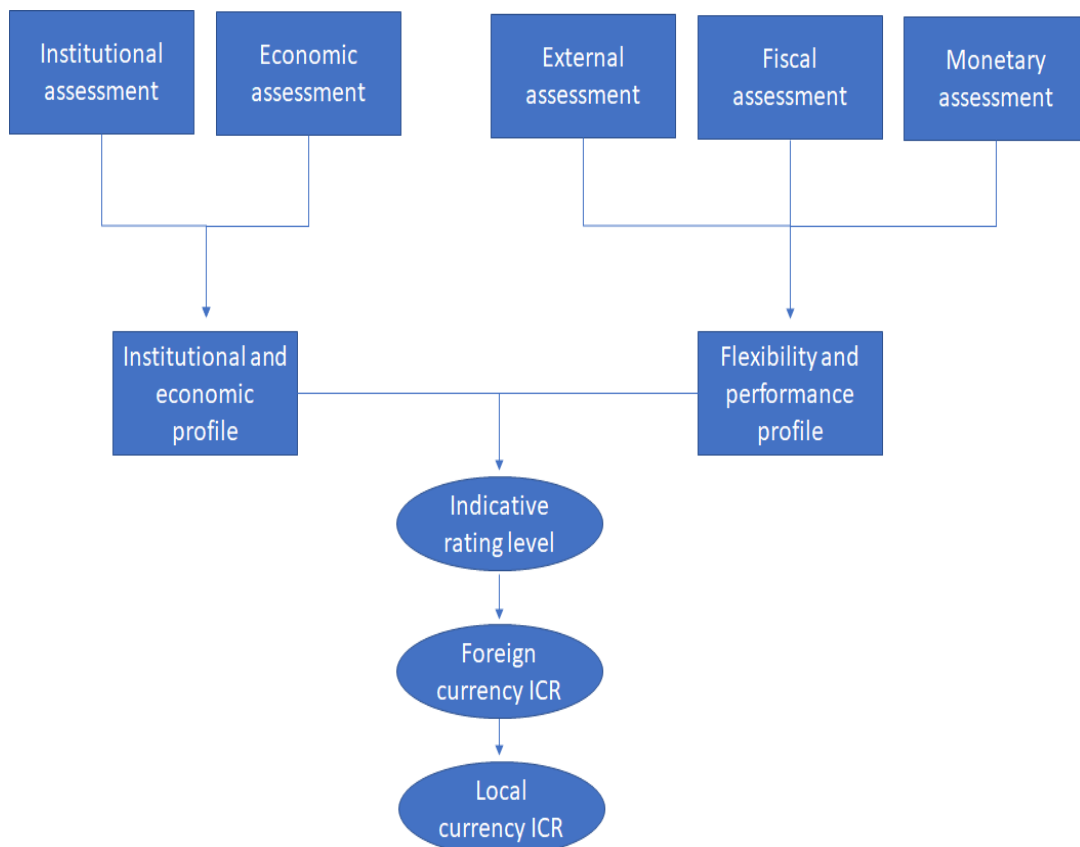


Figure 5 Schematic representation of the S&P Sovereign Rating Methodology

Source: S&P Global Ratings, 2017, p. 2.

The methodology operationalizes the factors by means of the key indicators displayed in Table 10 in the Appendix. The Institutional and Economic profile and the Flexibility and Performance profile are then merged via the weighting system shown in Figure 6.

Indicative Rating Levels From The Combination Of The Institutional And Economic Profile With The Flexibility And Performance Profile

		Institutional and economic profile											
		Category	Superior	Extremely strong	Very strong	Strong	Moderately strong	Intermediate	Moderately weak	Weak	Very weak	Extremely weak	Poor
	Category	Assessment	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6
Flexibility and performance profile	Extremely strong	1 to 1.7	aaa	aaa	aaa	aa+	aa	a+	a	a-	bbb+	bb+	bb-
	Very strong	1.8 to 2.2	aaa	aaa	aa+	aa	aa-	a	a-	bbb+	bbb	bb+	bb-
	Strong	2.3 to 2.7	aaa	aa+	aa	aa-	a	a-	bbb+	bbb	bb+	bb	b+
	Moderately strong	2.8 to 3.2	aa+	aa	aa-	a+	a-	bbb	bbb-	bb+	bb	bb-	b+
	Intermediate	3.3 to 3.7	aa	aa-	a+	a	bbb+	bbb-	bb+	bb	bb-	b+	b
	Moderately weak	3.8 to 4.2	aa-	a+	a	bbb+	bbb	bb+	bb	bb-	b+	b	b
	Weak	4.3 to 4.7	a	a-	bbb+	bbb	bb+	bb	bb-	b+	b	b-	b-
	Very weak	4.8 to 5.2	bbb	bbb	bbb-	bb+	bb	bb-	b+	b	b	b-	b-
	Extremely weak	5.3 to 6	bb+	bb+	bb	bb-	b+	b	b	b-	b-	b-	b-

Note: Assigning 'CCC+', 'CCC', 'CCC-', and 'CC' ratings is based on "Criteria For Assigning 'CCC+', 'CCC', 'CCC-', And 'CC' Ratings," Oct. 1, 2012.
Source: S&P Global Ratings.

Figure 6 Determination of the final rating category based on the institutional and economic profile and the flexibility and performance profile.

Source: S&P Global Ratings, 2017, p. 4.

Climate risk in S&P rating methodology

As with Moody's, climate risk considerations are included within the sovereign rating framework through the qualitative analysis of environmental, social and governance factors similar to the ones listed in Table 11 (S&P Global Ratings, 2019, p. 3). Similarly to the credit risk indicators used by S&P to evaluate creditworthiness of a sovereign, the precise ESG risk indicators that form the basis of the evaluation are less clear.

ESG risk components are integrated within the sovereign ratings qualitatively (S&P Global Ratings, 2018, p. 4). The methodology of S&P accommodates them at four stages of the sovereign credit rating analysis, as Figure 7 shows. They play an important role in the Institutional, Monetary and Fiscal assessments of a sovereign. Additionally, they are incorporated in the supplemental adjustment factors applied after the initial indicative rating level is determined. At this stage they can result in an adjustment of one notch up or down (S&P Global Ratings, 2019, p. 18). S&P does not use a metric in quantifying how relevant ESG considerations are to a rating.

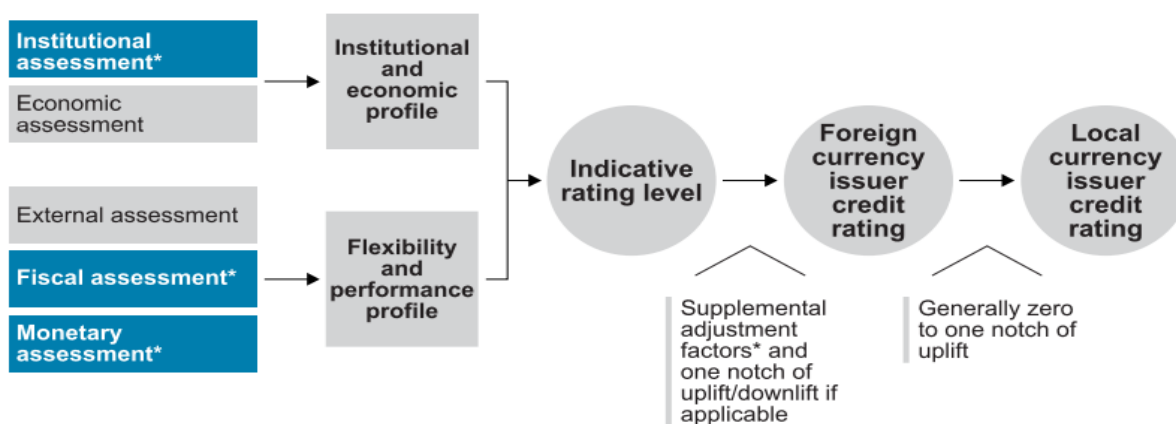
Nonetheless, among ESG, the governance factors are the most significant and account for about a quarter of the indicative sovereign rating (S&P Global Ratings, 2017a, p. 3). Social factors are assumed to affect the quality of institutional effectiveness (ibid.). The social factor cohesiveness of civil society, captures social mobility, social inclusion, prevalence of civic organizations, the degree of social order, and the capacity of political institutions to respond to societal priorities - as it is assumed that it correlates with stable, effective, and predictable policymaking (S&P Global Ratings, 2017a, p. 9). Social inclusion and fair distributional outcomes presumably play a vital role in defusing political polarization and foster the stability and

effectiveness of policymaking. Social inclusion is also hypothesized to stimulate the economy and contribute to economic growth, national savings, and public finances (ibid.). Considerable shortfalls in infrastructure and services to the population presumably have a negative effect on finances as reflected in the assessment of public finances assessment (ibid.).

The environmental factors connected to environmental degradation or a diminishing natural resource base are assumed to become relevant in a time frame beyond five to ten years and to have a stronger impact on emerging economies than on advanced ones, even though effects may spill over through trade and migratory flows (S&P Global Ratings, 2017a, p. 9). Environmental factors connected to natural conditions factors, e.g., extreme weather events, can weaken economic growth prospects (ibid.). A lack of diversification also exposes economies to large potential repercussions, e.g. sovereigns with a high agricultural output being more susceptible to weather-related events, and ones with resources depending on an environmentally unfriendly industry suffering from limited budgetary flexibility and contingent liabilities (ibid.). It is also possible that reducing the reliance on imported energy in favor of renewable energy could improve the external metrics of a sovereign (ibid.).

The Role Of Environmental, Social, And Governance Credit Factors In Our Ratings Analysis

Sovereign Criteria Framework



*Categories most likely to include consideration of environmental, social and governance credit factors.
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Figure 7 The stages of the sovereign rating analysis where the ESG considerations are integrated are marked by an asterisk.

Source: S&P Global Ratings, 2018, p. 5.

2.3. Fitch

The Fitch sovereign rating methodology is centered around four pillars: macroeconomic performance, policies and prospects, public and external finances (Fitch Ratings, 2020b, p. 1). These factors are operationalized using the eighteen variables in Table 12 in the Appendix.

In contrast to the Moody's and S&P approaches, Fitch uses an econometric model for its assessment of sovereign creditworthiness and subsequently integrates it with a qualitative assessment (qualitative overlay) to accommodate factors not reflected by the metrics (Fitch Ratings, 2020b, p. 1). The econometric model, the so-called sovereign rating model (SRM), relates past observations of the long-term foreign currency issuer default rating to the metrics indicative of key characteristics of the sovereign (Fitch Ratings, 2020b, p. 2). The

regression model is reassessed and re-estimated on a yearly basis to improve the consistency of the whole procedure with economic theory and the statistical significance (ibid.).

The dependent variable in the sovereign rating model is the long-term foreign currency issuer default rating mapped onto a linear scale, where the rating category AAA corresponds to 16 and the rating category CCC is equal to 0 (Fitch Ratings, 2020b, p. 33). The empirical analysis relies on a dataset covering the last eighteen observed values for the sovereign rating and the corresponding observations for the independent variables (Fitch Ratings, 2020b, p. 6). Some of the independent variables are included as a three-year centered average to counterbalance high volatility, which corresponds to the current year, the past year and the prognosis for one year ahead (ibid.). The sovereign rating is regressed on the eighteen variables x_k and an intercept via the linear regression model given in (2):

$$y_i = \alpha + \sum_{k=1}^{18} \beta_k x_k + e \quad (2)$$

The error term e is assumed normally distributed with an expected value of 0 and constant variance σ . The coefficients β_k are estimated by ordinary least squares and the estimates are interpreted as the weights of the variables x_k (Fitch Ratings, 2020b, p. 6). As such, the weights are the same for each sovereign in a specific year but evolve with time as the regression is estimated every year (ibid.). These weight estimates, obtained through the regression, are used to compute a preliminary sovereign credit rating based on the current values of the regressors, which is regarded as the output of the sovereign rating model (ibid.).

The output of the sovereign rating model is adjusted with a forward-looking qualitative overlay (QO) based on the factors in Table 13 to incorporate an additional analyst's judgement (Fitch Ratings, 2020b, p. 1). An adjustment up to two notches is possible at each analytical pillar and an overall adjustment of three notches for each rating (Fitch Ratings, 2020b, p. 7).

Climate risk in Fitch rating methodology

Climate risk is part of the ESG factors where it appears explicitly as “natural disasters and climate change” (Fitch Ratings, 2019, p. 5). Unfortunately, it is not totally clear which components are part of the “natural disasters and climate change” risk. In general, the ESG factors in Table 14 affect the sovereign credit ratings through both the sovereign rating model and the QO. The sovereign rating model accounts for both the ex-post impact of ESG considerations on the independent variables and for ex-ante correlations between the ESG risks and the regressors (Parker, 2020, p. 6). The QO incorporates forward-looking judgements where the ESG risks are relevant (ibid.). For instance, if a transition towards carbon neutrality is expected to limit GDP growth, which would not be reflected in the historical data used by the SRM, the QO GDP growth outlook will be adjusted to reflect this development. The general ESG categories were developed by the Fitch's Sovereign Group and the Global Sustainable Finance Group in accordance with the United Nations Principles for Responsible Investing (PRI) and the Sustainability Accounting Standards Board (SASB) (Fitch Ratings, 2019, p. 12). Tables 15, 16 and 17 illustrate the correspondence between the three ESG categories.

The relevance of the ESG considerations is determined in a multi-step procedure based on qualitative considerations (Fitch Ratings, 2019, p. 5). In a first step, the relevance of ESG risks to the variables incorporated in the sovereign rating model and to the factors captured in the qualitative overlay is evaluated (ibid.). The relevance is then established according to some given criteria which are reported in Tables 18, 19 and 20. An impact score is subsequently assigned to each ESG element for both the SRM and the qualitative overlay on a 1 to 5 scale, with 5 being the highest (Fitch Ratings, 2019, p. 6). The final score attached to the ESG factor is the highest across the SRM and QO component scores (Fitch Ratings, 2019, p. 5).¹

¹ For instance, it is assumed that the environmental risk factor “GHG Emissions and Air Quality” affects the SRM factor “Macroeconomic performance” by influencing the real GDP growth and the QO factor “Macroeconomic outlook, policies and prospects” by affecting the GDP growth outlook (ibid.). If it is decided that the environmental risk factor “GHG Emissions and Air Quality” is only somewhat relevant to current real GDP growth (consistent with a rating of 3), but highly relevant to GDP growth outlook (consistent with a rating of 5), then the relevance of the risk factor is expressed by the higher component score of 5.

The distribution of the relevance scores across different ESG risk categories is displayed in Figure 8. It should be noted that no sovereign has been assigned to a category “5” with respect to environmental risks and very few sovereigns are assigned to category “4”, which means that environmental risks are rarely seen as a rating driver. In most cases environmental risks are relevant to the rating, but only in combination with other factors.

ESG Element Scoring Distribution

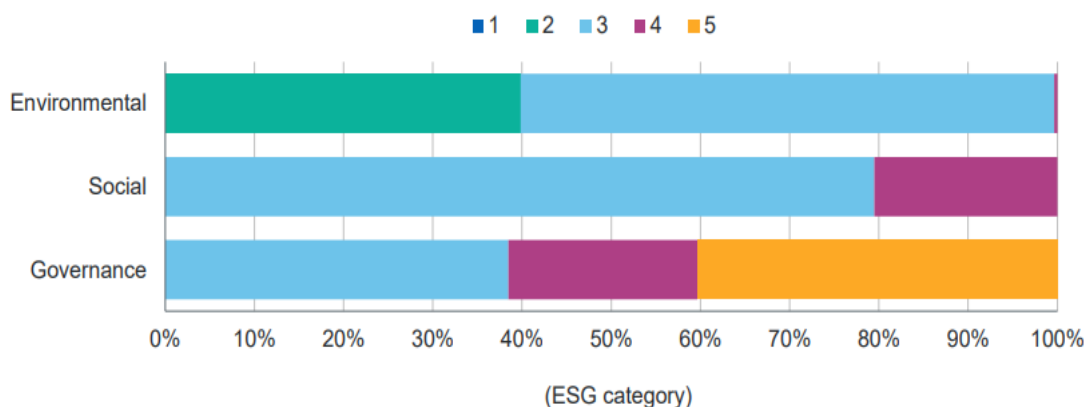


Figure 8 The distribution of relevance scores across the different categories. The possible categories are: ‘5’ (“highly relevant to the rating, a key rating driver with a high weight”), ‘4’ (“relevant to rating, a rating driver”), ‘3’ (“relevant to the sovereign rating, but only affect it indirectly or in combination with other factors.”), ‘2’ (“irrelevant to the entity rating but relevant to the sector”), ‘1’ (“irrelevant to the entity rating and irrelevant to the sector”).

Source: Fitch Ratings, 2019, p. 2.

3. Discussion

3.1. General comments

The three rating methodologies are tailored to their primary purpose of informing investors or policymakers rather than scientists. There is a higher interest in the rating outcome than in the procedure leading to it. Accordingly, the methodological description is sometimes vague, while no rigorous justification is offered for the choice of indicators, the normalization, the weighting, and the aggregation processes.

The choice of the economic indicators for sovereign risk rating is perhaps less of an issue, as all the three methodologies are based upon economic variables that are quite well founded in economic theory and historical evidence. Nonetheless, it is worth highlighting that only Fitch that makes use of an econometric approach, can test quantitatively the significance of the chosen variables in measuring sovereign risk. The econometric evidence is also at the basis of the constant update of the Fitch sovereign rating model that is not fixed a priori. It can on the contrary accommodate changes to constantly improve the measure of sovereign creditworthiness. The approaches used by Moody’s and S&P must assume that the indicators chosen are relevant. At the same time, compared to Fitch, S&P and Moody’s, offer an ampler set of sub-factors and metrics in the assessments.

This said, both Moody and S&P use a multi-step weighing system based on fixed, non-optimized weights in the lower aggregation levels and dynamic weight assignment in the higher level of aggregation. All the weighting procedure reflects a subjective preference structure. Taking for granted that some degree of subjectivity is unavoidable, it would be important to have more transparency on the choice made.

All this said, also the regression model used by Fitch presents important shortcomings. The simple linear function used in the estimation implies that more complex and higher-level interactions between rating factors are not considered. This might bias the estimates of statistical significance. The description of the sovereign rating model does not include regression diagnostics to evaluate the performance of the model

from a statistical point of view. Moreover, endogeneity might be present. This issue can be particularly problematic considering that the dependent variable in the SRM is the long-term foreign currency issuer default rating produced by the SRM and the QO. The dependent variable is thus highly dependent on the past values rather than a truly exogenous time series as would be the case in econometric applications. Said differently, the information set the weights are derived from, is the dataset used the first time that the regression model was applied. This feature to a large extent goes against the purpose of building an evidence-based, data driven index. Most importantly, after all the effort put in the econometric assessment, presumably to provide a robust quantitative, and as much objective as possible foundation to the evaluation, the more subjective qualitative overlay intervenes to correct the procedure. All the three methodologies finally are based on a linear aggregation.

3.2. Implementation of the ESG and climate risk in the rating methodologies

The arguments raised with respect to the overall rating approach apply also to the assessment of climate change as a sovereign risk mega trend. All the three agencies include the climate change risk dimension. However, this is implemented as a correction factor that concurs with the ESG indicators to refine the “core” rating procedure through an external qualitative (read analyst driven opinion) rather than a quantitative process. This is more evident in the Moody’s and S&P methodologies, but it also applies to Fitch that corrects the results from the econometric model with the qualitative overlay. In addition to the subjectivity or lack of robustness introduced, this procedure seems to allude to a lower importance of ESG in general and of climate risk factors in particular in the determination of sovereign risk.

While Moody’s and Fitch have introduced separate metrics measuring the relevance of the ESG considerations on the sovereign rating, only Moody’s enumerates the metrics used to operationalize the ESG risks and the data sources. Environmental risks appear to have a moderately negative impact on the credit scores. In the case of S&P, the exact ESG metrics used are not clear, which makes the appraisal and replication of the methodology difficult. Also unclear in this case remains the measurement, normalization, and weighting of the ESG factors and where exactly they enter the sovereign rating framework. The possibility of double counting cannot be ruled out a-priori in any of the three methodologies.

Furthermore, none of the three methodologies utilizes a “consolidated” climate risk definition such as, for instance that proposed by the IPCC AR5 based on hazard, exposure and adaptive capacity and largely adopted by other studies like Mysiak et al. (IPCC, 2014, p. 3), (Mysiak et al., 2018). Using a standardized conceptual framework can enable a more comprehensive and thus informative assessment of the role of climatic risk. Some elements of sensitivity and adaptive capacity are however reported among the rating factors used to evaluate the creditworthiness of sovereigns and in the social and governance factors. This calls for some caution in a straight use of the IPCC risk framework to avoid redundancies and double counting. An explicit appraisal and harmonization of the time horizons used in the definition of ESG risks are necessary to ensure comparability of the results.

3.3 Lines for future improvement

The methodologies can be improved along different lines. The indicators set used to reflect climate change risk are mostly represented by the hazard component, the exposure and vulnerability components are less considered or are included separately as part of the social or governance domains. A more structured approach could thus better represent the climate risk dimension. Essential in any indicator-based approach are the relevance of the chosen indicators and the parsimony. The first should be tested quantitatively with econometric or statistic techniques. When not possible, qualitative expert opinions could be employed. Once a screening of indicators is made, correlation analysis, principal component analysis or a lasso regression can be used to distill a narrower set of indicators still sufficiently representative.

The normalization could include the definition of suitable benchmark and/or the implementation of a value function with the aim to translate the original variable value, expressed into its own scale, into a common scale where low/high values indicate unsatisfactory/satisfactory values. A closed scale, common to all the involved variables, is useful for the subsequent aggregation phase. Nevertheless, this crucial activity is not

without its difficulties, given that the shape of the normalization functions strongly depends on the personal attitude of the decision maker. Alternatives based only the data distribution like linear interpolation among the minimum and the maximum, Z-score and so on can be critical and subjected to undesired phenomena like rank reversal. Conversely, internationally recognized benchmarks, or recommended by commonly applied policies, can be useful in these circumstances. Otherwise this information could be elicited by a group of experts using a focus group, brainstorming, questionnaire designed *ad hoc*, or other approach.

Transparency and objectivity in the normalization can be improved by value-neutral and data-driven benchmarking. Instead of arbitrary “target-based” benchmarking, k-mean clustering can be applied, whereby data are clustered together around centroids according to more objective similarity criteria (usually Euclidean distance) in order to minimize the distance within the clusters and maximize the distance across clusters. Of course, the flip side of such an agnostic approach is that what drives data aggregation is not necessarily self-evident, and a further interpretation effort is needed. However, unexpected clustering patterns can even lead to new insights about not so evident factors that may have driven these patterns (Altman and Krzywinski, 2017).

As previously noted, the way weights are determined generally suffers from intrinsic arbitrariness. Even an apparently neutral choice such as the one of equal weights attribution is implicitly based on a value judgment that allocates equal relevance to the factors involved. A partial exception is Fitch’s approach that derives the weights by means of OLS estimation. There are still some elements of arbitrariness in Fitch’s approach in the choice of the functional form to be estimated, that is, in the choice of the explanatory variables and in the use of a purely linear model. We propose to test alternative functional forms, including non-linear models and selecting explanatory variables using a rigorous approach.

Aggregation has the advantage of concentrating all the available data into a single number, in many circumstances used to obtain a ranking, but it is clear that some information is lost. Thus, it is necessary to clarify how a particular result is reached, which are criteria considered more important, and why. The aggregation procedures used by the rating agencies are partially linear, which implies perfect substitutability across indicators. More sophisticated methodologies can be adopted to reflect the joint relevance of cluster of indicators and account for complementarities and/or imperfect substitutability.

In general, a best practice with respect to normalization-aggregation consists in defining a general method which depends on some parameters to be elicited by the people involved in the decision process, decision maker(s) or expert(s). After having accepted the subjective nature of the decision process, the adopted normalization-aggregation procedure should reflect as best as possible the “real” preference structure of the decision maker, which usually is based on complex and not linear mental processes. This requires the introduction of more sophisticated approaches, as generalized mean, logical operators, non-additive measures, fuzzy logic, but also machine learning based algorithms and so on.

The climate risk indicator set can be used for forward looking exercises. Many climate hazard data are indeed available for different long-term climate change scenarios. These, coupled with social economic projections on exposure and vulnerability open the possibility for long-term projections of climate risk and of climate risk impact on sovereign risk. This can be particularly interesting for scenario analysis of the more general country risk and exploration of the subnational level for analysis.

4. Conclusion

We describe how climate change risk is currently, explicitly or implicitly, accounted for in the sovereign credit rating methodologies of Moody’s, S&P and Fitch We therefore review the credit rating methodologies by the agencies and analyze how they accommodate environmental, social and government risk factors. We elaborate on the idiosyncrasies of the three rating methodologies and critically evaluate their suitability and limitations. We conclude that the methodologies can be improved upon in various ways.

The subjectivity apparent in the current methodologies can be offset by introducing an indicator selection procedure that would allow for the testing of the indicator relevance with respect to climate change risk at the sovereign level. A structured, statistically based procedure would increase the parsimony as well. The normalization of the indicators could include the definition of an internationally recognized benchmark or an explicit value function. Another improvement of the normalization procedure would consist in applying a data-driven benchmarking technique such as statistical clustering. The weights could be determined by eliciting the preferences of people involved in the decision process, for instance decision makers or experts, which would minimize the arbitrariness of this choice. The linearity in the aggregation procedures, which implies perfect substitutability across indicators, could be improved upon by adopting more sophisticated approaches reflecting the complex interrelations between the indicators. A procedure could be introduced to avoid double counting of risk. Sensitivity analysis could be employed to understand the robustness of the results. Another improvement would be utilizing climate hazard data coupled with socio-economic projections of exposure and vulnerability for the long-term projections of climate risk and of climate risk impact on sovereign risk. This can offer insights to evaluate the risk profile of long-term investments in climate sensitive sectors.

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Appendix

Factor	Subfactor	Indicators (Sub-sub-factors)	Weight
Economic Strength	Growth Dynamics	Average Real GDP Growth over the ten years t-4 to current time (t)+5 years	25%
		Volatility in Real GDP Growth over the ten years t-9 to t	10%
	Scale of the Economy	Nominal GDP (US\$ bn) t	30%
	National Income	GDP per Capita (PPP, Int. USD) t	35%
	Adjustment	Other (0-9 notches)	
Institutions and Governance Strength	Quality of Institutions	Quality of Legislative and Executive Institutions	20%
		Strength of Civil Society and the Judiciary	20%
	Policy Effectiveness	Fiscal Policy Effectiveness	30%
		Monetary and Macroeconomic Policy Effectiveness	30%
	Adjustment	Government Default History and Track Record of Arrears (0-3 notches)	
		Other (0-3 notches)	
Fiscal Strength	Debt Burden	General Government Debt / GDP t	25%
		General Government Debt / Revenue t	25%
	Debt Affordability	General Government Interest Payments/GDP t	25%
		General Government Interest Payments/Revenue t	25%
	Adjustment	Debt trend over the five years t-4 to t+1 (0-6 nodes)	
		General Government Foreign Currency Debt / General Government Debt t (0-6 nodes)	
		Other Non-Financial Public Sector Debt/GDP t (0-6 nodes)	
		Public Sector Financial Assets and Sovereign Wealth Funds/ General Government Debt t (0-6 nodes)	

		Other (0-3 notches)	
Susceptibility to Event Risk	Political Risk	Domestic Political and Geopolitical Risk	min
	Government Liquidity Risk	Ease of Access to Funding	min
		(0-2 scores)	
	Banking Sector Risk	Risk of Banking Sector Credit Event	min
		Total Domestic Bank Assets /GDP t	
		(0-2 scores)	
	External Vulnerability Risk	External Vulnerability Risk	min
		(0-2 scores)	
	Adjustment	(0-2 scores)	

Table 1. Scorecard Overview. The subscript t refers to the current year.

Source: Moody's Investors Service, 2019, p. 4.

Factor	Economic Strength			
Indicator	Average Real GDP Growth (%)	Volatility in Real GDP Growth (%)	Nominal GDP (US\$ bn)	GDP per Capita (PPP, Int\$)
Alphanumeric category				
aaa	≥ 5.7	< 1.4	≥ 1000	≥ 48000
aa1	5.3 – 5.7	1.4 – 1.46	750 – 1000	42000 - 48000
aa2	4.9 – 5.3	1.46 – 1.53	600 – 750	37000 - 42000
aa3	4.4 – 4.9	1.53 – 1.62	450 – 600	32000 - 37000
a1	4 – 4.4	1.62 – 1.72	330 – 450	27500 - 32000
a2	3.7 – 4	1.72 – 1.83	250 – 330	24500 - 27500
a3	3.3 – 3.7	1.83 – 1.96	190 – 250	21000 – 24500
baa1	3 – 3.3	1.96 – 2.10	140 – 190	19000 – 21000
baa2	2.6 – 3	2.10 – 2.26	100 – 140	16000 – 19000
baa3	2.3 - 2.6	2.26 – 2.42	80 – 100	14000 – 16000
ba1	2 – 2.3	2.42 – 2.61	60 – 80	12000 – 14000
ba2	1.8 – 2	2.61 – 2.80	45 – 60	10750 – 12000
ba3	1.6 – 1.8	2.80 – 3.01	35 – 45	9500 – 10750
b1	1.3 – 1.6	3.01 – 3.23	26 – 35	8000 – 9500
b2	1.1 – 1.3	3.23 – 3.47	20 – 26	7000 – 8000
b3	0.9 – 1.1	3.47 – 3.71	15 – 20	6200 – 7000
caa1	0.7 – 0.9	3.71 – 3.98	10 – 15	5500 – 6200
caa2	0.5 – 0.7	3.98 – 4.25	8 – 10	4700 - 5500
caa3	0.3 – 0.5	4.25 – 4.54	6 – 8	4100 - 4700
ca	< 0.3	> 4.54	< 6	< 4100

Table 2. Conversion table for the factor Economic Strength to an alphanumeric score.
Source: Moody's Investors Service, 2019, p. 7.

Alphanumeric category	Numeric score
aaa	$x \leq 1.5$
aa1	$1.5 < x \leq 2.5$
aa2	$2.5 < x \leq 3.5$
aa3	$3.5 < x \leq 4.5$
a1	$4.5 < x \leq 5.5$
a2	$5.5 < x \leq 6.5$
a3	$6.5 < x \leq 7.5$
baa1	$7.5 < x \leq 8.5$
baa2	$8.5 < x \leq 9.5$
baa3	$9.5 < x \leq 10.5$
ba1	$10.5 < x \leq 11.5$
ba2	$11.5 < x \leq 12.5$
ba3	$12.5 < x \leq 13.5$
b1	$13.5 < x \leq 14.5$
b2	$14.5 < x \leq 15.5$
b3	$15.5 < x \leq 16.5$
caa1	$16.5 < x \leq 17.5$
caa2	$17.5 < x \leq 18.5$
caa3	$18.5 < x \leq 19.5$
ca	$19.5 < x \leq 20.5$
c	$x > 20.5$

Table 3 Alphanumeric score to numeric score for quantitative variables. The hypothetical value of the numeric score corresponding to different categories is given by “x”.

Source: Moody’s Investors Service, 2019, p. 53.

Indicator	aaa endpoint value (numeric score 0.5)	ca endpoint value (numeric score 20.5)
Average Real GDP Growth	15%	0%
Volatility in Real GDP Growth	0%	40%
Scale of the Economy	\$25000bln	\$1bln
National Income	Intl\$100000	Intl\$1000
General Government Debt / GDP t	0%	700%
General Government Debt / Revenue	0%	700%
General Government Interest Payments/GDP t	0%	35%
General Government Interest Payments/Revenue t	0%	35%

Table 4 Cutoff points for the conversion of the alphanumeric category to a numeric score. Intl\$ refers to international dollars.

Source: Moody's Investors Service, 2019, p. 55.

Sub-factor	Quality of Institutions
Sub-sub-factor	Strength of Civil Society and the Judiciary
Alphanumeric category	Sovereign Characteristics
aaa	<ul style="list-style-type: none"> ● WGI scores for voice and accountability, rule of law and control of corruption typically above 1.5. ● The enforcement of laws is highly predictable and consistent, including with respect to the government itself. ● An effective balance of power and separation of powers is consistently and dependably maintained between branches of government, and judicial independence is maintained and respected. ● There are few instances of corruption that act to the detriment of the sovereign's credit profile. ● Judicial processes are impartial, contracts are enforced, and legal cases are resolved in a timely manner. ● Institutions in civil society consistently act as an effective check on the exercise of government power.
aa	<ul style="list-style-type: none"> ● Generally have WGI scores for voice and accountability, rule of law and control of corruption typically between 1.5 and 1.0. ● The enforcement of laws is highly predictable and consistent, including with respect to the government itself. ● An effective balance of power and separation of powers is consistently and dependably maintained between branches of government, and judicial independence is maintained and respected. ● There are few instances of corruption that act to the detriment of the sovereign's credit profile. ● Judicial processes are impartial, contracts are enforced, and legal cases are resolved in a timely manner. ● Institutions in civil society consistently act as an effective check on the exercise of government power.
a	<ul style="list-style-type: none"> ● Generally have WGI scores for voice and accountability, rule of law and control of corruption typically between 1.0 and 0.5. ● The enforcement of laws is usually predictable and consistent, including with respect to the government itself. ● An effective balance of power and separation of powers is generally maintained between branches of government. However, judicial independence is not always maintained. ● Corruption can be a problem that acts to the detriment of the sovereign's credit profile. ● Judicial processes are impartial and contracts are enforced, but it often takes a long time for a case to be resolved in the courts. ● Civil society institutions often act as an effective check on the exercise of government power.
baa	<ul style="list-style-type: none"> ● WGI scores for voice and accountability, rule of law and control of corruption typically between 0.5 and 0.0.

	<ul style="list-style-type: none"> ● The enforcement of laws is usually predictable and consistent, including with respect to the government itself. ● An effective balance of power and separation of powers is generally maintained between branches of government. However, judicial independence is not always maintained. ● Corruption can be a problem that acts to the detriment of the sovereign's credit profile. ● Judicial processes are impartial and contracts are enforced, but it often takes a long time for a case to be resolved in the courts. ● Civil society institutions often act as an effective check on the exercise of government power.
ba	<ul style="list-style-type: none"> ● WGI scores for voice and accountability, rule of law and control of corruption typically between 0.0 and -0.5. ● The enforcement of laws is sometimes unpredictable and inconsistent. ● Checks on the exercise of government power are not consistently applied. The judiciary is subject to political influence in ways that affect the business climate or other aspects of the sovereign's credit profile. ● Corruption is a significant structural challenge that undermines policy formation, economic stability and/or social cohesion. ● There is evidence of judicial bias, and contract enforcement can be challenging. ● Civil society institutions exist, but have difficulty acting as an effective check on the exercise of government power.
b	<ul style="list-style-type: none"> ● WGI scores for voice and accountability, rule of law and control of corruption typically between -0.5 and -1.0. ● The enforcement of laws is sometimes unpredictable and inconsistent. ● Checks on the exercise of government power are not consistently applied. The judiciary is subject to political influence in ways that affect the business climate or other aspects of the sovereign's credit profile. ● Corruption is a significant structural challenge that undermines policy formation, economic stability and/or social cohesion. ● There is evidence of judicial bias, and contract enforcement can be challenging. ● Civil society institutions exist, but have difficulty acting as an effective check on the exercise of government power.
caa	<ul style="list-style-type: none"> ● WGI scores for voice and accountability, rule of law and control of corruption typically between -1.0 and -1.5. ● The enforcement of laws is usually unpredictable and inconsistent. ● There are few formal checks on the exercise of government power or the judiciary is not independent. ● Corruption is endemic and affects a wide range of policy choices. The courts system is ineffective.

	<ul style="list-style-type: none"> ● Civil society institutions either do not exist or have little discernable impact on the exercise of government power.
ca	<ul style="list-style-type: none"> ● WGI scores for voice and accountability, rule of law and control of corruption typically below -1.5. ● The enforcement of laws is usually unpredictable and inconsistent. ● There are few formal checks on the exercise of government power or the judiciary is not independent. ● Corruption is endemic and affects a wide range of policy choices. ● The courts system is ineffective. ● Civil society institutions either do not exist or have little discernable impact on the exercise of government power.

Table 5 Conversion table for the factor Strength of Civil Society and the Judiciary to an alphanumeric score.
Source: Moody's Investors Service, 2019, p. 14.

aaa	aa	a	baa	ba	b	Caa	ca
1	3	6	9	12	15	18	20

Table 6 Scale for the mapping of qualitative factors. Source: Moody's Investors Service.

Source: Moody's Investors Service, 2019, p. 52.

Carbon transition
Current positioning for carbon transition
Technology, market and policy risk
Action to mitigate risk
Long-term resilience to risk of accelerated carbon transition
Physical climate risks
Current and future effects of climate change
Exposure to heat stress, water stress, floods, hurricanes, sea level rise and wildfires
Water management
Non-climate related risks
Impact of economic activity
Availability, access and consumption
Innovations to enhance water use efficiency
Risk of pollution related regulatory violations
Waste and pollution
Non CO ₂ air pollutants
Land based accidents, spills and leaks
Hazardous and non-hazardous waste
Circular economy (product reuse, recycling)
Natural capital
Impact on natural systems (soil, biodiversity, forest, land, oceans, etc)
Dependency on goods and services derived from nature (agriculture, fiber, fish, etc)

Table 7 Environmental risk categories.

Source: Moody's Investors Service, 2020, p. 13.

Demographics
Age distribution
Immigration
Birth rates
Racial and ethnic composition or trends
Labor and income
Labor force participation
Income inequality
Education
Access to primary, secondary and tertiary education
Educated populace
Literacy
Housing
Availability and access to housing
Condition of housing
Health and safety
Healthcare
Food security
Environmental quality
Personal safety and well-being
Access to basic services
Water
Sewer
Electricity
Financial services
Transportation
Telecom and internet access

Table 8 Social risk categories

Source: Moody's Investors Service, 2020, p. 15.

Institutional structure
Strength of judiciary and civil society
Institutional arrangements that guide fiscal and macroeconomic policy
Control of corruption
Policy credibility and effectiveness
Fiscal policy track record and effectiveness
Monetary and macroeconomic policy effectiveness
Regulatory effectiveness
Transparency and disclosure
Comprehensiveness and reliability of economic, fiscal and financial data
Timely financial disclosure
Budget management
Budgetary and forecast accuracy
Management quality and experience
Effective use of multi year planning for operating and capital spending

Table 9 Governance risk categories

Source: Moody's Investors Service, 2020, p. 17.

Institutional Assessment
The effectiveness, stability, and predictability of policymaking and political institutions
The transparency and accountability of institutions, data and processes, and the coverage and reliability of statistical information
The sovereign's debt payment culture, external security risks
Economic and monetary assessments key indicators
GDP per capita (USD)
Percentage change in real GDP per capita
Percentage change in consumer price index
Percentage change in depository corporation claims
Monetary base
External assessment key indicators
Current account receipts (CAR)
Current account payments (CAP)
Official reserves
Usable reserves
Narrow net external debt/CAR or CAP (%)
Gross external financing needs (% of CAR plus usable reserves)
Current account balance/CAR (%)
Net foreign direct investment (FDI)/GDP (%)
Net external liabilities/CAR (%)
Terms of trade

Fiscal assessment key indicators
General government
Change in net general government debt as a percentage of GDP
Net general government debt/GDP (%)
General government liquid financial assets
Gross general government debt/GDP (%)
General government interest/general government revenues (%)

Table 10 Key factors considered in the credit rating methodology of S&P

Source: S&P Global, 2017.

Environmental factors
Greenhouse gas emission factors, including CO ₂ emissions
Natural conditions factors, e.g., weather events
Other pollution factors, separate from greenhouse gases
Other environmental factors, e.g., water and land use and biodiversity
Environmental credit benefits, e.g., factors that create revenue and earnings opportunities or reduce environmental risks
Social factors
Safety management factors, e.g., safety violations that lead to financial and reputational damage
Consumer-related factors, e.g., mis-selling of products, linked to environmental and social factors
Human capital management factors, e.g., factors linked to employee disputes and productivity
Social credit benefits, e.g., factors that create revenue and earnings opportunities or reduce social risks
Governance factors
Strategy, execution, and monitoring factors
Risk management and internal control factors
Transparency factors, including factors linked to the quality of information disclosure
Board-related factors, including factors linked to the board's composition, independence, turnover, skill sets, key person risk management, culture, and oversight of management
Other governance factors

Table 11 ESG factors considered in the sovereign rating methodology of S&P

Source: S&P Global Ratings, 2018, p. 3.

Variable	Description
Structural features	
Composite governance indicator	Simple average percentile rank of World Bank governance indicators: “rule of law”; “government effectiveness”; “control of corruption” and “voice & accountability”; “regulatory quality”; “political stability & absence of violence”
GDP per capita	Percentile rank of GDP per capita in US dollars at market exchange rates
Share in world GDP	Natural logarithm of % share in world GDP in US dollars at market exchange rates
Years since default or restructuring event	Non-linear function of the time since the last event; the indicator is zero if there has been no such event after 1980. For each year that elapses, the impact on the model output declines.
Money supply	Natural logarithm of broad money (% of GDP)
Macroeconomic performance (Macro)	
Real GDP growth volatility	Natural logarithm of an exponentially-weighted standard deviation of historical annual percent changes in real GDP
Consumer price inflation	Three-year centred average of the average annual % change in consumer price index (CPI), truncated between 2% and 50%
Real GDP growth	Three-year centred average of the average annual % change in real GDP
Public finances, general government	
Gross general government debt	Three-year centred average of gross (general) government debt (% of GDP)
Interest payments	Three-year centred average of gross government interest payments (% of general government revenues)
General government fiscal balance	Three-year centred average of general government (budget) balance (% of GDP)
Public foreign-currency debt	Three-year centred average of public foreign-currency-denominated (and indexed) debt (% of general government debt)
External finances	
Reserve currency flexibility	Reserve currency flexibility based on the natural logarithm of the share of that country’s currency in global foreign-exchange reserve portfolios (plus a technical constant), as reported by the IMF in its COFER database (updated quarterly with a four-month lag)
Commodity dependence	Non-manufactured merchandise exports as a share of current account receipts (CXR)

Official international reserves for non-reserve currency sovereigns	Year-end stock of international reserves (including gold) expressed as months' cover of current external payments (CXP). This variable is set to zero for all sovereigns with a reserve currency flexibility score above zero.
Sovereign net foreign assets	Three-year centred average of sovereign net foreign assets (% of GDP)
Current account balance plus net foreign direct investment	Three-year centred average of Current Account Balance (CAB) plus net FDI (% of GDP)
External interest service	Three-year centred average of external interest service expressed as a share of CXR

Table 12 Factors considered in the Sovereign Rating Model by Fitch

Source: Fitch Ratings, 2020b, p. 32.

QQ definitions	
Macroeconomic outlook, policies and prospects (Macro) (0-2 nodes)	Macroeconomic policy credibility and flexibility
	GDP growth outlook
	Macroeconomic stability
Public finances (0-2 notches)	Fiscal financing flexibility
	Public debt sustainability
	Fiscal structure
External finances (0-2 notches)	External financing flexibility
	External debt sustainability
	Vulnerability to shocks
Structural features (0-2 notches)	Political stability and capacity
	Financial sector risks
	Business environment and economic flexibility

Table 13 Factors considered in the qualitative overlay

Source: Fitch Ratings, 2020b, p. 9.

Environmental
GHG emissions and air quality
Energy management
Water resources and management
Biodiversity and natural resources
Natural disasters and climate change
Social
Human rights and political freedoms
Human development, health and education
Employment and income equality
Public safety and security
Demographic trends
Governance
Political stability and rights
Rule of law, institutional and regulatory quality, control of corruption
International relations and trade
Creditors rights
Data quality and transparency

Table 14 ESG risk categories accounted for in the Fitch ratings

Source: Fitch Ratings, 2019, p. 4.

Fitch risk category	Sustainability Accounting Standards Board (SASB)	United Nations Principles for Responsible Investing (PRI)
GHG Emissions and Air Quality	GHG emissions, Air quality	Carbon intensity, Pollution
Energy Management	Energy management, Fuel management	Energy resources and management
Water Resources and Management	Water and waste management	Water stress
Biodiversity and Natural Resource Management	Biodiversity impacts	Natural resources, Agriculture, Biodiversity, Biocapacity and ecosystem quality
Natural Disasters & Climate Change	Environmental and social impacts on assets and operations	Natural disasters, Climate change

Table 15 Environmental risk categories corresponding to the SASB and PRI categories

Source: Fitch Ratings, 2019, p. 12.

Fitch Risk Category	Sustainability Accounting Standards Board (SASB)	United Nations Principles for Responsible Investing (PRI)
Human Rights and Political Freedoms	Human rights and community relations	Political and press freedoms, Human rights, Trust in society and institutions
Human Development, Health & Education	-	Education and Human Capital, Health levels
Employment and Income Equality	Labour relations, Fair labour practices, Diversity and inclusion, Compensation and benefits, Recruitment, development and retention	Employment levels, Labour standards, Social exclusion and poverty, Income inequality
Public Safety and Security	-	Crime and safety
Demographic Trends	-	Demographic change

Table 16 Social risk categories corresponding to the SASB and PRI categories

Source: Fitch Ratings, 2019, p. 12.

Fitch Risk Category	Sustainability Accounting Standards Board (SASB)	United Nations Principles for Responsible Investing (PRI)
Rule of Law, Institutional & Regulatory Quality, Control of Corruption	Regulatory capture and political influencing	Institutional strength, Corruption, Rule of law, Regulatory effectiveness
Political Stability and Rights	-	Regime stability, Political rights and civil liberties
International Relations and Trade	-	International relations, Adherence to Conventions
Creditors Rights	Business ethics and transparency of payments	
Data Quality and Transparency	-	Accounting standards, Financial reporting

Table 17 Governance risk categories corresponding to the SASB and PRI categories

Source: Fitch Ratings, 2019, p. 12.

Environmental Risk Category	Key Issues	Sovereign Rating Criteria Affected
GHG Emissions and Air Quality	Emissions and air pollution as a constraint to GDP growth	SRM – Macro: real GDP growth, QO – Macro: GDP growth outlook
Energy Management	Management of energy resource endowments affecting exports, government revenues and GDP	SRM – External finances: commodity dependence; SRM and QO indirectly affects other SRM variables and QO judgements.
Water Resources and Management	Water resource availability and management as a constraint on GDP growth	SRM – Macro: real GDP growth; QO – Macro: GDP growth outlook
Biodiversity and Natural Resource Management	Biodiversity impacts	SRM – External finances: commodity dependence; SRM and QO – indirectly affects other SRM variables and QO judgements
Natural Disasters & Climate Change	Environmental and social impacts on assets and operations	SRM – Structural features: share in world GDP; Macro: GDP volatility; QO – External finances: vulnerability to shocks; SRM and QO – potential impact on other variables

Table 18 Environmental risk categories, corresponding issues and a reference to the sovereign rating criteria by Fitch

Source: Fitch Ratings, 2019, p. 5.

Social Risk Category	Key Issues	Sovereign Rating Criteria Affected
Human Rights and Political Freedoms	Social stability, voice and accountability, regime legitimacy	SRM – Structural features: World Bank governance indicators; QO – Structural features: political stability and capacity
Human Development, Health & Education	Impact of human development, health and education on GDP per capita and GDP growth	SRM – Structural features: GDP per capita; Macro: real GDP growth; QO: Macro: GDP growth outlook
Employment and Income Equality	Impact of unemployment and income equality on GDP per capita, GDP growth and political and social stability	SRM – Structural features: GDP per capita; Macro: real GDP growth; QO – Macro: GDP growth outlook; Structural features: political stability and capacity
Public Safety and Security	Impact of public safety and security on business environment and/or economic performance	SRM – Macro: real GDP growth; QO – Structural features: political stability and capacity and business environment; Macro: GDP growth outlook
Demographic Trends	Population’s decline or aging, rapidly rising youth population, pensions sustainability	SRM – Macro: real GDP growth; Public Finances: government debt/GDP; QO – Public finances: public debt sustainability; Structural features: political stability; Macro: growth outlook.

Table 19 Social risk categories, corresponding issues and a reference to the sovereign rating criteria by Fitch
Source: Fitch Ratings, 2019, p. 5.

Governance Risk Category	Key Issues	Sovereign Rating Criteria Affected
Rule of Law, Institutional & Regulatory Quality, Control of Corruption	Political divisions and vested interests; geo-political risks including conflict, security threats and violence; policy capacity: unpredictable policy shifts or stasis	SRM – Structural features: World Bank governance indicators; QO – Structural features: political stability and capacity
Political Stability and Rights	Government effectiveness, control of corruption, rule of law, regulatory quality	SRM – Structural features: World Bank governance indicators; QO – Structural features: political stability and capacity and business environment
International Relations and Trade	Trade agreements, membership of international organizations, bilateral relations, sanctions and other costly international actions	SRM – External finances: Current account deficit and FDI; Macro: real GDP growth; QO – Structural features: political stability and business environment; External finances: vulnerability to shocks
Creditors Rights	Willingness of service and repay debt	SRM – Structural features: years since default or restructuring even; QO – Potential adjustment in one of the QO pillars
Data Quality and Transparency	Availability, limitations and reliability of economic and financial data, including transparency of public debt and contingent liabilities	Data Sources, Limitations and Reasonable Investigation; Data Revisions and Limitations

Table 20 Governance risk categories, corresponding issues and a reference to the sovereign rating criteria by Fitch

Source: Fitch Ratings, 2019, p. 6.