Sustainability and Sovereign credit risk

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Abstract

We investigate the impact of Environmental, Social and Governance (ESG) scores on sovereign credit risk. Sovereign credit risk is measured following a market-based, structural and analyst-based approach and ESG scores are obtained from three different rating agencies. The contributions of this paper are twofold. First, we find that sustainability significantly decreases market-based and structural sovereign credit risk, but has no consistent impact on analyst-based sovereign credit risk. Second, we show that the relationship between sustainability and sovereign credit risk differs across ESG rating providers, which confirms the general concern about the lack of standardization and comparability of sustainability measures.

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1. INTRODUCTION

The case for integrating ESG factors in business processes is becoming increasingly compelling as the effects of climate change are becoming more visible. The rising importance of a sustainable economy has led investors to question how ESG factors impact the financial performance and reputation of a company. While the impact of corporate sustainability on stock returns is still debated on, there seems to be a general consensus that corporate credit risk is negatively related to environmental and social corporate performance. The bulk of the literature focuses exclusively on the incorporation of ESG concerns in corporate credit risk assessment and more standardized data on ESG factors is available at a corporate level than at the sovereign level. The incorporation of social and environmental risk in sovereign debt portfolios is currently not well understood. This is worrying because the global sovereign debt market is one of the largest asset markets in the world and sustainability risks may pose an important threat at the country level. Take for example environmental risk, which affects sovereign credit risk through three channels: (1) transition risk which refers to the necessary actions to meet a country's climate commitments, (2) physical risk that materializes through physical damage due to climate-related events, and (3) resilience, or the country's preparedness to cope with climate issues.[4] It is therefore necessary to investigate the extent to which ESG factors are incorporated in sovereign credit risk measures.

The importance of the urgency of dealing with sustainability risks has been reiterated by the recent global pandemic. In a recent interview, Richard Peers, founder of Responsible Risk argues that implementation of ESG measures in business processes creates value in the long run. To support his argument, Peers refers to the recent worldwide Covid-19 crisis in the stock markets, where many ESG funds have held up quite well. Next, he makes an analogy with the fast spreading of Covid-19 around the world and how the escalation has been visceral. A lot has been heard and said about climate change but it is a bit further away. However, the same conditions are in place for a global climate crisis to unfold. This has led people in the sustainable investment community to focus more on the triple bottom line by taking into account that the natural, human and financial capital needs to be managed all the way through the systems and supply chains (Finextra, 2020).

The consequences of the pandemic have also further reiterated the spillover effects from corporate risks to the country level. As a result of large compensation programs for the corporate sector, the Covid-19 crisis has put significant pressure on government finances which are likely to result in growth contraction, fiscal deficits and high debt ratios in the near future, calling for a need to reassess the credit risk scores at the sovereign level. Recently, G20 countries have provided a debt moratorium to the emerging economies on sovereign debt payments (Financial Times, 2020). However, there is a high risk that the current liquidity ease results in defaults when in addition to the existing debt, governments have to support their economies and social and health infrastructure which may generate a negative snowball effect (Forbes, 2020).

The idea for the paper is twofold. First, the paper aims to identify the relationship between sovereign credit risk measures and sustainability measures, notably environmental, social and governance factors. To get a complete picture of this relationship, we approach sovereign credit risk from a market-based (sovereign CDS spreads), a structural (sovereign distance-to-default) and an analyst-based (sovereign credit ratings) viewpoint. Country-level sustainability scores are calculated by aggregating corporate ESG scores by country.

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[4] Source: https://www.ftserussell.com/index/spotlight/climate-wgbi

A second aim of the paper is to compare the sustainability data, i.e. ESG scores provided by different rating agencies. In recent years, the number of ESG data providers and rating agencies have increased. Because of a lack of a standardized rating process, ESG scores from different providers are known to be weakly correlated. We use ratings data by three ESG rating agencies, notably SustainAnalytics, Refinitiv (former Thomson Reuters and ASSET4) and FTSE, and compare the ESG scores provided by these agencies. We investigate to what extent the ESG ratings by the different agencies explain the variance in the three different credit risk measures and whether the sustainability-credit risk relationship depends on the rating provider.

We find that higher corporate sustainability standards decrease market-based and structural sovereign credit risk. When dividing sustainability in its different factors, we show that the relationship between sustainability and sovereign credit risk is mainly driven by the environmental and social score, although this conclusions depends on the ESG rating provider used. With respect to analyst-based credit risk, which we measure with sovereign credit ratings, we find no consistent impact of sustainability. Depending on the ESG rating provider, the relationship between corporate sustainability standards and sovereign credit risk is found to be negative or positive. This finding illustrates the poor comparability of ESG scores across data providers and/or the inconsistent incorporation of sustainability in the credit risk evaluation by credit rating analysts.

The remainder of the paper is structured as follows. In Section 2 we discuss related literature. The data and research hypothesis are presented in Section 3 and Section 4 contains a description of the methodology. Section 5 discusses the results and the last section concludes.

2. LITERATURE

There are two competing hypotheses regarding the potential relationship between sustainability and credit risk. The risk mitigation hypothesis suggests that higher ESG ratings result in lower CDS spreads because corporate and country-level sustainability implies less uncertainty in future cash flows, a stronger reputation and better governance. The overinvestment hypothesis stipulates that ESG engagement and credit risk are positively related because higher investment in sustainability leads to additional costs which may increase a firm's or sovereign's default risk.

Several studies investigate the impact of ESG factors on credit risk. However, most of the studies have been conducted at a corporate level and not on a sovereign level because ESG data is available on a corporate level rather than for the country as a whole. We cover the literature on the relationship between sustainability scores and the three credit risk measures considered in this paper, notably CDS spreads, credit ratings and distance-to-default in the following paragraphs.

CDS Spreads and Sustainability Measures
Most studies investigating the relationship between corporate sustainability and corporate CDS spreads find supportive evidence for the risk mitigation hypothesis. Drago, Carnevale, and Gallo (2019) show that while ESG rating downgrades do not impact the CDS market, ESG rating upgrades result in a decrease in corporate CDS spreads 30 days post the announcement.

The impact of each sustainability factor on corporate credit risk is different. Clubb, Takahashi, and Tiburzio (2016) report a negative correlation between the ESG scores of S&P 500 companies and their respective option adjusted spreads (OAS). However, the impact of the individual sustainability factors on OAS is not

uniform. Only the environmental score has a significantly negative impact on the OAS whereas, social and governance scores show a positive but insignificant relation with the OAS. Barth, Hübel, and Scholz (2019) report similar findings on a sample of 108 European companies, for the period from June 2009 to Dec 2016. They find that environmental ratings have a significant and negative relation with CDS spreads whereas social and governance factors do not have a significant impact. Next, they test for non-linearities in the ESG-credit risk relationship. They group CDS spreads into quartiles based on their ESG ratings and analyze these quartiles individually. The results show that the highest CDS spreads for the first quartile i.e. lowest environmental ratings and lowest CDS spreads for last quartile i.e. highest environmental ratings are both significant. They find mixed results for social ratings as the CDS spreads decrease as they move from quartiles with higher social ratings to quartiles with lower social ratings except the lowest quartile where the CDS spreads increase.

There are only a few studies explore the relationship between sustainability and sovereign credit risk. Crifo, Diaye, and Oueghlissi (2017) analyze the effects of ESG factors on sovereign credit risk. They investigate the impact of Vigeo ESG ratings for 23 OECD countries on the government yield spreads calculated as the difference between the interest rate the government pays on its US-dollar denominated debt and the rate offered by the US treasury on debt of comparable maturity. The results of the study showed that the composite ESG has a significant negative impact on the bond yield spreads suggesting that higher ESG scores do result in lower borrowing costs. However, it also highlighted that the economic impact of financial variables and S&P credit ratings on sovereign spreads was higher than that of ESG ratings suggesting that the ESG ratings were used as a supplement to financial ratings and economic variables. In a subsequent study, Capelle-Blancard et al. (2019) analyze the impact of ESG factors on 20 OECD countries' sovereign bond spreads for the period 1996-2012. Instead of using ESG scores from an external agency, they create their own ESG indices using the guidelines outlined by various ESG rating agencies and asset managers arguing that ESG ratings mostly capture policies and symbolic activities rather than actual reductions in environmental and social impacts (Gonenc and Scholtens, 2017). Capelle-Blancard et al. identify a strong negative relationship between overall ESG scores and sovereign bond spreads. In contrast to what is found for corporate credit risk, the impact of the governance rating is more prominent than the social and environmental ratings. They also find that the strong relationship between ESG factors and bond spreads is more prevalent in euro zone than in other developed countries and that the effect became much stronger after the global financial crisis.

Margaretic and Pouget (2018) focus on the importance of ESG factors in emerging economies. The study uses a dataset of 33 emerging economies whose bonds are in the JP Morgan Emerging Markets Bond Index Global for the period 2001-2010. For ESG ratings, they consider the Environmental Performance Index constructed by the Yale University, Human Development Index constructed from data available on human development on World Bank and the World Governance Index constructed from the World Governance indicators are used as proxies for environmental, social and governance ratings respectively. They find that social and governance factors have a significant impact on emerging market sovereign bonds spreads, whereas environmental ratings do not have a significant impact on the bond spreads.

Credit Ratings and Sustainability Measures
As an alternative to market-based CDS spreads, credit ratings issued by specialized agencies such as S&P, Moody's and Fitch Ratings can be used as indicators of credit risk. Increased pressure from investors and the media has urged credit rating agencies to consider ESG risks in their credit risk assessment processes (Thompson, 2019). Due to a lack of transparency in the credit risk assessment methodologies, it is unclear to what extent the rating agencies value ESG risks as determinants of credit ratings. Another important development is that the credit rating agencies have been developing their own ESG scales by capitalizing

on their access to private information about companies. This may lead to more detailed ESG scoring because many independent ESG rating firms have access to publicly available information only (Reuters, 2019).

Much of the academic research on the relationship between credit ratings and ESG risks is done at the corporate level. Studies such as (Ashbaugh-Skaifea, W.Collins, and LaFondc, 2006; Tarigan and Fitriany, 2017; Sareen and Vij, 2014-2015) have demonstrated a significant positive relationship between corporate governance practices and corporate credit ratings. The majority of studies on corporate sustainability and credit ratings focus exclusively on the impact of governance factors on the ratings and do not thoroughly investigate the relation between environmental or social factors and credit ratings. An exception is the study by Bauer & Hann (2010) who test the effect of environmental concerns and proactive environmental engagement on corporate credit ratings. They conclude that environmental issues related to regulatory risk and climate change result in lower credit ratings and higher borrowing costs. In contrast, Devalle, Fiandrino, and Cantino (2017) show that social and governance factors meaningfully affect corporate credit ratings whereas environmental scores were not found to have an impact on the ratings.

Aktas, Karampatsas, and Witkowski (2019) examine whether an increase in a company's ESG score improves the credit ratings for companies which have fallen from an investment grade to speculative rating. They find that enhanced CSR engagement has a significant positive impact on the credit ratings of the firms, supporting the perspective that CSR engagement is a valuable risk-reducing mechanism.

Cubas-Díaz and Sedano (2018) evaluate not only the link between sustainable performance and credit ratings but also the weightage given to commitment to sustainability in the credit ratings. The authors create two measures, a Relative Sustainable Performance Measure (RSPM) and a Measure of Commitment Failure (MCF). The results show that sustainable performance (RSPM) has a significant positive relationship with corporate credit ratings. However, commitment failure (MCF) does not have a significant relationship implying that commitment to sustainability is not well-captured by the credit ratings.

Distance-to-default and Sustainability Measures
Distance-to-default is not a widely used credit risk measure for assessing sovereign credit risk so academic research is very scant on the measure. We found one study that analyzes the relationship between carbon emissions and a Merton model-based distance-to-default at the company level (Capasso and Gianfrate, 2019). The other variables included in the study include debt ratio, operating margin, retained earnings ratio, size, volatility and working capital ratio which are the standardized determinants of the distance-to-default of a company. They run the model for 458 companies included in the Bloomberg Barclays Agg Composite index for the period Dec 2006 to Dec 2017. A pooled and a fixed panel regression shows that the relationship between carbon emissions and distance-to-default is significantly negative i.e. higher carbon emissions reduce the distance-to-default of a company. The effect is even more prevalent in the post-Paris agreement period which revealed policymaker's intentions to implement stricter climate policies. The paper serves as a starting point for our research. We extend it to a sovereign level and incorporate further sustainability measures.

3. DATA AND HYPOTHESES
The earlier discussion and overview of the literature demonstrates that there should be a negative relationship between sustainability performance and sovereign credit risk. In light of this, three hypotheses are formulated below:

Hypothesis 1: There is a negative relationship between ESG scores and sovereign CDS spreads.

Hypothesis 2: There is a positive relationship between ESG scores and sovereign credit ratings.

Hypothesis 3: There is a positive relationship between ESG scores and the distance-to-default of the country.

The following paragraphs describe the data used to test the above hypotheses. Countries in the different samples are shown in Table 12 in Appendix C. The countries differ for the different panel datasets because of the differences in the availability of data. The empirical results are based on quarterly data covering the period from 2009-Q1 till 2019-Q2.

3.1. Credit risk metrics

We consider three measures for credit risk, each with a unique focus. The first credit risk measure under consideration is a market-based one, notably the sovereign CDS spread. We extract 5-year government CDS spreads on a quarterly basis from Refinitiv[5]. We take the Natural Log of CDS spreads as the dependent variable in the regressions. Drago, Carnevale, and Gallo (2019) make a compelling case for the use of CDS spreads instead of corporate bond spreads to measure corporate credit risk. They argue that corporate bonds issued by socially responsible companies are likely to be more attractive to investors who do not invest primarily for economic reasons and to fund managers who have to fulfill certain investment mandates regarding the CSR commitments. Therefore, there is likely to be an inherent bias in the pricing of corporate bonds with ESG ratings. The attention to corporate sustainability in CDS markets is more prevalent because the main participants are third party dealers, mostly banks, and to some extent asset managers or hedge funds who act for their reference entities and do not have any contractual obligations to consider corporate sustainability engagements (as cited in Cox, Brammer, and Millington, 2004; Graves and Waddock, 1994).

In addition to the traditional market-based indicators of credit risk, our second measure of sovereign credit risk is the distance-to-default of a country. Distance-to-default (DtD) is based on public sector balance sheet data and represents structural credit risk of a country. DtD is defined as the number of standard deviations a borrower's asset value is away from its contractual obligation. DtD is a measure derived from the Contingent Claims Analysis Approach (CCA) as outlined by Gray, Merton, and Bodie (2007)[6]. This structural model was originally developed to calculate corporate credit risk, but we use the modifications proposed in Gray et al. (2007) and Singh et al. (2018) to calculate DtD at the sovereign level. DtD is a measure of structural credit risk because default risk is calculated based on the asset (capital) structure of the borrower. The advantage of using DtD over traditional measures of sovereign credit risk is that it uses public sector balance sheets and therefore is better able to isolate default risk than traditional market-based measures. Singh et al. (2018) show that sovereign DtD is a more accurate and timely predictor of sovereign default than traditional credit risk measures such as CDS spreads and bond spreads. A detailed explanation on the calculation of DtD for our sample countries is provided in Table 19.

Third, we consider an agency-based measure of credit risk. Sovereign credit ratings reflect the opinion by a specialized committee of analysts on the default risk of a country. We use sovereign credit ratings issued

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[5] Formerly known as the Asset4 and Thomson Reuters
[6] CCA is a generalization of the option pricing theory of Black Scholes (1973) and Merton (1973) and is commonly called the Merton Model.

by S&P and Moody's, the two largest credit rating agencies in the market. An ordinal transformation of the credit ratings is performed, as shown in Table 11 in Appendix B. The transformed rating scale ranges from 21 for country's with a triple-A rating to 1 for countries rated C or lower.

An overview of the average credit risk per country over our sample period is presented in Table 1.

Country	CDS Spreads (Bps)	Distance-to-default	S&P Ratings	Moody's Ratings
Australia	31.35		21.00	21.00
Austria	50.02	33.23	20.25	20.69
Belgium	78.73	30.15	20.00	18.52
Brazil	194.99		11.83	11.69
Canada	33.23	27.02	21.00	21.00
Czech Republic	66.44	28.12	18.60	17.00
Denmark	33.12		21.00	21.00
Finland	28.71	32.62	20.53	20.69
France	58.38	28.98	21.00	19.98
Germany	29.80	37.29	21.00	21.00
Greece	10634.01			5.83
Hungary	228.78	13.60	11.35	11.86
Indonesia	163.22	17.76	11.25	11.60
Ireland	200.06		16.35	14.69
Italy		24.25		14.64
Japan	55.40		18.15	17.83
Malaysia	106.24			15.00
Mexico	126.54	26.05	15.63	14.52
Netherlands	36.46	30.75		21.00
New Zealand	42.74		20.20	21.00
Norway	17.89		21.00	21.00
Philippines	116.41			11.40
Poland	104.19		15.73	16.00
Portugal	329.76	17.80	11.10	12.17
Russia	202.43		13.18	12.52
South Africa	191.43	20.37	12.93	13.62
Spain	160.54	26.72	14.80	15.00
Sweden	25.27	25.80	21.00	21.00
Switzerland	31.26		21.00	21.00
Thailand	101.92		15.00	14.00
Turkey	232.40		11.40	10.64
United Kingdom	42.22	25.62	21.00	20.19
United States	20.60	21.18	21.00	21.00

Table 1: Average credit risk metrics by country 2009-Q1 - 2019-Q2

3.2.   ESG ratings

We use ESG scores by three third party rating providers. These rating agencies provide ratings at the corporate level and not at a sovereign level. We acquired data from the rating agencies at the corporate level and used that to calculate market value weighted average ESG scores at the sovereign level.

Sustainalytics is the merger of DSR (Netherlands), Scoris (Germany) and AIS (Spain). It provides ESG Scores for almost 6500 companies across 42 sectors across globe (Davis Polk, and Wardwell LLP, 2017). Sustainalytics scores out of 100 and they split the ESG issues in three dimensions; Environmental Social and Governance and a composite ESG score. The methodology involves giving specific weights to the ESG issues in each industry, so the weights vary from industry to industry. At least 70 indicators are covered in each industry and the ESG indicators are based on the three categories: Preparedness i.e. to what extent the company is prepared to manage the ESG risks, Disclosure i.e. whether the standard international best practices disclosure requirements are met or not, Performance (Quantitative and Qualitative) i.e. Practical implementation of ESG initiatives or review of controversial ESG incidents. We acquired monthly data on 3480 companies based in Europe and United States for the period from third quarter of 2009 till second quarter of 2019.

Refinitiv covers almost 6000 companies and uses 178 company level ESG metrics. These 178 metrics are grouped into 10 categories under 3 dimensions: Environmental (Resource use, emissions, innovation), Governance (Management, shareholders, CSR strategy), Social (Workforce, human rights, community, and product responsibility). Each of these 10 categories are weighted based on the number of issues that they include. Refinitiv also reports an ESG Controversies Scores which includes 23 controversy topics e.g. anti-competition, business ethics, tax fraud etc., which when combined and averaged with the Total ESG Score results in the ESG Combined Score (Refinitiv, 2019). We extracted quarterly ESG pillar Scores, Total ESG and ESG Combined Scores for 2389 companies covering Europe and US companies covering the same period as Sustainalytics data.

FTSE provides ESG scores for 7200 securities in 47 developed and emerging markets that are part of the FTSE All-World Index, FTSE All-Share Index and Russell 1000 Index. The FTSE ESG scores are also broken down in three pillars: Environment, Social and Governance. The three pillar scores are based on 14 underlying themes which are further based on almost 300 individual indicators which are applied to each company's unique circumstances. Almost 125 indicators are applied per company (FTSE). We acquired semi-annual data for 6681 companies across the globe for the period 12/2014 till 06/2019. The semi-annual data was interpolated into quarterly data.

Table 2 provides the summary statistics for the variables used in the study for each panel.

Table 2: Summary Statistics

Panel A: CDS Spreads

Statistic	N	Mean	Std. Dev.	Min	Max
Real GDP Growth Rate	2005	0.01	0.01	-0.06	0.23
Current Account/GDP	1914	0.01	0.05	-0.33	0.27
External Debt/GDP	1560	1.49	1.67	0.08	11.23
Natural Log of Foreign Reserves	1861	10.31	2.16	0.52	14.04
Unemployment Rate	1913	0.08	0.05	0.00	0.28
Change in Inflation Rate	1638	0.01	0.01	-0.03	0.08
Interest Rate	1779	0.03	0.03	-0.01	0.24
Financial Risk Rating	2058	38.79	4.71	25.50	48.50
Political Risk Rating	2058	73.38	10.96	44.50	92.50
Weighted Average Total ESG Score - Refinitiv	2211	49.96	8.62	10.01	72.43
Weighted Average Environmental Score - Refinitiv	2211	60.63	15.69	11.67	94.42
Weighted Average Social Score - Refinitiv	2211	59.90	15.15	8.38	97.11
Weighted Average Governance Score - Refinitiv	2211	57.13	8.50	8.54	91.25
Weighted Average Total ESG Score - Sustain	875	64.83	6.89	46.00	85.00
Weighted Average Environmental Score - Sustain	875	63.27	8.92	34.00	85.00
Weighted Average Social Score - Sustain	875	64.58	7.51	42.00	84.00
Weighted Average Governance Score - Sustain	875	68.16	6.45	47.00	87.00
Weighted Average Total ESG Score - FTSE	501	3.25	0.61	1.55	4.49
Weighted Average Environmental Score - FTSE	501	3.17	0.77	0.77	4.92
Weighted Average Social Score - FTSE	501	3.05	0.76	1.22	4.46
Weighted Average Governance Score - FTSE	501	3.62	0.56	1.89	4.92
Log of CDS Spreads	1872	4.47	1.14	1.99	10.52

Panel B: Distance-to-default

Statistic	N	Mean	Std. Dev.	Min	Max
Real GDP Growth Rate	1965	0.01	0.01	-0.06	0.20
Current Account/GDP	1874	0.01	0.05	-0.14	0.21
Natural Log of Foreign Reserves	1819	10.43	2.00	3.20	14.04
Change in Inflation Rate	1596	0.01	0.01	-0.03	0.08
Political Risk Rating	2016	73.19	10.98	44.50	92.50
Weighted Average Total ESG Score - Refinitiv	2169	49.85	8.61	10.01	72.43
Weighted Average Environmental Score - Refinitiv	2169	60.48	15.78	11.67	94.42
Weighted Average Social Score - Refinitiv	2169	59.73	15.23	8.38	97.11
Weighted Average Governance Score - Refinitiv	2169	57.12	8.57	8.54	91.25
Weighted Average Total ESG Score - Sustain	835	64.94	7.01	46.00	85.00
Weighted Average Environmental Score - Sustain	835	63.18	9.09	34.00	85.00
Weighted Average Social Score - Sustain	835	64.93	7.46	42.00	84.00
Weighted Average Governance Score - Sustain	835	68.17	6.59	47.00	87.00
Weighted Average Total ESG Score - FTSE	482	3.27	0.61	1.55	4.49
Weighted Average Environmental Score - FTSE	482	3.21	0.75	0.77	4.92
Weighted Average Social Score - FTSE	482	3.08	0.76	1.22	4.46
Weighted Average Governance Score - FTSE	482	3.62	0.57	1.89	4.92
Distance-to-default	1134	25.83	10.49	-6.90	68.00

Panel C: S&P Ratings

Statistic	N	Mean	Std. Dev.	Min	Max
Log GDP/Capita	2201	8.54	1.07	5.42	10.35
Current Account/GDP	1914	0.01	0.05	-0.33	0.27
External Debt/GDP	1560	1.49	1.67	0.08	11.23
Natural Log of Foreign Reserves	1861	10.31	2.16	0.52	14.04

	N	Mean	Std. Dev.	Min	Max
Unemployment Rate	1913	0.08	0.05	0.00	0.28
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Weighted Average Governance Score - Sustain	875	68.16	6.45	47.00	87.00
Weighted Average Total ESG Score - FTSE	501	3.25	0.61	1.55	4.49
Weighted Average Environmental Score - FTSE	501	3.17	0.77	0.77	4.92
Weighted Average Social Score - FTSE	501	3.05	0.76	1.22	4.46
Weighted Average Governance Score - FTSE	501	3.62	0.56	1.89	4.92
S&P Ratings	1600	17.21	3.73	4.00	21.00

Panel C: Moody's Ratings

Statistic	N	Mean	Std. Dev.	Min	Max
Log GDP/Capita	2201	8.54	1.07	5.42	10.35
Current Account/GDP	1914	0.01	0.05	-0.33	0.27
External Debt/GDP	1560	1.49	1.67	0.08	11.23
Natural Log of Foreign Reserves	1861	10.31	2.16	0.52	14.04
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Weighted Average Social Score - FTSE	501	3.05	0.76	1.22	4.46
Weighted Average Governance Score - FTSE	501	3.62	0.56	1.89	4.92
Moody's Ratings	2436	10.20	4.56	1.00	21.00

3.3. Control Variables

In addition to our primary independent variables i.e. the ESG Scores, we also use following the standard control variables in our analysis, as shown in Table 3.

Table 3: Definition and source of control variables

Variables	Definition	Source
Macroeconomic indicators		
Log GDP/Capita	Natural log of nominal GDP in US$ as a ratio of population	Refinitiv Eikon
Real GDP growth rate	Quarterly real GDP growth rate	Refinitiv Eikon
Current Account Balance/GDP	Current account balance in millions US$ (as a % of nominal GDP)	
External debt/GDP	Gross external debt position in million US$ (as a % of nominal GDP)	Refinitiv Eikon
International reserves	Log of the foreign currency reserves of the government	Refinitiv Eikon
Unemployment Rate	Quarterly unemployment rate	Refinitiv Eikon
Interest Rate	Quarterly Central Bank policy rate	Refinitiv Eikon
Change in Inflation Rate	Quarterly change in the inflation rate	Refinitiv Eikon
Risk Rating Scores	A means of assessing a country's position in terms of its economic, financial and political risk standing; 50 (least risk), 0 (highest risk) for economic and financial and 100 (least risk), 0 (highest risk) for political.	
Financial Risk Rating	Components include foreign debt as % of GDP, foreign debt as % of exports, current account as % of exports, net liquidity, exchange rate stability.	International Country Risk Guide (ICRG)
Political Risk Rating	Components include government stability, socioeconomic conditions, investment profile, internal conflict, external conflict, corruption, military in politics, religious tensions, law and order, ethnic tensions, democratic accountability, and bureaucracy quality	International Country Risk Guide (ICRG)

4. MODEL FRAMEWORK

In line with our hypotheses, we model the relationship between ESG ratings and two credit risk measures, CDS Spreads and Distance-to-default using a standard panel model with country fixed effects[7]. To counter the problems of autocorrelation and heteroscedasticity, we use clustered robust standard errors proposed by Arellano (1987).

The equations are specified as follows:

▪ **CDS Spreads**

$$Natural\ Log\ of\ CDS\ Spreads_{i,t} = x'_{it}\beta_{k-1} + ESG\_Rating_{it}\beta_k + c_i + \varepsilon_{it}$$

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[7] A F-test for unobserved heterogeneity is performed which tests for the null hypothesis that all individual intercepts are equal to zero. The p-values for all the regressions suggest that the null hypothesis can be rejected and that a significant fixed effect exists, hence a fixed effects model is preferred over a pooled model. For completion, we also perform Hausman tests which rejects the null hypothesis that the preferred model is random effects, thus we run a fixed effects model.

Where x' represent the vector of explanatory control variables, c_i represents the fixed intercept term for country i and ε_{it} represents the random disturbance term.

x: (Real GDP Growth rate, Current Account Balance/GDP, External Debt/GDP, Natural Log of Foreign reserves, Unemployment Rate, Change in Inflation Rate, Interest Rate, Financial Risk Rating, Political Risk Rating)

▪ **Distance-to-default**

$$Distance\ to\ Default_{i,t} = x'_{it}\beta_{k-1} + ESG\_Rating_{it}\beta_k + c_i + \varepsilon_{it}$$

x: (Real GDP Growth rate, Current Account Balance/GDP, Natural Log of Foreign reserves, Change in Inflation Rate, Political Risk Rating).

▪ **Credit Ratings (S&P and Moody's)**

We model the link between ESG and credit ratings using ordered probit regressions. In an ordered probit model, an underlying score is assessed as a linear function of the covariates and a set of threshold values (McCullagh, 1980). An ordered probit model with r categories of credit ratings will construct an optimal scoring rule R^*, linear in observed characteristics x. The equation is specified as follows:

$$R^* = x'\beta_{k-1} + ESG\_Rating\beta_k + \varepsilon$$

Where R^* is the unobserved underlying latent variable, x' represents a vector of time-varying explanatory variables, β represents the coefficient parameters and ε is a random disturbance term which is assumed to have a normal distribution. The underlying level of score R^* tells us the most likely rating given the threshold values c.

$$R = \begin{cases} AAA & if & R^* > c_{20} \\ AA+ & if & c_{20} > R^* > c_{19} \\ AA & if & c_{19} > R^* > c_{18} \\ \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots \\ C & if & c_1 > R^* \end{cases}$$

x: (Log GDP/Capita, Current Account Balance/GDP, External Debt/GDP, Natural Log of Foreign reserves, Unemployment Rate, Change in Inflation Rate, Interest Rate, Financial Risk Rating, Political Risk Rating).

5. RESULTS AND DISCUSSION

In this section, we present and discuss the empirical results obtained from four panel datasets with CDS spreads, distance-to-default, S&P ratings and Moody's ratings.

5.1. Significance of the ESG Ratings

The primary objective of the paper is to establish the relationship between the traditional credit risk measures and different sustainability metrics at the sovereign level. We discuss the results with respect to each credit risk measure in the following paragraphs.

CDS spreads
Table 4, Table 5 and Table 6 show the results for CDS spread regressions. The left panel of the tables show the unstandardized coefficient estimates. To determine the relative importance of each variable in explaining sovereign CDS spreads, the right panel of the tables shows the standardized coefficients. Overall, we find a significant negative relationship between CDS spreads and the sustainability ratings of the three ESG rating agencies. This suggests that the ESG risks are priced by the market in CDS spreads, which is in line with previous research (Capelle-Blancard, Crifo, Diaye, Oueghlissi, and Scholtens, 2019; Crifo, Diaye, and Oueghlissi, 2017).

Table 4: Fixed effects estimation results for CDS Spreads with Sustainalytics ESG Scores

Variables	Expected sign	Total ESG Score	Environmental Score	Social Score	Governance Score	TS	ES	SS	GS
		Dependent: Natural Log of CDS Spreads *Sustainalytics ESG Scores*							
		Unstandardized Coefficients				*Standardized Betas (β)*			
Real GDP Growth Rate	-	-2.461	-2.738	-2.442	-2.186	-0.087	-0.092	-0.086	-0.081
		(1.639)	(1.755)	(1.599)	(1.671)				
Current Account/GDP	-	-0.254	-0.308	-0.25	-0.692	0.024	0.024	0.023	-0.022
		(0.668)	(0.626)	(0.705)	(0.526)				
External Debt/GDP	+	0.310 *	0.311 *	0.291 *	0.324 *	0.133	0.131	0.129	0.118
		(0.132)	(0.124)	(0.137)	(0.150)				
Natural Log of Foreign Reserves	-	-0.054	-0.049	-0.061	-0.068	-0.058	-0.046	-0.070	-0.095
		(0.035)	(0.034)	(0.035)	(0.038)				
Unemployment Rate	+	11.533 ***	10.771 **	11.783 ***	13.411 ***	0.210	0.186	0.220	0.268
		(3.325)	(3.316)	(3.268)	(3.488)				
Change in Inflation Rate	+	7.502	8.034	7.308	9.599	0.067	0.071	0.063	0.099
		(5.267)	(5.249)	(5.014)	(5.847)				
Interest Rate	+	30.319 **	29.268 *	31.415 **	37.653 **	0.433	0.427	0.444	0.623
		(11.434)	(11.650)	(11.748)	(13.972)				
Financial Risk Rating	-	0.060 **	0.053 *	0.060 **	0.070 ***	0.045	0.040	0.050	0.059
		(0.020)	(0.023)	(0.019)	(0.016)				
Political Risk Rating	-	-0.002	-0.004	-0.005	0.013	-0.089	-0.091	-0.096	-0.060
		(0.021)	(0.022)	(0.021)	(0.019)				
Weighted Average Total ESG Score	-	-0.032 **				-0.195			
		(0.012)							
Weighted Average Environmental Score	-		-0.031 **				-0.237		
			(0.012)						
Weighted Average Social Score	-			-0.027 **				-0.186	
				(0.010)					
Weighted Average Governance Score	-				-0.006				0.171
					(0.012)				
Adjusted R^2		0.5401	0.5483	0.5400	0.5202				
Number of Obervations		680	680	680	680				

Note: ∗∗∗p < 0.001; ∗∗p < 0.01; ∗p < 0.05

Table 5: Fixed effects estimation results for CDS Spreads with Refinitiv ESG Scores

Variables	Expected sign	Total ESG Score	Environmental Score	Social Score	Governance Score	TS	ES	SS	GS
		Dependent: Natural Log of CDS Spreads							
		Refinitiv ESG Scores							
		Unstandardized Coefficients				*Standardized Betas (β)*			
Real GDP Growth Rate	-	-2.884 ***	-3.128 ***	-2.926 ***	-2.880 ***	-0.045	-0.042	-0.044	-0.046
		(0.841)	(0.850)	(0.849)	(0.773)				
Current Account/GDP	-	-0.994	-0.885	-0.885	-1.065	-0.024	-0.025	-0.027	-0.024
		(0.740)	(0.703)	(0.754)	(0.714)				
External Debt/GDP	+	0.208	0.189	0.201	0.186	0.167	0.151	0.154	0.142
		(0.194)	(0.204)	(0.187)	(0.185)				
Natural Log of Foreign Reserves	-	-0.187	-0.197	-0.181	-0.154	-0.165	-0.161	-0.16	-0.149
		(0.131)	(0.133)	(0.123)	(0.121)				
Unemployment Rate	+	16.153 ***	16.437 ***	15.709 ***	15.967 ***	0.244	0.24	0.256	0.248
		(3.925)	(4.230)	(3.991)	(4.080)				
Change in Inflation Rate	+	4.938 *	5.288 *	5.551 *	4.973 *	0.077	0.082	0.089	0.085
		(2.229)	(2.210)	(2.283)	(2.113)				
Interest Rate	+	9.964 *	9.964 *	9.746 *	9.599 *	0.414	0.426	0.416	0.416
		(4.368)	(4.524)	(4.350)	(4.018)				
Financial Risk Rating	-	0.022	0.027	0.031	0.021	-0.057	-0.037	-0.030	-0.049
		(0.022)	(0.022)	(0.022)	(0.021)				
Political Risk Rating	-	0.002	0.002	-0.002	0.003	-0.067	-0.076	-0.067	-0.064
		(0.018)	(0.017)	(0.017)	(0.017)				
Weighted Average Total ESG Score	-	-0.013 **				-0.117			
		(0.005)							
Weighted Average Environmental Score	-		-0.006				-0.116		
			(0.008)						
Weighted Average Social Score	-			-0.014 *				-0.082	
				(0.006)					
Weighted Average Governance Score	-				-0.028 ***				-0.115
					(0.008)				
Adjusted R^2		0.4066	0.3994	0.4082	0.4244				
Number of Obervations		1206	1206	1206	1206				

Note: ∗∗∗p < 0.001; ∗∗p < 0.01; ∗p < 0.05

For two rating providers, Sustainalytics and FTSE, we find that ESG risks are transmitted to sovereign CDS spreads via the environmental and social scores, while the governance score is not statistically significant. Similar results at the firm level have also been reported by other studies (Drago, Carnevale and, Gallo, 2019; Cheng, Ioannou, and Serafeim, 2011). Drago et al., (2019) and Cheng et al., (2011) attribute this lack of significance to the fact that the corporate governance scores are driven by institutional structures at the sovereign level and as a result the significance of the governance scores is likely to be stronger across countries rather than within a country. Our results contradict this potential explanation as we find no impact of corporate level governance on sovereign credit risk across countries. The results for Refinitiv ESG scores are different. Here we find that the governance score significantly impacts the CDS spread, while the environmental score is insignificant.

The economic impact of ESG ratings on sovereign CDS spreads is not large. The coefficients for Sustainalytics and Refinitiv imply that a one unit increase in the ESG rating decreases the CDS spread, on average, by only 2.122 basis points (bps)[8] and 1.62bps respectively. The unstandardized coefficients of the FTSE Score are much larger than those of Sustainalytics and Refinitiv due to a different scale of the

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[8] The dependent variable is log transformed, therefore, the coefficient value represents the percentage change. To have an idea of how much the spread changes in basis points, we multiply the average percentage change in ESG scores with the mean CDS spread i.e. {(exp(0.024)-1)*exp(4.47)} = 2.122 basis points.

ratings. A one unit increase in the total ESG score of FTSE decreases the log CDS spread by almost 45 percent, hence a CDS spread change of 50.33 basis points[9].

Table 6: Fixed effects estimation results for CDS Spreads with FTSE ESG Scores

Variables	Expected sign	Dependent: Natural Log of CDS Spreads FTSE ESG Scores							
		Total ESG Score	Environmental Score	Social Score	Governance Score	TS	ES	SS	GS
		Unstandardized Coefficients				*Standardized Betas (β)*			
Real GDP Growth Rate	-	0.683	0.878	0.75	0.073	0.061	0.095	0.062	0.057
		(0.540)	(0.508)	(0.536)	(0.512)				
Current Account/GDP	-	0.101	0.198	0.139	-0.349	0.053	0.051	0.047	0.041
		(0.419)	(0.444)	(0.387)	(0.442)				
External Debt/GDP	+	0.286 *	0.255 *	0.301 *	0.290 *	0.114	0.133	0.120	0.127
		(0.129)	(0.123)	(0.128)	(0.140)				
Natural Log of Foreign Reserves	-	0.184	0.208	0.153	0.172	-0.004	-0.024	-0.024	-0.038
		(0.143)	(0.134)	(0.141)	(0.150)				
Unemployment Rate	+	12.340 **	14.898 ***	13.896 ***	16.286 **	0.345	0.443	0.420	0.464
		(4.428)	(3.366)	(4.153)	(5.163)				
Change in Inflation Rate	+	0.631	-0.49	-0.046	-0.143	0.049	0.038	0.037	0.039
		(1.576)	(1.587)	(1.583)	(1.539)				
Interest Rate	+	8.449	7.621	7.821	8.302	0.170	0.154	0.149	0.133
		(6.160)	(6.191)	(5.945)	(8.657)				
Financial Risk Rating	-	0.03	0.024	0.032	0.031	0.120	0.146	0.133	0.142
		(0.020)	(0.019)	(0.020)	(0.021)				
Political Risk Rating	-	-0.029	-0.012	-0.029	-0.014	-0.088	-0.046	-0.085	-0.059
		(0.030)	(0.029)	(0.032)	(0.035)				
Weighted Average Total ESG Score	-	-0.455 ***				-0.268			
		(0.135)							
Weighted Average Environmental Score	-		-0.343 ***				-0.214		
			(0.077)						
Weighted Average Social Score	-			-0.339 ***				-0.168	
				(0.102)					
Weighted Average Governance Score	-				-0.120				-0.097
					(0.149)				
Adjusted R^2		0.5061	0.5070	0.5020	0.4611				
Number of Obervations		394	394	394	394				

Note: ∗∗∗p < 0.001; ∗∗p < 0.01; ∗p < 0.05

An alternative way to judge the relative importance of ESG factors in explaining sovereign credit risk is by computing standardized coefficient estimates. This allows us to compare the magnitude of the impact of the ESG ratings with respect to the other variables and helps to identify the most important variables in the determination of the credit risk measure. The standardized coefficients for Sustainalytics (FTSE) show that ESG ratings do explain a significant proportion of the variance in the CDS spreads and are an important determinant in the determination of CDS spreads. One standard deviation increase of the environmental score decreases the log CDS spread by about 0.237 (0.214) standard deviations. For Sustainalytics, the environmental factor is the third most important determinant of CDS spreads, after interest rates and unemployment rates. This shows that ESG ratings are an important variable in the market pricing of the CDS spreads and not just supplementary variables to the rest of the significant variables.

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[9] The coefficient estimates of the FTSE ESG scores cannot be compared with those of Refinitv and Sustainalytics because the FTSE ratings range from 1 to 5, while Refinitiv and Sustainalytics range from 0 to 100.

Distance-to-default

Table 7, Table 8 and Table 9 show the results for the distance-to-default regressions. In accordance with the results for sovereign CDS spreads, we find a significantly positive relationship between ESG ratings and sovereign distance-to-default. This implies that sustainability concerns affect the structural creditworthiness of a country (Capasso & Gianfrate, 2019).

In terms of economic significance, the unstandardized coefficients for Sustainalytics, Refinitiv and FTSE show that a one unit increase in the ESG rating coincides, on average, with a 0.97, 0.31 and 25.9 unit increase in the distance-to-default, respectively. The results for the subscores of the ESG ratings of the different agencies are similar, they all have a significantly positive effect on DtD with the exception of the governance score of Sustainalytics. The governance score of Refinitiv is only significant at a 90% confidence level.

The standardized variables show that ESG are the most important determinants explaining the variability in the distance-to-default across countries, the standardized coefficient estimates are larger than those of macroeconomic variables. When using Sustainalytics and Refinitiv ratings, a one standard deviation increase in the environmental score increases the DtD measure by more than 0.4 standard deviations whereas, governance score has the lowest explanatory power. These findings are not confirmed by the standardized coefficients of FTSE, that point to the governance score as the most important determinant of distance-to-default.

Table 7: Fixed effects estimation results for Distance-to-default with Sustainalytics ESG Scores

Variables	Expected sign	Total ESG Score	Environmental Score	Social Score	Governance Score	TS	ES	SS	GS
		Dependent: Distance to Default							
		Sustainalytics ESG Scores							
		Unstandardized Coefficients				*Standardized Betas (β)*			
Real GDP Growth Rate	+	149.544 *	170.261 *	151.074 **	140.745 *	0.071	0.072	0.077	0.083
		(63.852)	(70.525)	(57.915)	(55.027)				
Current Account/GDP	+	-129.148 *	-127.973 *	-125.654 *	-104.951 *	-0.210	-0.231	-0.189	-0.159
		(52.730)	(52.047)	(54.345)	(47.925)				
Natural Log of Foreign Reserves	+	-5.443 *	-5.991 **	-3.479	-3.298	0.014	-0.029	0.060	0.096
		(2.571)	(2.192)	(2.596)	(3.785)				
Change in Inflation Rate	+/-	195.677 ***	189.876 **	191.666 ***	116.733 *	0.174	0.184	0.158	0.118
		(56.424)	(66.733)	(51.190)	(57.569)				
Political Risk Rating	+	0.678 **	0.605 **	0.621 **	0.332	0.159	0.162	0.145	0.093
		(0.218)	(0.203)	(0.238)	(0.261)				
Weighted Average Total ESG Score	+	0.970 **				0.293			
		(0.302)							
Weighted Average Environmental Score	+		0.901 **				0.401		
			(0.238)						
Weighted Average Social Score	+			0.654 *				0.194	
				(0.273)					
Weighted Average Governance Score	+				0.614				0.037
					(0.367)				
Adjusted R^2		0.1634	0.2072	0.1247	0.0741				
Number of Obervations		476	476	476	476				

Note: ***$p < 0.001$; **$p < 0.01$; *$p < 0.05$

Table 8: Fixed effects estimation results for Distance-to-default with Refinitiv ESG Scores

Variables	Expected sign	Total ESG Score	Environmental Score	Social Score	Governance Score	TS	ES	SS	GS
		Dependent: Distance to Default Refinitiv ESG Scores							
		Unstandardized Coefficients				*Standardized Betas (β)*			
Real GDP Growth Rate	+	128.813 *	97.143	96.244	133.910 *	0.079	0.034	0.061	0.084
		(59.197)	(56.870)	(57.393)	(62.561)				
Current Account/GDP	+	-79.57	-79.836 *	-79.707	-84.561 *	-0.135	-0.126	-0.123	-0.148
		(40.525)	(39.733)	(43.803)	(42.446)				
Natural Log of Foreign Reserves	+	-0.398	-1.437	-1.324	-2.067	0.071	0.012	0.065	0.021
		(2.107)	(2.016)	(2.217)	(2.331)				
Change in Inflation Rate	+/-	73.839 *	57.965	12.287	49.17	0.123	0.115	0.087	0.102
		(37.329)	(40.940)	(46.288)	(38.448)				
Political Risk Rating	+	0.148	0.212	0.153	0.054	0.077	0.028	0.066	0.035
		(0.271)	(0.271)	(0.250)	(0.257)				
Weighted Average Total ESG Score	+	0.306 *				0.216			
		(0.104)							
Weighted Average Environmental Score	+		0.675 ***				0.468		
			(0.158)						
Weighted Average Social Score	+			0.518 **				0.237	
				(0.190)					
Weighted Average Governance Score	+				0.448 *				0.225
					(0.196)				
Adjusted R^2		0.0689	0.1362	0.1230	0.0727				
Number of Obervations		632	632	632	632				

Note: ***p < 0.001; **p < 0.01; *p < 0.05

Table 9: Fixed effects estimation results for Distance-to-default with FTSE ESG Scores

Variables	Expected sign	Total ESG Score	Environmental Score	Social Score	Governance Score	TS	ES	SS	GS
		Dependent: Distance to Default FTSE ESG Scores							
		Unstandardized Coefficients				*Standardized Betas (β)*			
Real GDP Growth Rate	+	-65.393	-120.264	-101.896	38.006	-0.032	-0.100	-0.028	0.003
		(71.623)	(85.085)	(73.700)	(70.549)				
Current Account/GDP	+	-14.785	22.618	-0.612	-37.405	-0.003	0.030	-0.008	-0.033
		(23.524)	(24.166)	(30.008)	(23.943)				
Natural Log of Foreign Reserves	+	-9.293 ***	-5.62	-8.925 *	-11.050 ***	0.127	0.162	0.138	0.106
		(2.379)	(4.202)	(3.483)	(2.448)				
Change in Inflation Rate	+/-	175.669	385.394 ***	252.468 *	149.871	0.185	0.272	0.192	0.141
		(106.808)	(101.885)	(103.337)	(118.822)				
Political Risk Rating	+	0.414	0.121	0.843	0.431	0.055	0.048	0.138	0.021
		(0.459)	(0.528)	(0.523)	(0.456)				
Weighted Average Total ESG Score	+	25.913 ***				0.558			
		(3.231)							
Weighted Average Environmental Score	+		15.563 ***				0.394		
			(3.543)						
Weighted Average Social Score	+			20.403 ***				0.504	
				(4.034)					
Weighted Average Governance Score	+				19.939 ***				0.581
					(4.480)				
Adjusted R^2		0.3941	0.1573	0.3067	0.3561				
Number of Obervations		208	208	208	208				

Note: ***p < 0.001; **p < 0.01; *p < 0.05

Sovereign credit ratings
The majority of related literature aims to establish a relationship between corporate credit ratings and ESG metrics. We question whether higher corporate sustainability standards in a country spill over to help to reduce sovereign credit risk. Much of the previous studies have identified governance factors at the company level to have a significant impact on corporate credit ratings (Ashbaugh-Skaifea, W.Collins, and LaFondc, 2006; Tarigan and Fitriany, 2017; Sareen and Vij, 2014-2015; Skaife, Collins, and Lafond, 2004). Some studies found a significant relationship between governance and social factors but not environmental factors (Devalle, Fiandrino, and Cantino, 2017) . Throughout the literature there have been differences in results obtained for different credit rating agencies. Several studies have identified that there is a very high correlation between the credit ratings of the three big credit rating agencies, S&P, Moody's and Fitch, however, the literature does not provide a common consensus on the impact of ESG metrics on the credit rating agencies. Another important consideration is that previous studies have mostly used self-developed ESG metrics or metrics provided by local ESG rating agencies.

To fill these gaps in the literature, our aim is to determine the extent to which commonly used ESG scores play a part in the credit ratings of two biggest rating agencies (S&P and Moody's) and whether the ESG scores of the different sustainable rating providers are reflected in a similar way in the sovereign credit ratings.

S&P ratings
The coefficient estimates of the ordered probit regressions are standardized coefficients by construction (presented in Table 13, Table 14 and Table 15 in Appendix D for S&P rating regressions). The results are not very conclusive. The ESG scores for Sustainalytics are all negative and significant, implying that higher ESG scores result in low credit ratings which is in line with the overinvestment theory. Amongst the ESG ratings, the maximum variance is explained by the governance score where one notch increase in the score decreases the S&P rating by 0.087 notches whereas, environmental score explains the least variance where one notch increase in the rating decreases the S&P rating by 0.058 notches.

We obtain mixed results for Refinitiv where only social and governance scores are positive and the rest of the sustainability scores are negative. The only significant scores are the total ESG score and governance score, but they have opposite signs. A possible explanation is that S&P gives higher weightage to governance metrics in sovereign credit ratings whereas, considers the importance of the environmental metrics less relevant in ratings of developed economies and more prevalent in ratings of emerging economies (S&P Global). We have a mix of both emerging and developed economies (Table 12) in the Refinitiv dataset which might explain the mixed results because of the different methodologies used by the credit rating agency.

For FTSE we obtain all positive and significant coefficients except for the governance score which is positive but not significant. The results for FTSE are more in line with the general results obtained in the literature and are in line with the risk mitigation hypothesis of the impact of ESG on credit risk. What is most remarkable about the regression results presented in Table 13, 14 and 15 is that the conclusions depend crucially on the ESG rating provider.

Moody's ratings
The results for Moody's regressions are shown in Table 16, Table 17 and Table 18 in Appendix E. The results of the Moody's regressions are also not conclusive on their own, but they are in line with the

conclusions obtained from the S&P regressions. The coefficient estimates for the ESG scores of Sustainalytics are all negative and significant. The size effect of the ratings is similar to that of the S&P regressions. When we use Refinitiv ESG scores as explanatory variables, the results become less conclusive. The overall ESG score has no significant effect on Moody's sovereign credit ratings. This is due to the negative impact of the social and environmental score, which is offset by the positive effect of the governance score. The results for the regressions with FTSE ESG ratings explaining Moody's credit ratings are opposite to this. The null effect of the overall ESG score is caused by a positive effect of the environmental and social score, which is offset by a negative effect of the governance score.

The lack of consistency and significance of sustainability in explaining sovereign credit ratings may be attributed to the fact that it is only very recently that the credit rating agencies have started communicating about the incorporation of ESG metrics in their ratings and about the allocation of their resources to the ESG issues. However, credit ratings agencies are not transparent about their methodologies, data and the extent to which the ESG factors are incorporated in the credit ratings.

5.2. Differences in the impact of ESG ratings across ESG rating providers

We find that the relation between sustainability scores and sovereign credit risk varies depending on the ESG rating provider. This is especially the case when we use market-based and analyst-based measures for sovereign credit risk, and to a lesser extent when we use structural credit risk. The divergence between the different ESG data providers is the most prevalent when they are used to explain sovereign credit ratings.

For the market-based measure, CDS spreads, results for the ESG scores provided by Sustainalytics and FTSE differ to the results based on the Refinitv ratings. The ESG scores published by Sustainalytics and FTSE are better able to explain the variance in the CDS spreads that Refinitiv ESG scores. This finding can be explained by the low correlation between ESG ratings across rating agencies, as reported by Berg, Koelbel, and Rigobon (2019). Refinitiv ratings are mainly used in academic research, while FTSE and Sustainalytics ratings are typically used by fund managers and other investors. This can explain why these two rating agencies show up as pricing factors in CDS spreads, while this is to a lesser extent the case for Refinitiv ratings.

The differences in the impact of the scores by the different agencies indicate that there is a lack of standardization of the scores by the different ESG rating agencies. The correlation matrix (as shown in Table 10 in Appendix A) further emphasizes the deviance in the ESG ratings of the different ratings agencies. The correlation between the Total ESG scores of Refinitiv and Sustainalytics is equal to 0.29, and between Refinitiv and FTSE it is only 0.11. The correlation between the ESG scores of Sustainalytics and FTSE is higher, notably 0.74. The sub-scores also have a correlation between 0.4-0.5 across the three agencies. The low correlation between the total ESG score of Refinitiv and other two agencies could be attributed to the presence of a controversy score in the composite ESG score of Refinitiv whereas, Sustainalytics and FTSE do not use a controversy score in their methodologies.

As discussed above, the extent of incorporation of ESG scores by credit rating agencies is very opaque. Another reason for the significant differences in the impact of the ESG scores across the three different agencies could be that the credit rating agencies have started developing their own ESG metrics. Moody's bought a major stake in Vigeo Eiris in the last quarter of 2019, whereas S&P has been working with RobecoSAM, an asset manager that specializes in sustainability research (Financial Times, 2019). It has been established that there is a huge lack of standardization in the ESG ratings by different providers,

which could explain that the methodologies used by the ESG rating agencies used in the study may not be highly correlated with the methodologies adopted by the credit rating agencies.

6. CONCLUSION

Sustainable investing is becoming more mainstream as more evidence suggests that ESG is not only about doing good but also involves managing sustainability risks and incorporating sustainable practices, which results in better financial performance as well as better credit management. The majority of studies are focused at the corporate level which explores different relationships i.e. the relationship between ESG and financial performance, the impact of ESG on stock returns and the importance of ESG on the credit risk management of a company.

Little or no research exists at the sovereign level. Despite the size and importance of the sovereign debt market, not much attention is given to the systematic consideration of ESG factors into sovereign debt valuations. A primary reason for this is that sovereign debt has traditionally been considered a risk-free asset, however, events such as the global financial crisis, the European sovereign debt crisis and the most recent global Covid-19 pandemic have highlighted the need to change directions and stresses the need to review the drivers of the creditworthiness of a country.

In this paper, we identify to what extent sustainability factors are incorporated in traditional credit risk measures, notably CDS spreads and credit ratings, as well as whether ESG factors are important determinants of the structural creditworthiness of a country for which we use the distance-to-default. Another important contribution of the paper is the use of ESG ratings provided by three different agencies. We use the more commercially used sustainability ratings provided by Sustainalytics and FTSE, next to the Refinitiv ratings that are commonly used in scientific research. Our results show that the impact of ESG ratings on credit risk measures varies across agencies and across credit risk measures.

The overall results of our regressions are what we hypothesized: ESG scores have a negative and significant impact on sovereign CDS spreads, implying that ESG concerns are priced in marketable sovereign debt. Countries in which companies stand out in terms of ESG practices are associated with lower sovereign CDS spreads. As a second credit risk measure, we considered the distance-to-default based on the Merton model. In line with our findings for CDS spreads, ESG factors play a significant role in explaining the distance-to-default of a country where a higher ESG score results in a higher distance-to-default. Our results confirm the risk mitigation hypothesis that stipulates that investments in sustainability reduce risk.

The results for sovereign credit ratings are not very conclusive in terms of both the sign of the effect and in terms of the size of the effect. The impact of the three ESG rating agencies is different for the credit rating agencies. Sustainalytics ESG scores have a negative significant impact, FTSE ESG scores have a positive significant impact, whereas Refinitiv ESG scores showed mixed results for different scores. These discrepancies may be attributed to the different methodologies and weightage given to different scores by each credit rating agency as well as different approaches by credit rating agencies to the incorporation of the ESG factors for the emerging economies and the developed economies. In addition to this, credit rating agencies are also attempting to create their own ESG ratings where in addition to the public information available to the ESG rating agencies, they can also make use of the other information that might be available to the credit rating agencies.

In terms of the relative importance of the ESG ratings on the different credit risk measures, we show that ESG factors have significant explanatory power in explaining CDS spreads and distance-to-default in addition to the other important macroeconomic variables, whereas, they have very less explanatory power compared to the rest of the variables in the determination of the credit ratings. It is also evident from the results that the methodologies adopted by the ESG rating agencies are not standardized and quite different in terms of the metrics used, weightages calculated, and the overall methodologies used to calculate the ESG scores.

One of the biggest issues in ESG scoring is the availability and standardization of the ESG data at the sovereign level. Existing ESG data is predominantly at the corporate level which also has its deficiencies. The data is mostly self-reported which raises concerns on reliability and consistency. The coverage of the ESG data is very patchy and mostly not available for high yield debt or emerging markets. Better quality data is required on top of what companies are reporting. There has to be evidence for whatever is being done and technology such as blockchains, machine learning and AI needs to play a big part in this (Finextra, 2020). In addition to this, the frequency of ESG metrics is also a concern where majority of the metrics are not updated consistently or frequently which means that recent ESG related information is incorporated in the credit risk measures. Standardization is another major issue. The lack of standardization means that the ESG ratings cannot be compared or there is no one reliable source of ratings (BlackRock, 2018).

The current scenario calls for the need to devise techniques to integrate ESG into the valuation of sovereign debt instruments and the starting point for which should be in-depth research of sustainability factors at the sovereign level and a creation of ESG scores at the country level.

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8. Appendices

Appendix A: Correlation Matrix

Table 10: Correlation Matrix

Correlation Matrix

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)
% Δ Real GDP (1)	1																									
GDP/capita (2)	0.128	1																								
Cur Acc./GDP (3)	-0.008	0.024	1																							
Ext.D/GDP (4)	0.305	0.325	0.042	1																						
Reserves (5)	-0.26	-0.092	-0.145	-0.688	1																					
Unemp. Rate (6)	0.05	-0.569	0.166	-0.022	-0.207	1																				
Inf. Rate (7)	-0.144	0.039	-0.032	-0.195	0.194	-0.184	1																			
Int. rate (8)	-0.045	0.076	-0.352	-0.167	0.294	-0.284	0.097	1																		
Fin. RR (9)	-0.21	-0.044	0.202	-0.421	0.459	-0.209	0.187	-0.067	1																	
Pol. RR (10)	0.063	0.615	-0.033	0.142	-0.082	-0.638	0.046	0.151	0.215	1																
Env. Refinitiv (11)	-0.084	-0.438	0.092	-0.189	0.203	0.36	-0.073	-0.281	0.166	-0.369	1															
Soc. Refinitiv (12)	0.032	-0.394	0.222	0.023	0.17	0.36	-0.078	-0.275	0.222	-0.355	0.707	1														
Gov. Refinitiv (13)	-0.036	0.08	-0.257	0.073	0.332	-0.28	0.091	0.532	-0.066	0.124	0.009	0.048	1													
Tot. Refinitiv (14)	0.129	-0.227	0.041	0.317	-0.318	0.455	-0.221	-0.257	-0.123	-0.025	0.464	0.484	-0.162	1												
Env. Sustain (15)	-0.032	-0.468	0.246	-0.003	-0.143	0.374	-0.11	-0.513	0.055	-0.449	0.717	0.519	-0.09	0.235	1											
Soc. Sustain (16)	-0.144	-0.761	0.217	-0.392	0.02	0.46	-0.07	-0.419	0.26	-0.482	0.619	0.456	-0.364	0.237	0.755	1										
Gov. Sustain (17)	-0.01	-0.724	0.028	-0.033	-0.153	0.433	-0.151	-0.267	0.181	-0.22	0.485	0.383	-0.23	0.419	0.583	0.736	1									
Tot. Sustain (18)	-0.096	-0.711	0.21	-0.233	-0.063	0.456	-0.108	-0.468	0.212	-0.448	0.689	0.494	-0.288	0.289	0.883	0.96	0.808	1								
Env. FTSE (19)	-0.148	-0.519	0.109	-0.571	0.543	0.315	0.071	-0.1	0.281	-0.401	0.644	0.335	0.054	0.011	0.508	0.631	0.365	0.603	1							
Soc. FTSE (20)	-0.066	-0.627	0.256	-0.309	0.323	0.301	0.032	-0.311	0.324	-0.482	0.71	0.614	-0.031	0.089	0.71	0.749	0.535	0.767	0.795	1						
Gov. FTSE (21)	-0.062	-0.5	-0.189	-0.099	0.073	0.141	0.158	0.09	0.196	-0.086	0.243	0.31	-0.016	0.269	0.109	0.387	0.578	0.357	0.232	0.316	1					
Tot. FTSE (22)	-0.116	-0.668	0.121	-0.43	0.402	0.305	0.108	-0.17	0.334	-0.42	0.68	0.503	0.005	0.108	0.599	0.751	0.586	0.739	0.883	0.92	0.561	1				
CDS spreads (23)	0.058	-0.729	-0.114	0.197	-0.309	0.546	-0.131	0.04	-0.237	0.163	0.087	0.209	-0.068	0.319	0.194	0.348	0.64	0.364	-0.012	0.194	0.459	0.215	1			
DtD (24)	-0.186	0.326	-0.016	-0.496	0.397	-0.32	0.278	0.108	0.371	0.163	0.062	-0.25	0.067	-0.346	-0.012	-0.013	-0.359	-0.058	0.349	0.062	-0.163	0.148	-0.709	1		
S&P (25)	-0.106	0.72	-0.094	-0.197	0.407	-0.634	0.13	0.182	0.215	0.409	-0.255	-0.43	0.153	-0.432	-0.356	-0.496	-0.674	-0.505	-0.069	-0.322	-0.548	-0.342	-0.817	0.681	1	
Moody's (26)	-0.14	0.646	-0.063	-0.374	0.451	-0.635	0.132	0.194	0.306	0.503	-0.222	-0.422	0.071	-0.4	-0.381	-0.392	-0.595	-0.439	-0.019	-0.302	-0.469	-0.288	-0.82	0.71	0.953	1

Appendix B: Ordinal Transformation of Credit Ratings

Table 11: Ordinal Transformation of Credit Ratings

Ordinal transformation of sovereign credit ratings

Grade	Moody's	S&P	*Linear transformation* Scale
Investment	Aaa	AAA	21
	Aa1	AA+	20
	Aa2	AA	19
	Aa3	AA-	18
	A1	A+	17
	A2	A	16
	A3	A-	15
	Baa1	BBB+	14
	Baa2	BBB	13
	Baa3	BBB-	12
Speculative	Ba1	BB+	11
	Ba2	BB	10
	Ba3	BB-	9
	B1	B+	8
	B2	B	7
	B3	B-	6
	Caa1	CCC+	5
	Caa2	CCC	4
	Caa3	CCC-	3
	Ca	CC	2
	C	C,SD,C	1

Appendix C: List of Countries

Table 12: List of Countries

List of Countries

Panel A: CDS Spreads			Panel B: Distance-to-default			Panel C: S&P ratings			Panel D: Moody's ratings		
Refinitiv	**FTSE**	**Sustainalytics**	**Refinitiv**	**FTSE**	**Sustainalytics**	**Refinitiv**	**FTSE**	**Sustainalytics**	**Refinitiv**	**FTSE**	**Sustainalytics**
Australia	Australia	Austria	Austria	Austria	Austria	Australia	Australia	Austria	Australia	Australia	Austria
Austria	Austria	Belgium	Belgium	Belgium	Belgium	Austria	Austria	Belgium	Austria	Austria	Belgium
Belgium	Belgium	Canada	Canada	Canada	Canada	Belgium	Belgium	Canada	Belgium	Belgium	Canada
Brazil	Brazil	Denmark	Czech Republic	Czech Republic	Finland	Brazil	Brazil	Denmark	Brazil	Brazil	Denmark
Canada	Canada	Finland	Finland	Finland	France	Canada	Canada	Finland	Canada	Canada	Finland
Czech Republic	Czech Republic	France	France	France	Germany	Czech Republic	Czech Republic	Germany	Czech Republic	Czech Republic	Germany
Denmark	Denmark	Germany	Germany	Germany	Italy	Denmark	Denmark	Ireland	Denmark	Denmark	Ireland
Finland	Finland	Ireland	Hungary	Hungary	Netherlands	Finland	Finland	Norway	Finland	Finland	Italy
France	France	Netherlands	Indonesia	Italy	Portugal	France	France	Poland	France	France	Netherlands
Germany	Germany	Norway	Italy	Mexico	Spain	Germany	Germany	Portugal	Germany	Germany	Norway
Greece	Greece	Poland	Mexico	Netherlands	Sweden	Hungary	Hungary	Russia	Greece	Greece	Poland
Hungary	Hungary	Portugal	Netherlands	Portugal	United Kingdom	Indonesia	Indonesia	Spain	Hungary	Hungary	Portugal
Indonesia	Indonesia	Russia	Portugal	South Africa	United States	Ireland	Ireland	Sweden	Indonesia	Indonesia	Russia
Ireland	Ireland	Spain	South Africa	Spain		Japan	Japan	Switzerland	Ireland	Ireland	Spain
Japan	Japan	Sweden	Spain	Sweden		Mexico	Mexico	United Kingdom	Italy	Italy	Sweden
Malaysia	Malaysia	Switzerland	Sweden	United Kingdom		New Zealand	New Zealand	United States	Japan	Japan	Switzerland
Mexico	Mexico	United Kingdom	United Kingdom	United States		Norway	Norway		Malaysia	Malaysia	United Kingdom
Netherlands	Netherlands	United States	United States			Poland	Poland		Mexico	Mexico	United States
New Zealand	New Zealand					Portugal	Portugal		Netherlands	Netherlands	
Norway	Norway					Russia	Russia		New Zealand	New Zealand	
Philippines	Philippines					South Africa	South Africa		Norway	Norway	
Poland	Poland					Spain	Spain		Philippines	Philippines	
Portugal	Portugal					Sweden	Sweden		Poland	Poland	
Russia	Russia					Switzerland	Switzerland		Portugal	Portugal	
South Africa	South Africa					Thailand	Thailand		Russia	Russia	
Spain	Spain					Turkey	Turkey		South Africa	South Africa	
Sweden	Sweden					United Kingdom	United Kingdom		Spain	Spain	
Switzerland	Switzerland					United States	United States		Sweden	Sweden	
Thailand	Thailand								Switzerland	Switzerland	
Turkey	Turkey								Thailand	Thailand	
United Kingdom	United Kingdom								Turkey	Turkey	
United States	United States								United Kingdom	United Kingdom	
									United States	United States	

D.1. Results with Sustainalytics ESG Scores

Table 13: Standard ordered probit estimation results for S&P Ratings with Sustainalytics ESG Scores

Variables	Expected sign	*Dependent: S&P Ratings* *Sustainalytics ESG Scores*			
		Total ESG Score	Environmental Score	Social Score	Governance Score
Log GDP/Capita	+	3.960***	4.141***	3.560***	4.075***
		(0.251)	(0.261)	(0.242)	(0.251)
Current Account/GDP	+/-	-4.757***	-4.791***	-4.645***	-5.974***
		(1.327)	(1.331)	(1.336)	(1.302)
External Debt/GDP	-	-0.152***	-0.112***	-0.190***	-0.106**
		(0.044)	(0.043)	(0.046)	(0.042)
Natural Log of Foreign Reserves	+	0.464***	0.486***	0.449***	0.459***
		(0.049)	(0.050)	(0.049)	(0.049)
Unemployment Rate	-	-6.486***	-6.599***	-5.709***	-6.092***
		(1.608)	(1.614)	(1.591)	(1.592)
Change in Inflation Rate	-	-17.460*	-15.834	-16.884*	-16.900*
		(10.164)	(10.164)	(10.147)	(10.127)
Interest Rate	-	6.442	10.882**	1.884	12.417**
		(5.163)	(5.009)	(5.587)	(4.907)
Financial Risk Rating	+	0.03	0.021	0.03	0.057**
		(0.026)	(0.026)	(0.026)	(0.026)
Political Risk Rating	+	0.026**	0.026*	0.035***	0.032**
		(0.013)	(0.013)	(0.013)	(0.013)
Weighted Average Total ESG Score	+	-0.077 ***			
		(0.011)			
Weighted Average Environmental Score	+		-0.058 ***		
			(0.009)		
Weighted Average Social Score	+			-0.068 ***	
				(0.011)	
Weighted Average Governance Score	+				-0.087 ***
					(0.011)
McFadden R^2		0.8532	0.8521	0.8515	0.8549
Number of Obervations		655	655	655	655

Note: ∗∗∗p < 0.01; ∗∗p < 0.05; ∗p < 0.1

D.2. Results with Refinitiv ESG Scores

Table 14: Standard ordered probit estimation results for S&P Ratings with Refinitiv ESG Scores

Variables	Expected sign	*Dependent: S&P Ratings* *Refinitiv ESG Scores*			
		Total ESG Score	Environmental Score	Social Score	Governance Score
Log GDP/Capita	+	1.543***	1.589***	1.526***	1.421***
		(0.094)	(0.102)	(0.097)	(0.095)
Current Account/GDP	+/-	-3.776***	-3.860***	-4.228***	-2.388**
		(0.938)	(0.951)	(0.955)	(0.964)
External Debt/GDP	-	-0.139***	-0.140***	-0.144***	-0.198***
		(0.034)	(0.034)	(0.034)	(0.035)
Natural Log of Foreign Reserves	+	0.048	0.055	0.047	-0.043
		(0.131)	(0.133)	(0.123)	(0.121)
Unemployment Rate	-	-4.247***	-4.214***	-4.567***	-5.641***
		(0.715)	(0.745)	(0.728)	(0.730)
Change in Inflation Rate	-	10.750**	11.275**	11.298**	12.134**
		(5.199)	(5.195)	(5.199)	(5.224)
Interest Rate	-	-6.410***	-6.056***	-5.405***	-3.825**
		(1.725)	(1.736)	(1.746)	(1.736)
Financial Risk Rating	+	0.083***	0.085***	0.088***	0.092***
		(0.013)	(0.013)	(0.013)	(0.013)
Political Risk Rating	+	0.026***	0.026***	0.029***	0.027***
		(0.007)	(0.007)	(0.007)	(0.007)
Weighted Average Total ESG Score	+	-0.012**			
		(0.005)			
Weighted Average Environmental Score	+		-0.004		
			(0.004)		
Weighted Average Social Score	+			0.003	
				(0.004)	
Weighted Average Governance Score	+				0.056***
					(0.006)
McFadden R^2		0.5499	0.5492	0.5492	0.5610
Number of Obervations		1090	1090	1090	1090

Note: ∗∗∗p < 0.01; ∗∗p < 0.05; ∗p < 0.1

D.3. Results with FTSE ESG Scores

Table 15: Standard ordered probit estimation results for S&P Ratings with FTSE ESG Scores

Variables	Expected sign	*Dependent: S&P Ratings* *FTSE ESG Scores*			
		Total ESG Score	Environmental Score	Social Score	Governance Score
Log GDP/Capita	+	4.289***	4.228***	4.257***	4.450***
		(0.335)	(0.339)	(0.334)	(0.334)
Current Account/GDP	+/-	-2.560*	-2.930**	-3.289**	-2.227
		(1.481)	(1.488)	(1.498)	(1.525)
External Debt/GDP	-	-0.429***	-0.425***	-0.434***	-0.468***
		(0.066)	(0.067)	(0.066)	(0.065)
Natural Log of Foreign Reserves	+	0.174**	0.109	0.175**	0.164**
		(0.069)	(0.068)	(0.069)	(0.072)
Unemployment Rate	-	-12.503***	-13.649***	-12.586***	-11.313***
		(2.285)	(2.381)	(2.275)	(2.256)
Change in Inflation Rate	-	16.288	17.308	18.567	22.253
		(16.637)	(16.543)	(16.612)	(16.525)
Interest Rate	-	15.265***	16.043***	17.322***	10.138**
		(4.618)	(4.737)	(4.649)	(4.289)
Financial Risk Rating	+	-0.067*	-0.052	-0.070**	-0.069**
		(0.035)	(0.034)	(0.035)	(0.035)
Political Risk Rating	+	-0.068***	-0.070***	-0.056***	-0.084***
		(0.019)	(0.019)	(0.020)	(0.019)
Weighted Average Total ESG Score	+	0.518***			
		(0.162)			
Weighted Average Environmental Score	+		0.420***		
			(0.136)		
Weighted Average Social Score	+			0.561***	
				(0.131)	
Weighted Average Governance Score	+				0.108
					(0.153)
McFadden R^2		0.9070	0.9068	0.9081	0.9056
Number of Obervations		354	354	354	354

Note: ∗∗∗p < 0.01; ∗∗p < 0.05; ∗p < 0.1

Appendix E: Results for Moody's Regressions

E.1. Results with Sustainalytics ESG Scores

Table 16: Standard ordered probit estimation results for Moody's Ratings with Sustainalytics ESG Scores

Variables	Expected sign	*Total ESG Score*	*Environmental Score*	*Social Score*	*Governance Score*
		Dependent: Moody's Ratings			
		Sustainalytics ESG Scores			
Log GDP/Capita	+	1.298***	1.489***	1.104***	1.342***
		(0.161)	(0.166)	(0.163)	(0.162)
Current Account/GDP	+/-	1.513	1.001	1.428	0.77
		(1.070)	(1.050)	(1.096)	(1.044)
External Debt/GDP	-	-0.257***	-0.232***	-0.273***	-0.225***
		(0.034)	(0.034)	(0.035)	(0.033)
Natural Log of Foreign Reserves	+	-0.035	-0.011	-0.038	-0.036
		(0.039)	(0.039)	(0.039)	(0.039)
Unemployment Rate	-	-1.259	-1.567	-0.732	-0.567
		(1.376)	(1.382)	(1.367)	(1.363)
Change in Inflation Rate	-	4.244	4.207	3.99	5.923
		(8.633)	(8.655)	(8.614)	(8.624)
Interest Rate	-	-10.048**	-9.368**	-9.467**	-3.157
		(4.546)	(4.409)	(4.787)	(4.198)
Financial Risk Rating	+	0.077***	0.071***	0.072***	0.088***
		(0.019)	(0.019)	(0.019)	(0.019)
Political Risk Rating	+	0.060***	0.052***	0.069***	0.071***
		(0.011)	(0.011)	(0.011)	(0.011)
Weighted Average Total ESG Score	+	-0.055***			
		(0.009)			
Weighted Average Environmental Score	+		-0.052***		
			(0.008)		
Weighted Average Social Score	+			-0.037***	
				(0.009)	
Weighted Average Governance Score	+				-0.045***
					(0.009)
McFadden R^2		0.8462	0.8470	0.8450	0.8455
Number of Obervations		735	735	735	735

Note: ∗∗∗p < 0.01; ∗∗p < 0.05; ∗p < 0.1

E.2. Results with Refinitiv ESG Scores

Table 17: Standard ordered probit estimation results for Moody's Ratings with Refinitiv ESG Scores

Variables	Expected sign	*Dependent: Moody's Ratings* *Refinitiv ESG Scores*			
		Total ESG Score	Environmental Score	Social Score	Governance Score
Log GDP/Capita	+	0.542***	0.644***	0.589***	0.471***
		(0.067)	(0.076)	(0.072)	(0.068)
Current Account/GDP	+/-	0.846	1.257	1.183	1.470*
		(0.761)	(0.768)	(0.773)	(0.765)
External Debt/GDP	-	-0.190***	-0.186***	-0.184***	-0.227***
		(0.027)	(0.027)	(0.027)	(0.027)
Natural Log of Foreign Reserves	+	-0.100***	-0.090***	-0.092***	-0.152***
		(0.027)	(0.027)	(0.027)	(0.028)
Unemployment Rate	-	-0.808	-0.207	-0.501	-1.262*
		(0.649)	(0.668)	(0.654)	(0.647)
Change in Inflation Rate	-	8.483*	8.319*	8.407*	8.235*
		(4.376)	(4.369)	(4.370)	(4.374)
Interest Rate	-	-2.732*	-3.586**	-3.361**	-1.302
		(1.564)	(1.567)	(1.568)	(1.571)
Financial Risk Rating	+	0.029***	0.023**	0.026**	0.032***
		(0.010)	(0.010)	(0.010)	(0.010)
Political Risk Rating	+	0.050***	0.046***	0.047***	0.049***
		(0.006)	(0.006)	(0.006)	(0.006)
Weighted Average Total ESG Score	+	0.004			
		(0.004)			
Weighted Average Environmental Score	+		-0.010***		
			(0.003)		
Weighted Average Social Score	+			-0.006*	
				(0.003)	
Weighted Average Governance Score	+				0.034***
					(0.005)
McFadden R^2		0.5934	0.5940	0.5936	0.5977
Number of Obervations		1286	1286	1286	1286

Note: ∗∗∗p < 0.01; ∗∗p < 0.05; ∗p < 0.1

E.3. Results with FTSE ESG Scores

Table 18: Standard ordered probit estimation results for Moody's Ratings with FTSE ESG Scores

| Variables | Expected sign | Dependent: Moody's Ratings FTSE ESG Scores | | | |
		Total ESG Score	Environmental Score	Social Score	Governance Score
Log GDP/Capita	+	1.349***	1.292***	1.301***	1.464***
		(0.209)	(0.210)	(0.209)	(0.210)
Current Account/GDP	+/-	2.371*	1.935	1.838	1.844
		(1.274)	(1.287)	(1.292)	(1.283)
External Debt/GDP	-	-0.271***	-0.267***	-0.274***	-0.299***
		(0.047)	(0.047)	(0.047)	(0.047)
Natural Log of Foreign Reserves	+	-0.131**	-0.169***	-0.136**	-0.196***
		(0.055)	(0.056)	(0.055)	(0.058)
Unemployment Rate	-	5.905***	4.649**	5.403***	6.235***
		(1.777)	(1.842)	(1.777)	(1.750)
Change in Inflation Rate	-	-9.588	-11.833	-10.603	-2.336
		(10.689)	(10.675)	(10.630)	(10.718)
Interest Rate	-	26.853***	30.211***	30.099***	25.554***
		(4.731)	(5.036)	(5.017)	(4.570)
Financial Risk Rating	+	-0.024	-0.017	-0.026	-0.012
		(0.022)	(0.022)	(0.022)	(0.022)
Political Risk Rating	+	0.053***	0.055***	0.063***	0.043***
		(0.016)	(0.016)	(0.016)	(0.016)
Weighted Average Total ESG Score	+	0.122			
		(0.121)			
Weighted Average Environmental Score	+		0.286***		
			(0.104)		
Weighted Average Social Score	+			0.288***	
				(0.100)	
Weighted Average Governance Score	+				-0.398***
					(0.118)
McFadden R^2		0.8829	0.8835	0.8835	0.8837
Number of Obervations		413	413	413	413

Note: ∗∗∗p < 0.01; ∗∗p < 0.05; ∗p < 0.1

Appendix F: Data and Methodology for calculating the Distance-to-default measure at sovereign level using the Contingent Claims Analysis Approach

Background and calculation of DtD

We use distance-to-default to measure and analyze sovereign credit risk using the Contingent Claims Analysis Approach (CCA) as outlined by Gray, Merton, and Bodie (2007). CCA is a generalization of the option pricing theory of Black Scholes (1973) and Merton (1973) and is also called the Merton Model. The CCA approach is commonly used to measure corporate credit risk where the equity of firm is modelled as a call option on the market value of assets with a strike price that is equal to the face value of debt of a firm. The first paper to adapt the model at to the sovereign balance sheet was by Gray et al., (2007) and we follow the process outlined in the paper to compute distance-to-default at the sovereign level. Default risk at the sovereign level is driven by interaction between three elements: the value of sovereign assets, asset volatility which captures the uncertainty in the future market value of sovereign assets and the value of liabilities. The likelihood of a sovereign default increases when the market value of sovereign assets falls relative to the debt obligations or when the asset volatility increases such that the value of sovereign assets become uncertain increasing the default probability (Gapen, Gray, Lim, and Xiao, 2005). Unlike the liabilities, the market value of sovereign assets and their volatility are not directly observable from a sovereign balance sheet. The CCA approach applies the Merton Model to derive an implied market value of sovereign assets and volatility using the observable values on the liability side of a sovereign balance sheet.

The sovereign balance sheet is constructed as an consolidated balance sheet of the government and the central bank as shown in the table below:

Assets	Liabilities
Foreign reserves	Guarantees
Net fiscal assets	Foreign currency debt
Credit to other sectors	Local currency debt
Other public assets	Monetary base

Essentially, the sovereign CCA model is similar to the corporate CCA model, where the market value of the company's equity is replaced by the market value of local currency liabilities. The distress barrier is based on the foreign currency debt.

The study seniority of sovereign liabilities is not pre-defined. Therefore, foreign currency liabilities are regarded as senior claims because in times of crisis, governments like to stay current on their foreign currency obligations, whereas, they say that the local currency liabilities have "equity-like" features such that local currency debt and base money are like "equity" on a sovereign balance sheet making the domestic debt obligations junior claims.

An interesting outlook is proposed by the study K.Singh et al., (2018) for European Area (EA) countries where they argue that the structure of debt is different for EA countries because the denomination of the currency in which the debt is issued is determined by the European Central Bank (ECB) so they propose an alternative framework to determine the priority structure of debt for EA countries instead of treating foreign and local currency debt as senior and junior claims respectively as in the previous study. They use the data provided by Bruegel database which classifies liabilities into resident banks, non-resident banks, other public institutions, other residents and non-residents. They considered the market value of non-

resident bank holdings (external) and resident bank holdings as senior claim and the rest as the junior claim. We follow the same methodology for all the 11 countries for which the classification was available at the Bruegel website including the non-European developed countries i.e. UK and US, because we believe that amount of foreign currency debt may not be necessarily be high for developed economies whereas, using alternative methodology to distinguish between senior and junior claims is likely to portray better credit health of the developed nations.

The datasets and variables used in the calculation of DtD are:
1. Market value of sovereign debt: We use the Quarterly Public Sector Debt Statistics (QPSD) database, which has been jointly developed by World Bank and International Monetary Fund (IMF) which provides public sector debt data at a country level (Quarterly Public Sector Debt).
2. Risk-free interest rate: We extract quarterly data on 10-year government bond yields as the risk-free interest rate from Refinitiv .
3. Volatility of sovereign debt: We use the Total Return Index on 5-year government bonds, extracted from Refinitiv , to calculate the volatility of sovereign debt. The standard deviation is calculated on a quarterly basis and is then annualized for each quarter.
4. Sectoral sovereign bond holdings: For the classification of public debt in senior and junior claims for European countries and other developed nations, we use the cross-country sectoral sovereign bond holdings data developed by Merler and Pisani-Ferry (2012) available at Bruegel (2018). The dataset provides sectoral break-down of the public debt for the following countries (Belgium, Finland, France, Germany, Ireland, Italy, Netherlands, Portugal, Spain, UK and US).

Methodology for DtD Calculation

We perform the classification of debt for the 11 countries based on the sectoral holdings provided by the Bruegel website. K.Singh et al., (2018) consider the non-resident debt holdings(external) and resident holdings as senior claims. We also follow the same procedure and in order to calculate the value of senior claims we multiply the percentage attributed to non-resident debt holdings and resident holdings to the amount of Total Debt (in US$) from the QPSD database. The value of junior claims is calculated by subtracting the value of senior claims from the Total Debt figure. For the remaining countries, we extract the total debt in domestic currency (in US$) and foreign currency (in US$) from the QPSD database to be used as junior and senior debt claims respectively.

For the calculation of DtD in R, we use the package "ifrogs". The function "dtd" in the "ifrogs" package implements the Merton Model methodology at the firm level and requires four set of values: market value of the equity of the firm ('mcap'), its volatility ('vol'), the face value of debt ('debt'), and the annualized interest rate ('r'). The function is as follows:
dtd (mcap, debt, vol, r)

For the calculation of DtD of the 11 countries, we plug in the value of senior public debt as the face value of debt and the value of junior public debt as the market value of equity, whereas, for the calculation of DtD for the remaining countries, we plug in foreign currency debt as the face value of debt and the domestic currency debt as the market value of equity. The annualized volatility and risk-free interest rate are also plugged in respectively. The function returns three values: asset value of the sovereign, volatility of the asset value and the distance to default of the sovereign. Table 19 in Appendix G provides a country wise summary statistics for distance-t-default.

Appendix G: Summary statistics for Distance-to-default

Table 19: Summary Statistics for Distance-to-default

Country	Mean	Std.Dev.	Min	Max
Argentina	7.3	6.13	2.7	28.94
Austria	33.23	10.49	24.38	62.51
Belgium	30.15	3.62	23.58	39.21
Canada	27.02	5.5	21.63	42.39
Czech Republic	28.12	3.56	23.93	40.38
Finland	32.62	7.61	23.37	59.52
France	28.98	5.3	22.43	48.03
Germany	37.29	20.88	-6.9	68
Hungary	13.6	4.18	8.86	25.49
Indonesia	17.76	1.51	13.45	20.14
Italy	24.25	5.74	17	35
Netherlands	30.75	6.38	22.8	56.18
Portugal	17.8	12.81	7.36	46.61
South Africa	20.37	6.15	13.82	31.91
Spain	26.72	6.54	18.06	40.13
Sweden	25.8	5.87	19.73	42.77
United Kingdom	25.62	5.56	18.9	39.35
United States	21.18	4.33	17.23	32.25