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DOES BETTER ESG PERFORMANCE LOWER CREDIT RISK? A SOVEREIGN CREDIT PERSPECTIVE

Key Points:

- *Environmental, social and governance (ESG) factors have become increasingly important in investment and financial valuation in recent years. Public sectors in many economies have launched or planned to launch ESG bonds to demonstrate their commitment to sustainable development and combat the challenges of climate change. Against this backdrop, this study examines how ESG factors have affected sovereign credit risk over time and across economies.*

- *We find that investors have generally factored in ESG performance and the development of ESG debt market in pricing sovereign credit risk since the mid-2010s. On comparing emerging market economies (EMEs) with advanced economies (AEs), the still shallow ESG debt market in EMEs has yet to exert material effect on their sovereign credit risks, and investors tend to disregard environmental factors when pricing EMEs' sovereign credit risk, probably as a sacrifice to economic development.*

- *As such, policymakers need to continue to support the ESG-related developments especially in EMEs, for example, by growing the awareness of the linkage between environmental well-being and financial investment return, and strengthening international cooperation to improve the environmental performance of EMEs, e.g. fostering technology transfer.*

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1. INTRODUCTION

Environmental, Social and Governance (ESG) investing has evolved to become a mainstream investment strategy since the mid-2010s. Following the establishment of the Doha Amendment in 2012 and the Paris Agreement in 2015[1], institutions started to create framework and guidelines to manage and disclose climate risks in accordance with the Task Force on Climate-Related Financial Disclosures (TCFD) under the Financial Stability Board (FSB). Investors also increased their appetites on incorporating ESG principles into their portfolio decisions after the COVID-19 outbreak in early 2020.[2] Accordingly, the number of economies with available ESG debt information has grown steadily since early 2000s, and the amount of ESG debt issuance skyrocketed after 2014 (Chart 1).

Alongside the expansion in the global ESG debt market, more studies have examined the linkage between corporate ESG performance and financial performance (Buallay, 2019; Giese et al., 2019; and Taliento et al., 2019), and generally pointed to two channels through which ESG performance would affect corporate financial performance: (1) the *cash-flow channel*, through which higher ESG-rated firms might have better competitive advantage (e.g. more efficient use of resources and better innovation management) to generate abnormal returns (Gregory et al., 2014); (2) the *risk control channel*, through which firms with better ESG performance are typically more devoted to maintaining high quality risk control and compliance standards, and hence can reduce the potential exposures to downside risks, such as corruption and fraud (Godfrey et al., 2009; Jo et al., 2012; and Oikonomou et al., 2012). The literature also suggested that investors have increasingly been willing to pay a premium for firms' good ESG performance.

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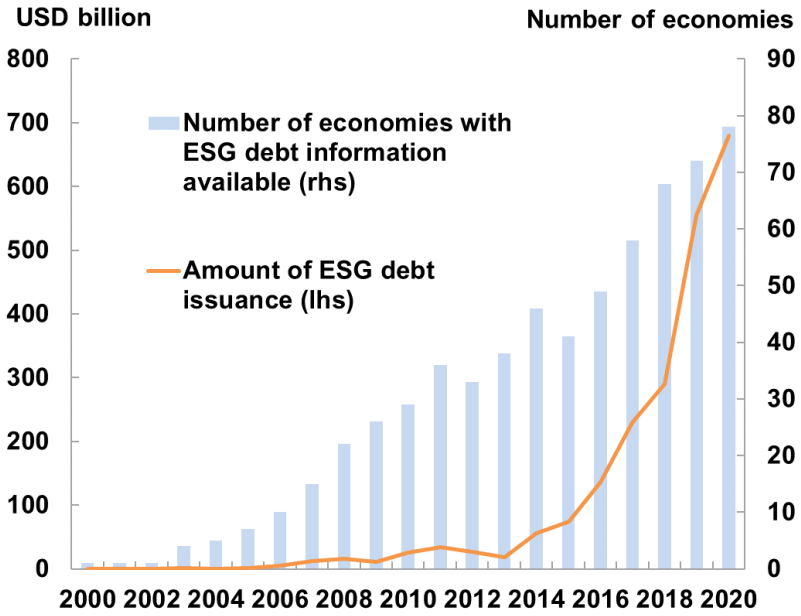
[1] The 26th UN Climate Change Conference of the Parties (COP26) summit in 2021 called for accelerating global actions to achieve the goals of the Paris Agreement.

[2] See "Why COVID-19 Could Prove to Be a Major Turning Point for ESG Investing", J. P. Morgan, July 2020 (URL: https://www.jpmorgan.com/insights/research/covid-19-esg-investing).

Chart 1. Global ESG Debt Issuance



Note: Supranational ESG debt excluded.

Source: Bloomberg.

Meanwhile, there are comparatively few studies on the effect of economy-wide ESG performance on sovereign credit risk, even though many economies have launched or planned to launch ESG bonds to demonstrate their commitment to sustainable development and combat the challenges of climate change. **To fill this blank, our study aims to examine *the influence of* the ESG factors on sovereign credit risk.** Specifically, the study addresses four key questions: (1) Could better national ESG performances reduce sovereign credit risk (i.e. in practice, reduce the CDS spread)? (2) Could a faster ESG debt market development reduce sovereign credit risk? (3) When did investors start including ESG factors in their investment decision making? (4) Whether the ESG effect on sovereign credit risk is homogeneous across advanced economies (AEs) and emerging market economies (EMEs)? The answers to these questions could provide important insights for ESG-related policymaking in the medium- to long-term.

The rest of the paper is organised as follows. Section 2 reviews the literature. Section 3 and Section 4 discuss the methodology and data respectively. Section 5 elaborates on the empirical results and the corresponding robustness check is reported in Section 6. Section 7 discusses the policy implications and concludes

the study.

2. LITERATURE REVIEW

According to the literature, sovereign credit risk is determined by three major factors, namely: (1) *sovereign credibility* – which is determined by an economy's fiscal and macroeconomic position, including the level of government debt, fiscal space, GDP growth, inflation, etc.; (2) *liquidity risks* – which reflects the size and the depth of financial market; and (3) *global risk aversion* – which reflects international investors' attitude towards different types of risk factors.[3]

Some studies suggest that the linkages between macroeconomic fundamentals and sovereign credit risk might have weakened after the GFC (De Grauwe and Ji, 2013; Poghosyan, 2012; Di Cesare et al., 2012). A possible reason is the distortion caused by the unprecedentedly accommodative monetary conditions and excessive global liquidity. Other than the macroeconomic fundamentals, non-financial factors, such as concerns over the governance issue – which was cited as a key cause of the GFC – as well as the increase in environment awareness, are also considered to have played a role. At this time, studies began to investigate the impact of the ESG elements on sovereign credit risk (Ciocchini et al., 2003; Baldacci et al., 2011; Drut, 2010).

Margaretic and Pouget (2018) establish a framework that explicitly links up the ESG factors and sovereign credibility. Their study hypothesises that sovereign bond returns can be affected by the "extra-financial performance", i.e. the ESG factors, through four economic channels. First, an economy with good ESG performance implies its commitment to sustainable development and therefore the default risk of its debt obligations is lower than those economies with poor ESG performance. Second, a better public communication on ESG issues could reduce information asymmetries and strengthen the trust between investors and the economy.

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[3] For details, please refer to Afonso et al.(2015), Aizenman et al. (2013), Alichi (2008), Baldacci et al.(2011), D'Agostino and Ehrmann (2014), and Garcia-Herrero et al. (2006).

Third, in specific cases, the preservation of important natural resources is conducive to the long-term sustainable development in some economies (e.g. the habitat of the Amazon rainforest). Fourth, natural and social resources can be treated as the extra-buffer against unexpected shocks.

Capelle-Blancard et al. (2019) introduces several new findings based on Margaretic and Pouget (2018)'s framework. First, the study verifies the strong negative relationship between ESG performance and sovereign bond yield spread, i.e. a better national ESG performance is associated with narrower sovereign bond yield spread. Nonetheless, similar to the findings in Margaretic and Pouget (2018), the correlation is primarily contributed by the governance factor (G) and social factor (S), while the environmental factor (E) has an insignificant effect on sovereign bond yield spread. Second, the relationship between ESG performance and sovereign bond yield spread is more significant after the GFC, and this may imply that more investors included ESG factors in their investment decision after the GFC.[4]

Hübel (2020) proposes two distinct aspects to quantitatively explain the linkages between ESG factors and sovereign credit risk. First, the "level effect of ESG" indicates that a better ESG performance leads to a lower level of CDS spread, as better ESG performance can be viewed as a buffer to stabilise tax income and mitigate the impact of negative shocks. Second, the "slope effect of ESG" suggests that the negative relationship between ESG performance and sovereign credit risks should be more significant in the long-term than in the short-term horizons (measured by the differences between the 10-year CDS spreads and the 1-year CDS spreads).

3. METHODOLOGY AND DATA

To study the effects of ESG performance on sovereign credit risk, we

[4] Nevertheless, Crifo et al. (2017) argue that the effect of financial ratings (measured by S&P ratings) on sovereign borrowing cost is about three times stronger than the effect of ESG ratings, suggesting that any investment decisions still mainly depend on the financial performance of securities, and the ESG ratings are typically treated as the supplementary information.

estimate a fixed-effect model with the sovereign credit risk of an economy i in year t, $SCR_{i,t}$, as the dependent variable:

$$SCR_{i,t} = \alpha_i + \beta ESG_{\mathrm{i,t-1}} + \gamma Control_{i,t} + e_{i,t} \quad (1)$$

Where α_i is the fixed effect, $ESG_{i,t-1}$ are the ESG-related variables lagged by one year to circumvent the issue of reverse causality (see Hübel (2020)), $Control_{i,t}$ are the control variables and $e_{i,t}$ is the error term. The coefficient β captures the impact of ESG-related factors on the sovereign credit risk, which is the key estimate in this study. Our sample covers 44 economies (25 AEs and 19 EMEs)[5] with the time period covering 2005 to 2020. Details are listed in Tables A2 and A3.

i. Dependent Variable: Sovereign credit risk

The CDS spread is used as the dependent variable in the baseline model. Unlike Hübel (2020) which uses the year-end CDS spread in the estimation, we use the logarithm of the yearly-averaged CDS spread to capture the sovereign credit risk over the entire year (Our finding is robust to the use of the year-end CDS spread). We use the 10-year US dollar sovereign CDS spread as the long-term baseline dependent variable. The 5-year and 1-year CDS spreads are used in the robustness check to verify the heterogeneous impact of ESG factors on the medium- and short-term sovereign credit risk. The 10-year generic government bond yield spread over the US Treasury yield will also be used for the robustness check.

ii. Key Explanatory Variables:

a. ESG Indices

The **Environmental Index (E-Index)** is based on the index published by the Yale University.[6] The index covers 32 performance indicators across 11 issues,

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[5] Please see Table 7.

[6] Wendling, Z.A., Emerson, J.W., de Sherbinin, A., Esty, D.C., et al. (2020). 2020 Environmental Performance Index. New Haven, CT: Yale Center for Environmental Law & Policy. epi.yale.edu

including human health, ecosystem vitality and environmental health.

The **Social Index (S-Index)** is retrieved from the World Bank's World Development Indicators (WDI). There are several sub-indicators in the WDI that fit the definition of social performance. We narrow down the list to a set of four sub-indicators due to practical considerations, such as data availability across the economies in our sample and the length of the available time series. The four selected social indicators are: (1) share of individuals using the internet, (2) life expectancy at birth, (3) share of wage and salaried workers in total employment, and (4) share of vulnerable employment in total population. Similar to Capelle-Blancard et al. (2019), we use the principal component analysis (PCA) to construct the S- Index. [7]

The **Governance Index (G-Index)** is based on the World Bank's Worldwide Governance Indicators (WGI). To construct the G-Index by the PCA, we use all six governance indicators from the WGI, including (1) voice and accountability, (2) political stability and absence of violence, (3) government effectiveness, (4) regulatory quality, (5) rule of law, and (6) control of corruption.[8]

We then aggregate the above three indicators by repeating the PCA procedures. The resulting **ESG Index** summarises an economy's overall ESG performance (See Table A4c). Chart 2 depicts the ESG performance rankings of our sample economies with reference to their GDP per capita levels in 2017. It shows that AEs in general have better ESG performance than EMEs.

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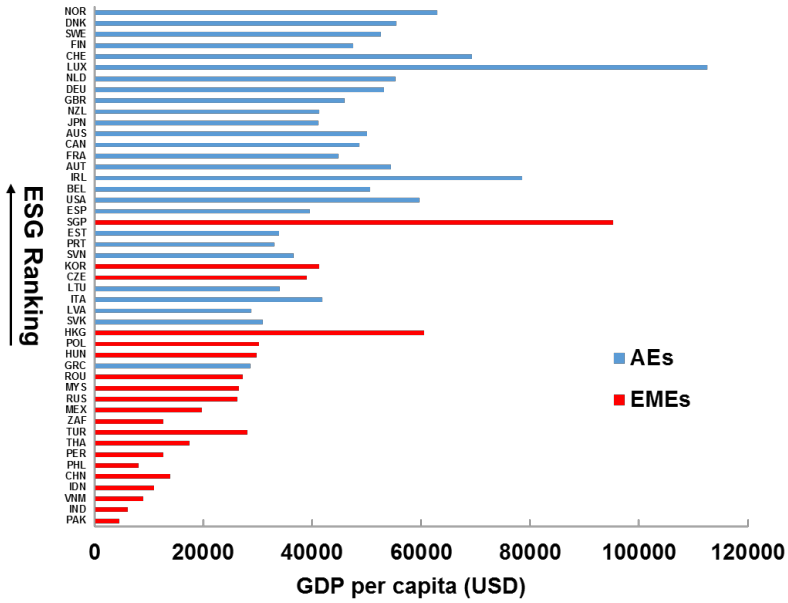
[7] According to Jolliffe and Cadima (2016), PCA is a technique to reduce the dimensionality of datasets by creating new uncorrelated variables to maximize the variance. Thus, it can increase the interpretability of those datasets while minimize the information loss. Following Kaiser's criterion, only components with the eigenvalue larger than 1 are extracted (See Table A4a). Thus, the first principal component is extracted as the Social Index, which accounts for more than 70% of total variance.

[8] Similar to the construction of S- Index, the first principal component (the only component with eigenvalue higher than 1) is extracted as the G- index (See Table A4b).

Chart 2. Ranking of ESG Index and GDP per capita in 2017



Note: GDP per capita in PPP exchange rate, nominal USD.

Sources: Oxford Economics, World Bank, Yale University and authors' estimation.

b. ESG Debt Issuance

Another key variable is the ESG debt issuance-to-GDP ratio which captures the development of ESG financial markets of the economies. The data on ESG debt issuance is collected from the Bloomberg Intelligence, which contains debt issuance data of 124 economies from 2000.

c. Control Variables

A list of conventional financial and macroeconomic factors is included in the regression as control variables. Financial factors include the US treasury yield (corresponding to the tenor of the CDS) and the VIX index. Macroeconomic factors include GDP growth, CPI inflation, government debt-to-GDP ratio and foreign exchange reserves (excluding gold) as a share of GDP. Variables are transformed to yearly frequency (by taking average) to align with the yearly ESG-related variables.

4. KEY FINDINGS

i. ESG factors have become more influential to the sovereign credit risk in recent years

Table 1 shows the baseline estimation results of Equation (1). Columns (1) and (2) respectively show the results using the ESG Index and ESG debt issuance as the key independent variables. **The significantly negative estimated coefficients in both cases indicate that a better ESG performance and a more established ESG financial market could narrow the sovereign credit risk**.

To examine the impact of the ESG concept since the mid-2010s, we divide the data into subsamples using year 2014 as the dividing point, as 2014 is the year when the ESG debt market began to thrive (see Chart 1). Columns (3) and (4) in Table 1 show the estimation results of the "pre-2014" subsample; and columns (5) and (6) show the results of the "post- 2014" subsample. The estimated coefficients of the ESG Index and ESG debt issuance are insignificant in the "pre-2014" period, but become significantly negative in the "post-2014" sample. **This implies the ESG factors have become influential in the sovereign bond market only since the mid-2010s.** To ascertain the robustness of this finding, we further perform a set of rolling window regressions. The estimations further confirm that the impact of ESG performance gradually increased over the period of 2008 to 2020.[9]

[9] Estimation details are reported in Section 6i.

Table 1. Panel fixed effect regression on Equation (1) by sample period

Sample period	(1) Full	(2) Full	(3) Pre-2014	(4) Pre-2014	(5) Since 2014	(6) Since 2014
ESG Index (lagged)	-0.347^		0.657		-1.200***	
	[-1.85]		[1.34]		[-5.69]	
ESG Debt Issuance (% GDP, lagged)		-0.385**		1.021		-0.353***
		[-3.19]		[1.56]		[-4.73]
10-y UST Yield (%)	-0.564***	-0.710***	-0.461***	-0.695***	-0.185***	-0.161***
	[-8.91]	[-8.72]	[-6.08]	[-6.64]	[-5.42]	[-3.87]
VIX (%)	0.051***	0.054***	0.054***	0.059***	0.003	-0.001
	[8.63]	[7.24]	[8.63]	[7.26]	[0.62]	[-0.07]
GDP Growth (%)	-0.043***	-0.033*	-0.030*	-0.002	0.002	0.006
	[-4.91]	[-2.52]	[-2.62]	[-0.10]	[0.26]	[1.15]
Inflation (%)	0.043**	0.072***	0.039*	0.062^	0.026*	0.048***
	[3.52]	[3.79]	[2.31]	[1.74]	[2.24]	[3.71]
Gov. Debt (% GDP)	0.025***	0.018***	0.040***	0.037***	0.024***	0.016*
	[5.21]	[3.90]	[7.31]	[7.10]	[4.07]	[2.31]
FX Reserve (% GDP)	-0.003	-0.004	-0.005	0.001	0.002	0.017
	[-1.09]	[-1.58]	[-1.19]	[0.68]	[0.72]	[1.33]
Constant	3.703***	4.031***	2.605***	2.322**	3.567***	3.294***
	[9.21]	[7.92]	[5.40]	[3.36]	[7.37]	[5.50]
No. of observations	621	294	373	126	248	168
No. of economies	44	41	42	33	44	40
R-squared	0.723	0.665	0.806	0.860	0.387	0.360
Economy FE	Yes	Yes	Yes	Yes	Yes	Yes
Robust SE	Yes	Yes	Yes	Yes	Yes	Yes

Note: The dependent variable is the logarithm of 10-year CDS spreads. All regressions are estimated in yearly frequency with economy fixed effect using Huber-White robust standard error. T-values are in parentheses. ***, **, * and ^ denote significance at the 0.1%, 1%, 5% and 10% levels respectively.

Source: authors' estimation.

ii. ESG debt markets in EMEs might still be too small to exert significant impact on EMEs' sovereign credit risks

To examine the difference in the sensitivity of sovereign credit risk to ESG-related factors across economies, we further divide the "post-2014" subsample into two groups, AEs and EMEs, and repeat the estimations. Table 2 shows the estimation results of Equation (1) using (i) all economies, (ii) AEs only and (iii) EMEs only. As shown, the estimated coefficients of ESG Index are significantly negative in both AEs and EMEs subsample estimations, but that of the ESG debt issuance with the EMEs subsample is insignificant (Column 6 of Table 2). **The results suggest that the relatively shallow ESG markets in EMEs has yet to exert material effect on EME sovereign credit risk** (See Chart 3).

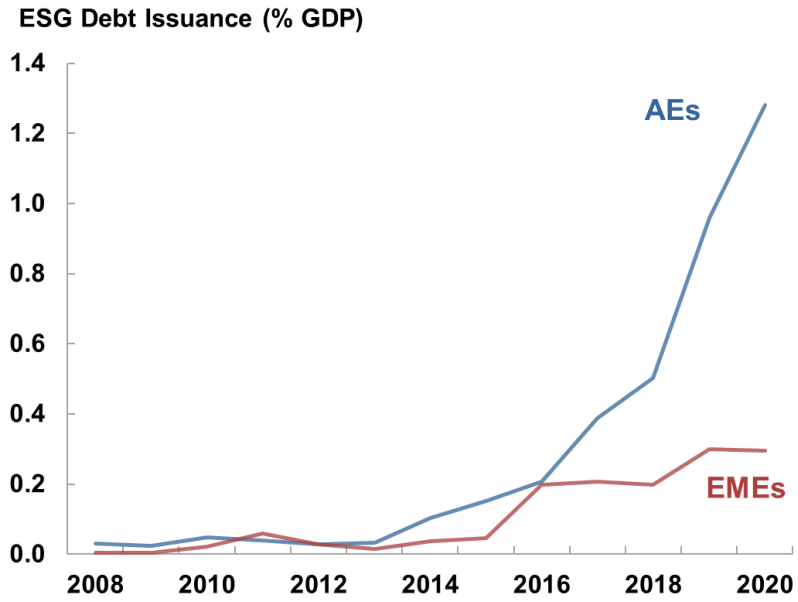
Table 2. Panel fixed effect regression on Equation (1) by economy group

	(1)	(2)	(3)	(4)	(5)	(6)
Sample economy	All	All	AEs	AEs	EMEs	EMEs
ESG Index (lagged)	-1.200*** [-5.69]		-1.389** [-3.13]		-1.138*** [-4.22]	
ESG Debt Issuance (% GDP, lagged)		-0.353*** [-4.73]		-0.336** [-3.38]		-0.201 [-1.54]
No. of observations	248	168	141	103	107	65
No. of economies	44	40	25	23	19	17
R-squared	0.387	0.36	0.399	0.446	0.493	0.253
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Economy FE	Yes	Yes	Yes	Yes	Yes	Yes
Robust SE	Yes	Yes	Yes	Yes	Yes	Yes

Note: The dependent variable is the logarithm of 10-year CDS spreads. Control variables are not reported for simplicity. Sample period is from 2014 to 2020. All regressions are estimated in yearly frequency with economy fixed effect using Huber-White robust standard error. T-values are in parentheses. ***, **, * and ^ denote significance at the 0.1%, 1%, 5% and 10% levels respectively.

Source: authors' estimation.

Chart 3. ESG Debt Issuance by Economy Group



Note: See Table A1 for economy classification.

Source: Bloomberg, World Bank and authors' calculation.

iii. Environmental factor is still out of investors' mind in EMEs

To study the impacts of the E-, S- and G-performances separately, the ESG Index is disaggregated into E-Index, S-Index and G-Index. The disaggregated indices are then put into Equation (1) as the explanatory variables in separated estimations. Table 3 summarises the signs of their coefficients[10].

Table 3: The signs of coefficients of ESG-related factors: AEs vs. EMEs

Factor	AEs	EMEs
E-Index	-ve	0
S-Index	-ve	-ve
G-Index	0	-ve
ESG Index	-ve	-ve
ESG Debt Issuance	-ve	0

Note: "-ve" refers to a negative coefficient that is significant under 5% confidence level. "0" refers to an insignificant coefficient under 5% confidence level.

Source: authors' estimation.

[10] Estimation results of each pillar are reported in Table A5.

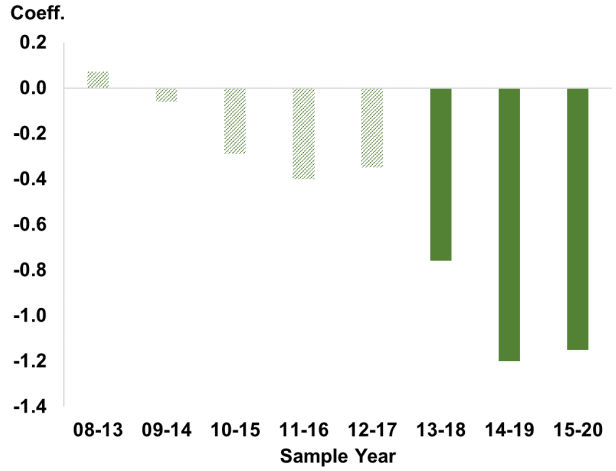
There are two interesting observations in Table 3. First, the impact of governance performance on the sovereign credit risk within AEs is not statistically substantial, possibly because governance performance of an economy would matter less once the economy has developed beyond a certain stage. Second, investors tend to have concern about the effectiveness of governance among EMEs but not the environmental risk when pricing their sovereign credit risk. The latter possibly indicates the conflict between economic development and environmental protection in developing economies due to their industrial structures and technology levels (Guo and Ma, 2008).

5. ROBUSTNESS CHECK[11]

i. Change in the impact of ESG performance over time

To further demonstrate the impact of the ESG performance on sovereign credit risk pricing, we additionally perform a set of rolling regression, with each window spanning six years. Chart 4 depicts the rolling coefficients of the ESG Index using Equation (1) in different windows.

Chart 4. Rolling Coefficient of ESG Index



Note: Rolling coefficient of ESG Index estimated by Equation (1) with a 6-year window. Shaded bar indicates insignificant coefficient and solid bar represents significant coefficient under 5% confidence level.
Source: authors' estimation.

[11] Detail estimation results in this Section are not reported for simplicity.

The chart verifies that the ESG performance had a negligible impact on sovereign credit risk in the early years, but its influence strengthened in recent years alongside the growing awareness of the ESG concept in global financial markets.

ii. Choice of CDS tenor

To ascertain the robustness of the results in Section 5 against the choice of CDS tenors, all estimations are repeated by substituting the dependent variables with 5-year and 1-year CDS respectively to measure the medium- and short-term sovereign credit risk. The results using the 5-year CDS spread are largely consistent with the estimation in Section 5, whereas most of the coefficients are insignificant when using 1-year CDS spreads as the dependent variable. The findings probably highlight the long-term nature of ESG risk, and ESG framework might be less prominent in pricing the short-term sovereign credit risk.

iii. Measure of sovereign credit risk

In addition to CDS spreads, we also proxy the sovereign credit risk by government bond yield spreads. The estimations in Section 5 are repeated by (i) substituting the dependent variable with nominal government bond yield spreads, which is defined by 10-year generic government bond yield of each economy over the 10-year US Treasury yield; and (ii) replacing the US Treasury yield in the list of control variables by FX return. The results are largely consistent with the estimation in Section 5, indicating that the results are robust to the measure of sovereign credit risk.[12]

[12] Although both CDS and government yield spreads generate similar results, the latter is less desirable in this study since the US would inevitably be removed from the sample, which has been one of the key stakeholders in the ESG development.

6. CONCLUSION AND POLICY DISCUSSION

Our empirical results show that investors have generally factored in ESG performance and the development of the ESG debt market when pricing sovereign credit risk in recent years. Such "ESG impact" is significant in both AEs and EMEs in general, but the EMEs' sovereign credit risk appeared to be less sensitive to the ESG debt market size, probably due to the still-underdeveloped ESG market in EMEs.

The study also shows some differences in the sensitivity of sovereign credit risk to the individual E-, S- and G- factors, depending on the stage of economic development. We found that (i) the sovereign credit risk of AEs is insensitive to their governance performance, and (ii) the sovereign credit risk of EMEs is insensitive to their environmental performance. The former suggests that the governance performance of an economy would matter less once the economy has developed beyond a certain stage. The latter might be more alarming: when pricing the sovereign credit risk of EMEs, investors tend to disregard environmental risk probably as a trade-off for economic development. This can be a source of concern given that EMEs are also the major stakeholders of environmental risk in the world. For example, among the top 20 economies of carbon dioxide emission in 2019, 11 were EMEs which were responsible for 49% of carbon dioxide emission of the world (See Table A6 for details).

Our findings have important policy implications. To better sovereign credit risk, policymakers need to continue to support ESG-related developments. For EMEs in particular, more education is needed to increase the awareness of the environmental well-being, as otherwise, sacrificing the environment for near-term economic development will result in irreversible damage to the economy in the long-term and could cause negative spillovers to other parts of the world. Stronger international corporation is also needed to improve environmental performance in EMEs, e.g. technology transfer via FDI to mitigate carbon emission (Williams et al., 2015).

APPENDIX

Table A1: Classification of economies

Group	Economies
Advanced economies (AEs)	Australia, Austria, Belgium, Canada, Denmark, Estonia, France, Germany, Greece, Ireland, Italy, Japan, Latvia, Lithuania, Netherlands, New Zealand, Norway, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, United Kingdom, United States
Emerging market economies (EMEs)	Mainland China, Czech Republic, Hong Kong SAR, Hungary, India, Malaysia, Mexico, Pakistan, Peru, Philippines, Poland, Romania, Russia, Singapore, South Africa, South Korea, Thailand, Turkey, Vietnam

Source: BIS.

Table A2. Data description and source

Variable	Description	Source
Sovereign Credit Risk		
CDS Spreads	Spread on CDS spreads (10-year, 5-year and 1-year). In logarithm of basis point.	S&P Capital IQ
Yield Spreads	Generic 10-year government yield spreads over US Treasury yield. In percentage point.	Bloomberg
ESG-related Variables		
E-Index	Environmental Performance Index (EPI) published by Yale University. Larger values indicate better environment performances. In index point.	Yale University and authors' estimation
S-Index	The first principal component of four social indicators from World Development Indicators (WDI). Larger values indicate better social performances. In index point.	World Bank and authors' estimation
G-Index	The first principal component of all six aspects of governance indicators from the Worldwide Governance Indicators (WGI). Larger values indicate better governance performances. In index point.	World Bank and authors' estimation
ESG Index	The first principal component of E-Index, S-Index and G-Index. Larger values indicate better broad-based ESG performances. In index point	Authors' estimation
ESG Debt Issuance	The amount of ESG-related debt issuance (in US dollar) to GDP ratio. In percentage.	Bloomberg
Control Variables		
US Treasury Yield	Generic US Treasury yield (10-year, 5-year and 1-year). In percentage.	Bloomberg
VIX	Chicago Board Options Exchange Volatility Index. In percentage.	Bloomberg
GDP Growth	Annual growth rate of GDP. In percentage.	World Bank
CPI Inflation	Annual growth rate in consumer price index. In percentage.	World Bank
Government Debt	Government debt-to-GDP ratio. In percentage.	World Bank
FX Reserve	Foreign exchange reserve (exclude gold)-to-GDP ratio. In percentage.	World Bank

Table A3. Descriptive Statistics

Variable	N	Mean	SD	Min	P25	Median	P75	Max
10-y CDS Spreads (bps)	621	135.94	148.87	0.67	45.05	90.55	184.60	1788.50
5-y CDS Spreads (bps)	621	112.73	154.65	0.38	27.98	66.06	145.46	1994.06
1-y CDS Spreads (bps)	621	64.24	157.57	0.10	7.97	21.76	56.73	2554.80
10-y Yield Spread (ppt)	521	1.11	2.95	-3.05	-0.71	0.33	1.70	21.47
E-Index	621	58.33	15.61	24.45	44.11	62.55	71.31	82.51
S-Index	606	0.37	1.57	-4.90	-0.34	0.96	1.55	2.29
G-Index	621	-0.13	2.18	-5.36	-1.87	0.23	1.82	3.11
ESG Index	606	0.11	1.54	-3.71	-1.14	0.47	1.43	2.23
ESG Debt Issuance (% GDP)	316	0.27	0.52	0.00	0.03	0.10	0.27	4.55
10-y UST Yield (%)	621	2.96	0.94	1.79	2.14	2.76	3.64	4.79
5-y UST Yield (%)	621	2.27	1.14	0.75	1.50	1.92	2.79	4.74
1-y UST Yield (%)	621	1.31	1.25	0.11	0.16	0.60	2.35	3.30
VIX (%)	621	18.49	6.28	11.09	14.23	16.64	22.55	32.70
Inflation (%)	621	2.99	3.10	-4.48	1.11	2.29	3.87	23.12
GDP Growth (%)	621	2.90	3.51	-14.84	1.38	2.69	4.81	25.16
Government Debt (% GDP)	621	60.55	44.47	0.05	32.46	47.11	78.66	222.87
FX Reserve (% GDP)	621	17.00	20.65	0.00	2.45	11.82	23.01	126.44

Source: Authors' estimation.

Table A4a. Principal Component Analysis of S- Index

Component	Eigenvalue	Difference	Proportion	Cumulative
1	2.87	2.06	0.72	0.72
2	0.80	0.47	0.20	0.92
3	0.33	0.33	0.08	1.00
4	0.00	.	0.00	1.00

Table A4b: Principal Component Analysis of G- Index

Component	Eigenvalue	Difference	Proportion	Cumulative
1	5.28	4.97	0.88	0.88
2	0.31	0.05	0.05	0.93
3	0.26	0.17	0.04	0.97
4	0.09	0.05	0.01	0.99
5	0.04	0.01	0.01	1.00
6	0.03	.	0.00	1.00

Table A4c: Principal Component Analysis of ESG Index

Component	Eigenvalue	Difference	Proportion	Cumulative
1	2.52	2.23	0.84	0.84
2	0.29	0.11	0.10	0.94
3	0.19	.	0.06	1.00

Notes: The eigenvalue for each principal component show the percentage of variation (explanatory power) in the dataset. We adopt Kaiser's criterion or the eigenvalue rule. The components with eigenvalue higher than 1 are selected. The results above indicate that the first component accounts for at least 70% of total variance for each case.

Source: authors' estimation.

Table A5: Regression on Equation (1) by ESG pillar and economy group

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Sample economy	All	All	All	AEs	AEs	AEs	EMEs	EMEs	EMEs
E- Index	-0.067**			-0.096***			-0.026		
(lagged)	[-3.46]			[-3.87]			[-0.87]		
S- Index		-0.745***			-1.151**			-0.617***	
(lagged)		[-5.43]			[-3.10]			[-4.33]	
G- Index			-0.131			0.258			-0.275*
(lagged)			[-1.06]			[1.31]			[-2.45]
No. of observations	258	248	258	147	141	147	111	107	111
No. of economies	44	44	44	25	25	25	19	19	19
R-squared	0.265	0.409	0.197	0.404	0.437	0.322	0.172	0.514	0.213
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Economy FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Robust SE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: The dependent variable is the logarithm of 10-year CDS spreads. Control variables are not reported for simplicity. Sample period is from 2014 to 2020. All regressions are estimated in yearly frequency with economy fixed effect using Huber-White robust standard error. T-values are in parentheses. ***, **, * and ^ denote significance at the 0.1%, 1%, 5% and 10% levels respectively.

Source: Authors' estimation.

Table A6: The 20 largest carbon dioxide emission economies in 2019

Economy	Share of global CO_2 emission (%)
Mainland China	27.9
United States	14.5
India	7.2
Russia	4.6
Japan	3.0
Germany	1.9
Indonesia	1.7
South Korea	1.7
Canada	1.6
South Africa	1.3
Mexico	1.2
Australia	1.1
Turkey	1.1
United Kingdom	1.0
Italy	0.9
France	0.9
Poland	0.9
Thailand	0.8
Spain	0.7
Malaysia	0.7
Sum	74.8
of which: EMEs	49.1 (65.5%)

Note: Red represents EMEs.

Source: Our World in Data.

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