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Is the Cost of Corporate Debt Influenced by ESG Factors? Evidence from the EMEAP Region

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Abstract

Motivated by the rapidly growing corporate bond market in the EMEAP region, and the lack of studies in understanding the financial impact of Environmental, Social and Governance (ESG) practices on firms in emerging markets, this paper attempts to explore the relationships between firms' debt funding costs and their ESG performances by analysing the bond data of listed companies in the region from 2008 to 2019. Our empirical analysis confirms that (1) sound ESG practices by corporates could have a long-term cost reduction effect on their debt funding; (2) the effect on cost reduction is more evident for firms in high greenhouse gas emission sectors and during market turbulence, and; (3) the country-level ESG performance plays a role only since the adoption of the Paris Agreement in 2015. Our study has three implications for firms and governments in the region. First, ESG-related risks have recently emerged in investors' concerns and need to be closely monitored as firms with relatively weak ESG scores are facing higher cost in funding their debts. Second, governments may consider further promoting sound ESG practices as both country-level and firm-specific ESG performances play a role in reducing firms' debt-funding costs. Third, with market participants starting to price-in firms' ESG risks in their investment, the lack of consistent and comparable ESG data could be a source of vulnerability itself, as disorderly adjustments might occur when pricing in ESG-related vulnerabilities. Therefore, government efforts on global initiatives aimed at strengthening international ESG reporting standards and promoting consistent ESG score methodology are vitally important.

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[1] Winnie Li is no longer with the Hong Kong Monetary Authority. This paper was written during her appointment as Graduate Intern in the Market Research Division of the Hong Kong Monetary Authority.

I. Introduction: why is this important to review

With sustainability concerns drawing more attention, investors are increasingly considering environmental, social and governance (ESG) factors as important investment criteria. For example, sustainability considerations have already played a prominent role in the investment guidelines for some institutional investors (Polbennikov et al., 2016).[2] To address the growing concerns of ESG-related issues in their investments, more firms have started improving their ESG disclosures and performance in recent years. This trend is expected to gather momentum as firms face increasing pressure from their investors and customers, while governments may also tighten relevant regulations, especially on climate-related issues.

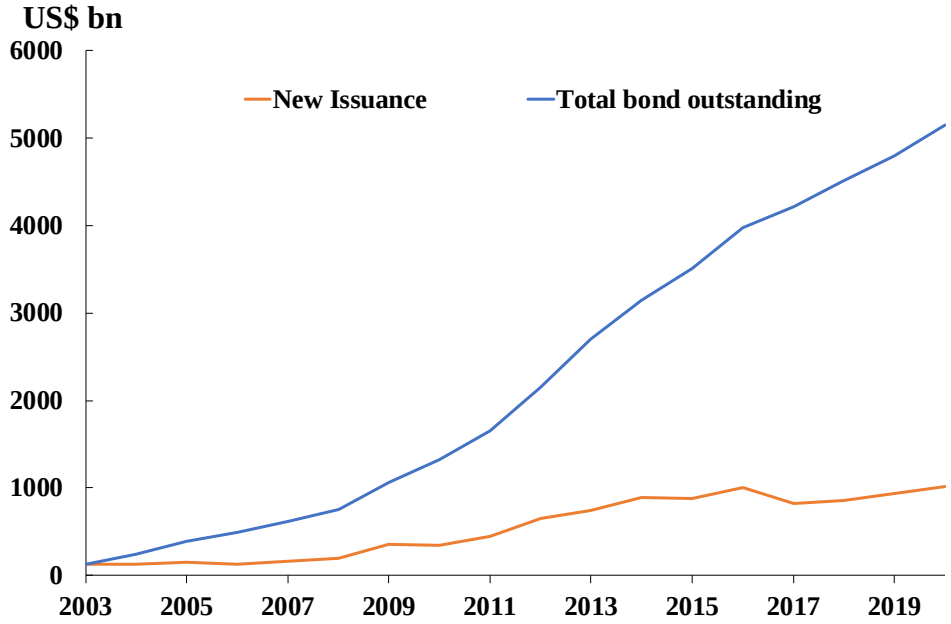
Amid this growing interest, discussions are progressing on the benefits and costs to firms in relation to improving their ESG disclosures and performance. So, from a firm's perspective, are these efforts economically justified? With more ESG related data available in recent years, growing literature has shown that firms with a sound ESG performance, especially those in developed markets, can benefit from higher credit ratings (Stellner et al., 2015), lower downside risks (Hoepner et al., 2019) and higher resilience to withstand the immediate impact during the COVID-19 crisis (Broadstock et al., 2021). Another research stream examined the relationship between ESG performance and the cost of debt, focusing either on a single country (e.g. Ge & Liu, 2015; Elias Erragragui, 2018; Hasan et al., 2017) or a selected group of developed economies (e.g., Stellner et al., 2015; Jung et al., 2018; Eliwa et al., 2019). As studies for firms in Asia and emerging market economies remain scant, this study focuses on firms in the EMEAP region and may go some way to filling the gap.

Our study is also motivated by the rapid growth of bond markets in the EMEAP region, suggesting a greater economic importance and policy relevance for this research. In the past decade, partly due to the global low interest rate environment, firms in the EMEAP region have actively tapped funds from the bond market. Between 2003 and 2020, all currency bond issuances by non-financial EMEAP corporates grew rapidly from US$125 billion to US$1,020 billion, an increment of more than seven times, while the outstanding amount jumped from US$123 billion to US$5,152 billion over the same period (Chart 1).[3] And, with the growing awareness of ESG issues, more firms in the region have improved the coverage and quality of their ESG disclosures. Such unprecedented growth in the region's corporate bond market and ESG data availability provide the platform for researchers to empirically examine the relationship between ESG performance and debt funding costs in the emerging market context.

[2] At the end of 2020, over half the new institutional passive investment mandates in Europe were climate-based or ESG-focused, and more than a quarter in North America and Asia-Pacific. Source: https://continuumeconomics.com/2021/04/28/emerging-markets/what-esg-means-for-em-sovereign-risk.

[3] Bonds issued in 2003 were mainly short maturity notes, which matured within that year. As a result, the outstanding amount was smaller than the issuance amount.

Chart 1. All currency non-financial corporate bonds in EMEAP 2003-2020



Sources: Bloomberg, Dealogic and authors' calculations.

One way to assess the net financial impact of ESG performance on firms is through the lens of the debt funding cost, which is measured by the option-adjusted spreads (OAS) in this study.[4] Anecdotally, there is evidence that firms with a better ESG performance tend to have a lower debt funding cost. In particular, Chart 2a, which plots bonds' OAS against their corresponding combined ESG scores (ESGC-scores, see Appendix B for details), shows a mildly negative correlation between the ESG performances and the cost of borrowing for firms in the EMEAP economies.[5] Such relationship is stronger for firms operating in the high greenhouse gas (GHG) emission sectors, namely the industrial, heat & electricity and transportation sectors (Chart 2b).[6] One plausible explanation is that investors are particularly concerned about the ESG performance of those firms from high GHG emissions sectors, as their business performance is subject more to climate-related risks, particularly the transition risk. [7]

[4] Our dataset covers all currency bonds in the region. Option adjusted spread (OAS) is the measurement of the bond yield spread in excess of the risk-free rate of return of the denominated currency after accounting for the option premium. It has been widely used in literature as a measurement for the cost of debt. In the ESG context, some studies (e.g. Stellner et al., 2015) use Z-spread as a measurement of cost of debt in studying its relationship with corporate social responsibility. However, as bonds issued in EMEAP economies are mostly embedded with options, we adopt the OAS in our study.

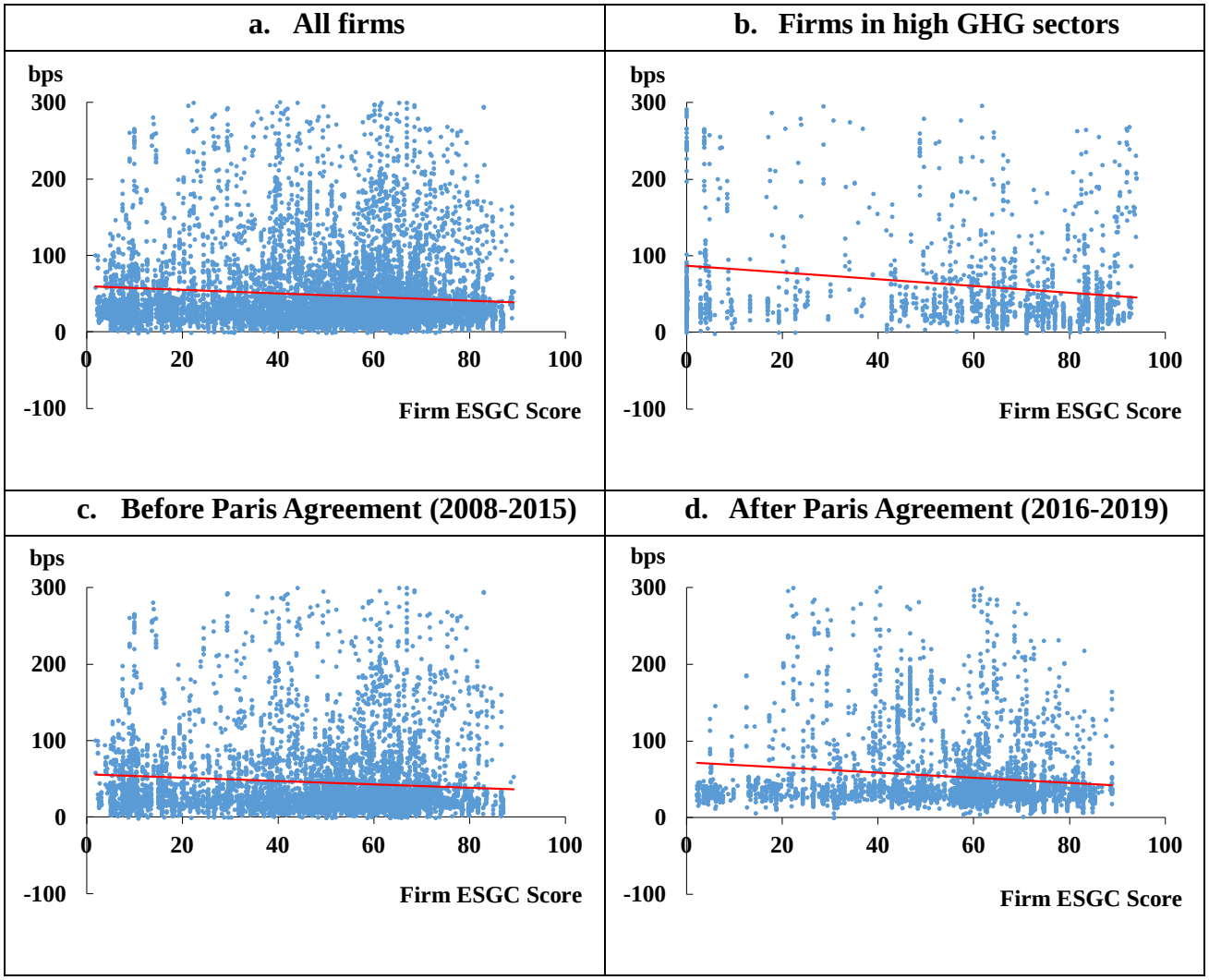
[5] ESG scores range from 0 to 100, with the 0 score indicating relatively poorest ESG performances and the 100 score indicating excellent ESG performance and the highest degree of transparency in ESG data reporting. The score is in the relative sense. Improvement in a firm's score implies a higher ranking relative to its peer in the same industry.

[6] The report published by Climate Watch and the World Resources Institute in 2016 states that almost three quarters of GHG emissions were generated from energy use, with the top three contributors coming from energy produced in the industrial sector (24.2%), the heat & electricity sector (17.5%), and the transportation sector (16.2%). More details can be found at: https://ourworldindata.org/emissions-by-sector.

[7] The transition risk arises as a result of the global governmental and economic shift towards a low-carbon economy, which includes policy and regulatory risks, technological risks, market risks,

By comparing Charts 2c and 2d, we also observe a stronger relationship between firms' ESG performance and the debt funding cost after the Paris Agreement,[8] probably reflecting that the Agreement increased the awareness of firms in the region to climate-related risks, and signalled a strong commitment by policymakers to tackle such risks. Together these factors may push investors to price-in such risks in their debt funding costs.

Chart 2. Scatterplot of OAS and ESGC-scores for corporates in EMEAP Economies



Note: Only firms with ESG scores available for both periods are included.
Sources: Bloomberg, Dealogic and authors' calculations.

reputational risks, and legal risks. In particular, with more governments announcing their "net zero carbon emission" targets, the transition risk faced by firms might be disorderly if authorities start to take material action to reduce greenhouse gases; and the policy or changes may come earlier than previously anticipated.

[8] The Paris Agreement is a legally binding international treaty on climate change. It was adopted by 196 Parties at COP 21 in Paris on 12 December 2015 and came into force on 4 November 2016. More details are available at https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement.

Although the observations from Charts 2a to 2d support the hypothesis that firms with a better ESG performance can benefit from a lower debt financing cost, particularly for those firms in high GHG emission sectors and after the Paris Agreement, further empirical investigations are needed as many factors, such as the financial characteristics of individual firms and country risk factors have not been taken into account.

To this end, based on non-financial corporate bonds in the EMEAP region from 2008 to 2019, this study examines the empirical relationship between ESG performances (both individual pillar scores and the overall ESGC-score) and the cost of debt measured by the OAS. Various empirical models will also be specified to examine whether and to what extent the relationship may be different (i) between normal and stress periods, (ii) between firms from high GHG emission sectors and others, and (iii) between the pre- and post-periods of the Paris Agreement. Finally, we will also examine the relationship between the country sustainability level (as measured by country-level ESG score[9]) and OAS.

The remainder of this paper is structured as follows. Literature review is in the next section. Section 3 describes details of our dataset and specifies the empirical models. Section 4 presents and discusses our results. Section 5 concludes the paper and discusses the policy implications.

II. Literature Review

The findings of recent studies show that a firm with a better ESG performance tends to have a profile of lower downside risks, consistent with the risk mitigation view (Goss and Roberts, 2011). Specifically, the stakeholder theory posits that firms should uphold the interest of their stakeholders by addressing their sustainability concerns. By doing so, firms are rewarded with a lower cost on their debts. Consistent with this theory, some studies found empirical evidence of a negative association between the cost of debt and sustainability performance (Ye and Zhang, 2011; Crifo et al., 2017; Eliwa et al., 2019; Fonseka et al., 2019).

However, whether such debt financing benefit persists during financial stress periods remains unknown, as it has hardly been investigated in the literature. Prior studies which investigated whether such benefit existed during financial stress periods mainly focused on the equity financing cost. For example, when comparing the performance of the CSI 300 constituents during the COVID-19 crisis, Broadstock et al. (2021) find that portfolios with a better ESG performance outperform others. The findings are consistent with those of existing studies that firms with a better ESG performance tend to have a lower downside risk (Hoepner et al., 2019), tail risk (Ilhan et al., 2019) and systematic risk exposure (Albuquerque et al., 2020) during market turbulence.

[9] Country-level ESG scores range from 0 (poorest) to 10 (excellent). The score is in the relative sense. Improvement in the score implies higher ranking relative to other countries.

Some studies found that the 2015 Paris Agreement may have had a strong impact on the ESG-OAS relationship. Palea & Drogo (2020) show that while high emitters had already been charged a higher premium before the Paris Agreement, firms operating in less polluting sectors started being charged a higher spread after the Agreement. In addition, following the adoption of the Paris Agreement, firms with high carbon footprints were found to have higher default risks in terms of market-based default risk measures (e.g. distance to default, Capasso et al., 2020), credit ratings and yield spreads (Seltzer et al, 2021).

Some studies found that the sustainability performance of the country where a firm operates was a key determinant in the firm's cost of debt. Theoretically, firms operating in a country with a greater awareness of sustainability issues may be subject to stricter legal requirements, monitoring and enforcement of sustainability-related issues such that these firms may have a higher incentive to improve their ESG performance. Consistent with this theoretical argument, Eliwa et al. (2019) and Stellner et al. (2015) find a negative relationship between countries' sustainability performance and firms' cost of debt for developed economies, while similar evidence is also observed in selected Asian economies by Gracia et al. (2020).

III. Data and methodology

Our dataset covers all currency bonds issued by listed non-financial EMEAP corporates retrieved from Dealogic. [10] After incorporating firm-specific and macroeconomic information extracted from Bloomberg, and ESG performances obtained from Refinitiv (more details can be found in Appendixes B and C), our panel dataset eventually includes 39,650 observations from 8,420 bonds from 649 firms over the period from 2008 to 2019. [11] [12] Table 1 presents the summary statistics by economy.

Table 1. Number of firms, bonds and observations by economy

[10] We use "deal nationality" in Dealogic to filter bonds issued by the EMEAP economies. Those bonds without ISIN, with less than two E/S/G-scores, with no OAS data available, as well as their early tranches with duplicate ISIN, are eliminated.

[11] One should note that there are limitations of using the Refinitiv ESG data, even though it is a commonly used dataset in some studies. Refinitiv ESG data has been updated once a year in most cases to in line with companies' own ESG disclosures. However, missing ESG scores of some firms is not uncommon in the Refinitiv database. Besides, it is found that some of firm ESG performances have changed little over time, which might be a result of the data quality or the methodology issue in arriving at the score. The possible bias from treatment of missing observations and the data quality issues might have impacts on the robustness of the regression results.

[12] Existing research also mentioned limitations of Refinitiv ESG data. Berg et al. (2021) mention the details of the Refinitiv ESG methodology are not clearly defined and their score changes are sometimes not updated in a timely manner. In addition, not all information about ESG performance is effectively reflected in the scores.

Economy	Firms	Bonds	Observations
Australia	39	182	983
China	92	430	1,403
Hong Kong	14	43	184
Indonesia	13	165	595
Japan	282	4,579	24,415
Malaysia	24	170	682
New Zealand	29	107	484
Philippines	10	19	90
Singapore	20	104	394
South Korea	96	2,096	8,538
Thailand	30	525	1,882
EMEAP	649	8,420	39,650

Sources: Dealogic, Refinitiv and authors' calculations.

We first examine the empirical relationship between the cost of debt and ESG performances at normal periods. Similar to Eliwa et al. (2019), two-way fixed effects unbalanced panel regression models are specified to estimate how the cost of debt (*OAS)* is affected by ESG-related performances (measured by both the overall ESG score of firms and individual pillar scores), after controlling for individual firm characteristics and macroeconomic variables. Our baseline regression model is specified as Equation (1):

$$OAS_{i,c,n,t} = \beta_0 + \beta_1 ESG\ score_{i,c,n,t} + \beta_2 Profitability_{c,n,t} + \beta_3 Leverage_{c,n,t} + \beta_4 Interest\ coverage\ ratio_{c,n,t} + \beta_5 Equity\ volatility_{c,n,t} + \beta_6 Rollover\ risk_{c,n,t} + \beta_7 Firm\ size_{c,n,t} + \beta_8 CDS_{n,t} + \alpha_i + \gamma_t + \varepsilon_{i,c,n,t}$$

Equation 1

where subscript i, c, n, and t denote bond, issuer, country, and time respectively; α_i denotes the bond fixed effects, γ_t denotes the time fixed effects, and $\varepsilon_{i,c,n,t}$ is the error term.

Firm ESGC-score in our baseline case is the overall ESG score of firms. However, we are also interested in exploring the impact of scores of individual pillars of ESG (i.e. examining *firm E-, S* and *G-score separately)* on the cost of debt, as their

effects may be different. To this end, we will modify the model by replacing the overall ESG score by the score of individual pillars of ESG (e.g. by considering *E-score* only).

We include additional factors that may affect a firm's bond spread as control variables in our estimation: (1) *profitability* measured by the return on invested capital (ROIC); (2) *leverage* defined as the ratio of total debt to total capital; (3) *interest coverage ratio* measured as the ratio of EBITDA to interest expense; (4) *equity volatility* measured by the annualised standard deviation of the stock closing price change for the last thirty trading days; (5) *rollover risk* defined as the ratio of the current portion of long-term debt (CPLTD) to the sum of CPLTD and total long term debt outstanding;[13] (6) *firm size* measured by the logarithm of the firm's total asset. In addition, the sovereign CDS spread (*CDS*) is also added to control for differences in sovereign risk. These variables are commonly adopted in the literature. We expect that firms with a lower profitability, higher leverage ratio, lower interest coverage ratio, higher equity price volatility, larger exposure to rollover risk and smaller firm size, are more likely subject to higher default risk and, therefore, result in higher OAS. Detailed definitions, interpretations and the summary statistics for these explanatory variables are shown in Tables A1 and A2 of Appendix A.

Secondly, we study whether and to what extent the relationship may be different between normal and stress periods. In order to examine the relationship between ESG performance and OAS during stress periods, we construct a dummy variable ($CVol90$) which is defined as one if the stock market volatility of the country stays above its 90th percentile threshold during the sample period and zero otherwise. By definition, $CVol90$ captures the stress periods as revealed from the stock market volatility index of the economy. The dummy variable $CVol90$ and its interaction term with firm level $ESG\ score$ are added to our baseline model and as shown below:

$$OAS_{i,c,n,t} = \beta_0 + \rho_0 CVol90 + \beta_1 ESG\ score_{i,c,n,t} + \rho_1 ESG\ score_{i,c,n,t} \times CVol90 + \beta_2 Profitability_{i,c,n,t} + \beta_3 Leverage_{c,n,t} + \beta_4 Interest\ coverage\ ratio_{c,n,t} + \beta_5 Equity\ volatility_{c,n,t} + \beta_6 Rollover\ risk_{c,n,t} + \beta_7 Firm\ size_{c,n,t} + \beta_8 CDS_{n,t} + \alpha_i + \gamma_t + \varepsilon_t \quad \text{Equation 2}$$

Apart from focusing on the non-financial corporate as a whole, we also zoom in on firms from high GHG emissions sectors to conduct sub-sample estimations using the baseline specifications in Equations 1 and 2.

[13] The current portion of long-term debt (CPLTD) is the portion of a long-term liability that is coming due within the next twelve months. It is categorised as current liability in the balance sheet as it has to be paid within one year.

Finally, the impact of the country sustainability level (*Country ESG score*) on a firm's funding cost will also be examined. [14] As previously mentioned, some studies found that the Paris Agreement may have a significant impact on the ESG-OAS relationship. In order to study whether there is any change in the impact of a country's sustainability performance on firms' debt funding cost over time, we divide the whole sample period into pre- and post- Paris Agreement sub-samples. We modify our baseline model by adding the variable of country-level ESG-score as shown in Equation 3:[15]

$$OAS_{i,c,n,t} = \beta_0 + \theta_0\, Country\ ESG\ score_{i,c,n,t} + \beta_1 ESG\ score_{i,c,n,t} + \beta_2 Profitability_{i,c,n,t} + \beta_3 Leverage_{c,n,t} + \beta_4 Interest\ coverage\ ratio_{c,n,t} + \beta_5 Equity\ volatility_{c,n,t} + \beta_6 Rollover\ risk_{c,n,t} + \beta_7 Firm\ size_{c,n,t} + \beta_8 CDS_{n,t} + \alpha_i + \gamma_t + \varepsilon_t \qquad \text{Equation 3}$$

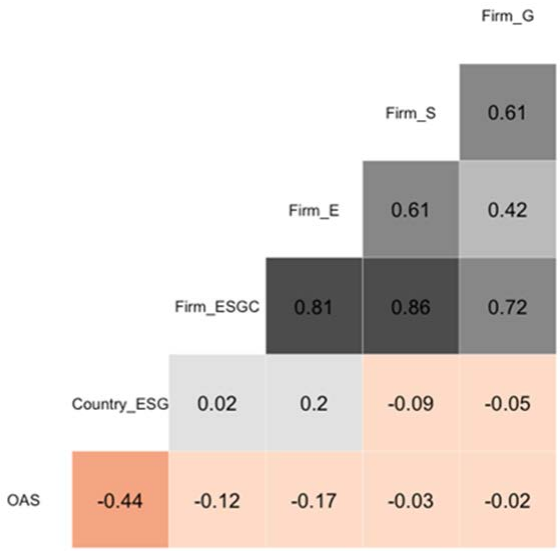
Before estimating the model, we review the correlation between variables. Chart 3 shows the correlation matrix between OAS and ESG scores.[16] As observed, the cost of debt is negatively correlated with both firm-level and country-level ESG performances. Among individual pillar scores, firms with a sound E-score are likely to perform well. In the S- and G- aspects, their correlation coefficients are also negative, but the magnitudes are relatively small. As the ESGC-score is largely composed of individual E-, S- and G-scores, significant and positive correlations are found as expected.

Chart 3. Pearson correlations between OAS and ESG-scores

[14] The methodology for constructing country-level ESG scores can be found in Appendix C. It should be noted that some country-level ESG scores are missing in between, so we have to proxy them by interpolations.

[15] To study the interactive relationship between country level and firm level ESG performances, Stellner et al. (2015) separate the companies into two groups depending on their relative overall scores (above average versus below average) and they create a dummy variable (Equal Company-Country ESG Rating Segment) that takes a value of "1" if a company and the corresponding country are either both above average or both below average with regard to their overall ESG rating. In this paper, we modified the dummy variable which takes the value of "1" if country ESG-score and firm ESG-scores both improve in a respective year and "0" if otherwise.

[16] Pearson correlations among all variables are available upon request.



Source: Authors' calculations.

IV. Empirical results

Table 2 presents the estimation results of Equation 1.[17] Other than the firm ESGC-score (Model 1), we are also interested to see whether individual ESG sub-scores play a role in determining the firms' debt funding cost. The E-, S- and G-scores are tested separately by Models 2 to 4 respectively, as well as jointly by Model 5. The response of OAS to firm ESGC-score is estimated to be -0.09 and statistically significant, suggesting that a one-point increase in firm ESGC-score leads to a 0.09 basis points (bps) deduction in OAS, other things being equal. For individual pillars of ESG, only the social pillar is found to have a significant impact on the cost of debt in both single and joint models; for the E-score and G-score, although the coefficient estimates are found to have an expected sign, they are not statistically significant. This indicates that the negative impact of the aggregate firm level ESGC score on the cost of debt may be driven mainly by the superior performance of the firms' social pillar, which is related to their ability to manage social relationships with employees, suppliers, customers and local communities.

Table 2. Pooled regressions of the ESG-scores on the cost of debt

Dependent variable:	ESGC	E-score	S-score	G-score	E, S, G
OAS	(1)	(2)	(3)	(4)	(5)
Firm ESGC-score	-0.09*				
	(0.05)				
Firm E-score		-0.07			0.01

[17] Some firms' ESG scores were almost unchanged over time and this impacts the robustness of the regression results. The issue exists in all the models we have tried.

		(0.04)			(0.05)
Firm S-score			-0.19*** (0.04)		-0.19*** (0.05)
Firm G-score				-0.05 (0.04)	-0.04 (0.04)
Profitability	0.02 (0.02)	0.02 (0.02)	0.02 (0.02)	0.02 (0.02)	0.02 (0.02)
Leverage	1.12*** (0.25)	1.11*** (0.25)	1.12*** (0.25)	1.11*** (0.25)	1.12*** (0.25)
Interest coverage ratio	-0.02 (0.02)	-0.02 (0.02)	-0.02 (0.02)	-0.02 (0.02)	-0.01 (0.02)
Equity volatility	0.61*** (0.06)	0.60*** (0.06)	0.62*** (0.06)	0.60*** (0.06)	0.62*** (0.06)
Rollover risk	36.31*** (10.80)	36.23*** (10.81)	36.55*** (10.79)	36.36*** (10.79)	36.54*** (10.79)
Firm size	-10.11*** (2.74)	-10.07*** (2.71)	-9.53*** (2.73)	-10.25*** (2.74)	-9.56*** (2.74)
CDS	0.89*** (0.32)	0.89*** (0.32)	0.85*** (0.32)	0.92*** (0.32)	0.85*** (0.32)
Observations	13,898	13,898	13,898	13,898	13,898
R^2	0.06	0.06	0.06	0.06	0.06
F Statistic	78.41*** (df = 8; 9975)	78.17*** (df = 8; 9975)	80.60*** (df = 8; 9975)	78.10*** (df = 8; 9975)	64.63*** (df = 10; 9973)

Note: ***, **, and * denote statistical significances of 1%, 5%, and 10% respectively given that the standard errors shown in parenthesis are single-clustered at the cross-section dimension.
Source: Authors' calculations

For the regression results of Equation (2), a positively significant estimated coefficient for $CVol90$ is found across the models considered (Table 3). This indicates that firms' debt funding cost in general is higher under adverse market conditions, although on average the increase is found to be relatively moderate at around 10 bps. [18] For the impact of ESG performances on OAS during market turbulence, the effects from sound ESG performances (for both the overall ESGC-score and S-score) on the deduction of debt funding costs remain significant. However, the effect during stress periods is found to be not different statistically from that during normal periods, as

[18] As a robustness check, various percentile thresholds (e.g. the 80th, the 85th, the 90th and the 95th percentiles) representing different extremities of financial distress have been tested. The results are qualitatively similar.

suggested by the insignificant estimated coefficient of the interaction term between $CVol90$ and firm ESGC-score in Model 1. In other words, there is no additional cost deduction effect of ESG-scores in times of equity market stress. A similar result is found when considering the S-score in Model 3.

It is worth noting that contrary to the regression results for normal periods as reported in Table 2, other individual pillar besides S-score is also found to have a significant impact on debt funding cost. In particular, the response to the firm G-score becomes negative and significant in periods of market distress, indicating that greater leadership and better internal controls might help corporations reduce their cost of debt during stress periods. The results from the joint model (Model 5) also find a negatively significant estimated coefficient of firm E-score, suggesting the importance of an environmental score in reducing the cost of debt despite that E-score and G-score are statistically insignificant in Model 2 and Model 4 respectively. Overall, the regression results should be interpreted with caution.

Table 3. Panel regressions of the ESG-scores on the cost of debt with stress dummy

Dependent variable: OAS	ESGC (1)	E-score (2)	S-score (3)	G-score (4)	E, S, G (5)
CVol90	7.12** (2.85)	8.63*** (2.60)	4.08* (2.23)	11.71*** (2.33)	10.46*** (2.67)
Firm ESGC-score	-0.09** (0.05)				
Firm ESGC-score * CVol90	-0.01 (0.05)				
Firm E-score		-0.07 (0.04)			0.03 (0.05)
Firm E-score * CVol90		-0.03 (0.04)			-0.10** (0.04)
Firm S-score			-0.21*** (0.04)		-0.24*** (0.05)
Firm S-score * CVol90			0.06 (0.04)		0.26*** (0.05)
Firm G-score				-0.04 (0.04)	-0.01 (0.05)
Firm G-score * CVol90				-0.09** (0.04)	-0.19*** (0.05)
Profitability	0.02 (0.02)	0.02 (0.02)	0.02 (0.02)	0.02 (0.02)	0.02 (0.02)
Leverage	1.13*** (0.25)	1.13*** (0.25)	1.15*** (0.25)	1.12*** (0.25)	1.15*** (0.25)

Interest coverage ratio	-0.02 (0.02)	-0.02 (0.02)	-0.01 (0.02)	-0.02 (0.02)	-0.01 (0.02)
Equity volatility	0.58*** (0.06)	0.58*** (0.06)	0.58*** (0.06)	0.59*** (0.06)	0.58*** (0.06)
Rollover risk	37.48*** (10.80)	37.56*** (10.81)	37.50*** (10.79)	37.71*** (10.79)	37.60*** (10.80)
Firm size	-9.67*** (2.71)	-9.61*** (2.68)	-8.91*** (2.68)	-9.87*** (2.71)	-8.82*** (2.69)
CDS	0.99*** (0.32)	1.00*** (0.32)	0.95*** (0.32)	1.03*** (0.32)	0.95*** (0.32)
Observations	13,898	13,898	13,898	13,898	13,898
R^2	0.06	0.06	0.06	0.06	0.07
F Statistic	65.16*** (df = 10; 9973)	65.09*** (df = 10; 9973)	67.51*** (df = 10; 9973)	65.59*** (df = 10; 9973)	50.30*** (df = 14; 9969)

Note: ***, **, and * denote statistical significances of 1%, 5%, and 10% respectively given that the standard errors shown in parenthesis are single-clustered at the cross-section dimension.
Source: Authors' calculations

To investigate whether the impact of the ESG performance on OAS is more pronounced for those firms in high GHG emission sectors, we repeat the estimations as reported in Table 3 for the subsample of the top three GHG emission sectors.[19] Overall, the results point to a greater impact of ESG performance on OAS for those firms in high GHG emission sectors relative to other firms. This can be revealed by the fact that the estimated coefficients of those variables that proxy for firms' ESG performance (e.g. ESGC-score and E-score) tend to be more negative with higher statistical significance for the subsample (reported in Table 4) compared to the full sample results (Table 3). A similar conclusion can be also drawn for estimates for stress periods when comparing the size and statistical significance of the estimated coefficients of the interaction terms between ESG performance and $CVol90$ reported in Table 4 with those in Table 3. In terms of economic significance, the difference in debt funding costs between a firm with a high ESGC score (at the upper quartile) and that with a low score (at the lower quartile) is found to be 42.7 bps during market stress compared to those with scores at the lower quartile. A similar saving of about 31.4 bps is also found for high E-score firms.

Table 4. Panel regressions for high GHG emission sectors under stress periods

Dependent variable: OAS	ESGC (1)	E-score (2)	S-score (3)	G-score (4)	E, S, G (5)
CVol90	30.65*** (9.03)	28.02*** (9.80)	13.78* (7.33)	16.85** (7.60)	30.60*** (10.21)

[19] As a robustness check, we also adopt the interaction variable approach which uses all the observations in the regression (Table D1 in Appendix D). A high GHG emission sector dummy (which takes the value of "1" if the firm belongs to high GHG emission sector, "0" if otherwise) is created. The cross terms of the high GHG emission sector dummy with ESG scores and CVol90 are all negatively significant across models. The results are generally in line with those in Table 4.

Firm ESGC-score	-0.47*** (0.15)				
Firm ESGC-score * CVol90	-0.66*** (0.16)				
Firm E-score		-0.14 (0.12)			0.05 (0.13)
Firm E-score * CVol90		-0.53*** (0.14)			-0.50*** (0.18)
Firm S-score			-0.45*** (0.17)		-0.52*** (0.18)
Firm S-score * CVol90			-0.44*** (0.13)		0.04 (0.18)
Firm G-score				-0.26** (0.12)	-0.30** (0.12)
Firm G-score * CVol90				-0.48*** (0.15)	-0.13 (0.15)
Profitability	1.86** (0.84)	1.87** (0.85)	1.57* (0.86)	1.99** (0.84)	1.86** (0.88)
Leverage	1.49*** (0.39)	1.47*** (0.39)	1.42*** (0.40)	1.53*** (0.39)	1.61*** (0.39)
Interest coverage ratio	-0.06 (0.11)	-0.05 (0.11)	0.03 (0.11)	-0.07 (0.11)	0.01 (0.12)
Equity volatility	1.47*** (0.32)	1.48*** (0.33)	1.46*** (0.32)	1.34*** (0.32)	1.41*** (0.32)
Rollover risk	90.72** (35.57)	96.21*** (35.97)	88.44** (35.38)	85.15** (34.61)	89.16** (34.97)
Firm size	-59.46*** (19.51)	-57.26*** (20.75)	-63.37*** (19.86)	-65.40*** (19.39)	-62.55*** (19.85)
CDS	-1.36 (0.89)	-1.34 (0.88)	-1.58* (0.92)	-1.18 (0.86)	-1.45 (0.89)
Observations	2,087	2,087	2,087	2,087	2,087
R^2	0.15	0.14	0.14	0.14	0.16
F Statistic	26.48*** (df = 10; 1490)	24.97*** (df = 10; 1490)	24.94*** (df = 10; 1490)	24.37*** (df = 10; 1490)	20.25*** (df = 14; 1486)

Note: ***, **, and * denote statistical significances of 1%, 5%, and 10% respectively given that the standard errors shown in parenthesis are single-clustered at the cross-section dimension.
Source: Authors' calculations

So far, our analysis has assumed a contemporaneous empirical relationship between firms' ESG performance and OAS. Given that ESG-related risks would be structurally different from traditional types of risks, investors may take a longer time horizon to price in ESG-related risks. This may suggest that a firm's ESG performance may have a persistent effect on the OAS. To examine this, we assume the impact of the ESGC-score on OAS can last up to three years (i.e. *t* to *t-2*). We also follow the literature

to separately estimate the effects for pre- and post-periods of the Paris Agreement.[20] In addition, given that the E-pillar may be more sensitive to the Paris Agreement than the other two pillars (i.e. S- and G-pillars), we also modify the specification by replacing the ESGC-score with the E-Score so that we can examine the persistence of the impact of E-score on OAS after the Paris Agreement.

The estimation results are presented in Table 5. Overall, the findings support the hypothesis that a firm's ESGC- or E-score has a persistent effect on the OAS of its debt after the Paris Agreement. Quantitatively, a one-point increase in the firm's ESG-score would reduce the OAS by 0.29 bps contemporaneously, and by another 0.88 bps in the next two years, resulting in a cumulative response of 1.17 bps (i.e. a one-point change in the ESGC-score would reduce the OAS by 1.17 bps cumulatively). This suggests that considering the contemporaneous impact only may underestimate the benefit of improvement in the ESG performance on reducing debt funding costs. A similar conclusion can be drawn for the analysis of the impact of a firm's E-score on OAS.

We assess the economic significance of the estimates by comparing the difference in OAS for two hypothetical firms that differ only in their ESGC-scores, with one having its ESGC-score at the upper quartile (75%) of the overall sample and the other at the lower quartile (25%). Based on the upper and lower quartiles of the ESGC-scores (which are 69.3 and 40.6 at time t respectively) and the cumulative response of OAS to ESGC-score at 1.17 bps, the difference in OAS for these two hypothetical firms would be 33.4 bps cumulatively, or an average of 11.1 bps per year.

Table 5. Estimation results of the impact of firm ESGC- or E-score on the cost of debt before and after the adoption of the Paris Agreement

Dependent variable: OAS	Firm ESGC-score Before	Firm ESGC-score After	Firm E-score Before	Firm E-score After
Firm ESGC-score at t	0.10* (0.06)	-0.29*** (0.08)		
Firm ESGC-score at t-1	0.004 (0.08)	-0.35*** (0.08)		
Firm ESGC-score at t-2	0.08 (0.07)	-0.53*** (0.07)		
Firm E-score at t			-0.04 (0.06)	0.24*** (0.06)

[20] Other than the sub-sample approach, we also adopt the interaction variable approach as a robustness check (Table D2 in Appendix D). A PA dummy variable (which takes the value of "1" for post-PA period, "0" if otherwise) is added. However, the results are less clear-cut than those from Table 5. The dummy variable PA is only negatively significant for time lag 2. However, it is worth noting that the dummy variable is automatically dropped from the model due to its high correlation with other independent variables. In other words, the results could be biased due to the collinearity issue.

Firm E-score at t-1			-0.11**	-0.15**
			(0.05)	(0.07)
Firm E-score at t-2			0.12**	-0.39***
			(0.05)	(0.08)
Profitability	0.09**	0.03**	0.09**	0.01
	(0.04)	(0.01)	(0.04)	(0.01)
Leverage	1.76***	0.84***	1.77***	0.80***
	(0.41)	(0.27)	(0.41)	(0.29)
Interest coverage ratio	-0.03	0.03	-0.03	0.01
	(0.03)	(0.03)	(0.03)	(0.03)
Equity volatility	0.71***	0.05	0.71***	0.1
	(0.07)	(0.16)	(0.07)	(0.16)
Rollover risk	55.55***	-10.6	55.04***	-17.08
	(14.31)	(10.98)	(14.29)	(11.15)
Firm size	-11.83***	-2.47	-11.56***	0.72
	(3.70)	(5.61)	(3.64)	(6.25)
CDS	1.27	0.96***	1.38	0.96***
	(1.31)	(0.26)	(1.37)	(0.26)
Observations	8,830	4,678	8,830	4,678
R^2	0.1	0.07	0.1	0.05
F Statistic	70.42*** (df = 10; 6102)	20.00*** (df = 10; 2690)	71.06*** (df = 10; 6102)	14.41*** (df = 10; 2690)

Note: ***, **, and * denote statistical significances of 1%, 5%, and 10% respectively given that the standard errors shown in parenthesis are single-clustered at the cross-section dimension.
Source: Authors' calculations

Finally, to study whether a country's sustainability performance may reduce firms' debt funding costs, we estimate Equation 3 and present the results in Table 6. It is found that after the Paris Agreement, a country with a better sustainability performance can help reduce the OAS of debt issued by firms that operate in that country. Empirically, a one-point increase in the country ESG-score would reduce the OAS of debt for firms operating in that country by 2.6 bps. This finding is consistent with the conjecture that improvements in the ESG performance at the country level may signal a strong commitment of the government to address sustainability issues, which may drive investors to price-in such developments in corporate debt financing.

Table 6. Estimation results of the impact of firm ESGC- and country ESG-scores on the cost of debt

Dependent variable: OAS	Before	After
Firm ESGC-score at t	0.061	-0.317***
	(0.06)	(0.08)
Country ESG at t	19.957***	-2.593***
	(2.07)	(0.79)

Profitability	0.095** (0.04)	0.023* (0.01)
Leverage	1.544*** (0.40)	0.894*** (0.26)
Interest coverage ratio	-0.019 (0.03)	0.015 (0.03)
Equity volatility	0.638*** (0.07)	0.093 (0.17)
Rollover risk	52.755*** (14.39)	-22.327** (10.86)
Firm size	-15.512*** (4.06)	-8.699 (5.29)
CDS	-2.787** (1.36)	0.721*** (0.26)
Observations	9,178	4,720
R^2	0.111	0.047
F Statistic	87.939*** (df = 9; 6370)	14.742*** (df = 9; 2713)

Note: ***, **, and * denote statistical significances of 1%, 5%, and 10% respectively given that the standard errors shown in parenthesis are single-clustered at the cross-section dimension.
Source: Authors' calculations

V. Conclusion

With the increasing awareness of investors about non-financial risks and the recent attention to the ESG performance of firms, this study aims to empirically examine whether sound ESG practices will reward firms in the EMEAP region with lower debt funding costs.

Our empirical analysis confirms the importance of firm-level ESG performance in reducing the cost of debt after controlling the financial characteristics of individual firms and country risk factors. Such benefit is found to be more evident for firms operating in the high GHG emission sectors and during market turbulence. In addition, firms with good ESGC- or E-scores enjoy a long-term beneficial effect on their debt funding costs after the Paris Agreement, suggesting that sound ESG performances may increase the intrinsic value of the firm in the medium term. This study also sheds light on the role of a country's ESG performance in reducing the cost of debt for firms. This is shown by the different impact of a country's ESG performance on the cost of borrowing by firms before and after the adoption of the Paris Agreement in 2015. Not only does it highlight the importance of the Agreement and the structural changes taking place, but also focuses investors' attention on the region and countries' ESG performances.

Indeed, our empirical findings have three implications. First, ESG-related risks have recently emerged in investors' concerns over the vulnerability of corporates in the EMEAP region, and need to be closely monitored as corporates with relatively weak

ESG performances, other things being equal, are facing higher costs in funding their debt. In addition, firms that only consider the contemporaneous impact may underestimate the benefits to be gained from improvements in ESG performance in reducing those costs, especially for firms in the high GHG emission sectors. Secondly, governments may consider further promoting sound ESG practices because of the positive role that both the country-level and firm-specific ESG performances play in reducing debt-funding costs.

Thirdly, it should be noted that besides the Refinitiv, there exist numerous alternative ESG data providers that have their own sourcing process and research methodologies available for market analysis. The limitations of using Refinitv data alone in this study (discussed in footnotes 11, 12, 14 and 17 in the previous section) confirm with the findings of prior studies that any analysis based on data of one single ESG source could have possible bias and needs to be cautioned.[21] The lack of consistent and comparable ESG data means that ESG-related vulnerabilities might not be adequately incorporated into asset prices when investors have started to price in ESG risks in funding corporate debt.[22] In this regard, the data gap problem could be a source of vulnerability by itself as disorderly adjustments might occur when pricing in ESG-related vulnerabilities. Therefore, government efforts on global initiatives in strengthening international ESG reporting standards and promoting consistent ESG score methodology are important. Such efforts are crucial to enhance ESG disclosure practices, boost the credibility and popularity of ESG data, and help investors adequately incorporate the related risks into asset prices in the medium term.

While this study contributes to the literature by understanding whether firms will benefit financially from their ESG performances, it should be noted that the results should be interpreted with caution. In fact, there are several possible ways that future research can further improve people's understanding of this topic. Firstly, despite the fact that ESG score database established by Refinitiv is widely accepted in the literature and useful information about firms' cost of debts are found in our analysis, there are sample bias and data quality issues as mentioned in previous sections. Using alternative ESG databases would be helpful in examining the robustness of the conclusions. With the improved data quality over time, more robust findings could be drawn in the future. Secondly, to control firms' financial characteristics, this study focuses only on non-financial corporate bonds denominated in all currencies issued by listed firms in EMEAP economies. It is important to have a more comprehensive picture in this area if future research can expand the sample to include non-listed firms when more data is available.

[21] It is not surprising that different ESG data don't always correlate highly with one another and in some cases even contradict each other. Boffo et al. (2020) highlight the issues of methodological inconsistencies, the quality, comparability and availability of ESG data, as well as the lack of standardized ESG disclosures. Bender & Maffina (2021) also find that the rating for a single company can vary widely across different providers.

[22] As pointed out by the Financial Stability Board (2021), differences in the construction of ESG ratings across jurisdictions and providers limit their usage in assessing transition risks.

References

Albuquerque, R., Koskinen, Y., Yang, S., Zhang, C. (2020). Resiliency of environmental and social stocks: An analysis of the exogenous COVID-19 market crash, *The Review of Corporate Finance Studies*, 9(3), pp. 593-621.

Bender, J, & Maffina, S (2021). The ESG data challenge: The importance of data quality in ESG investing, *State Street Global Advisors*, January 2021.

Berg, F., Fabisik, K. & Sautner, Z. (2021). Is History Repeating Itself? The (Un)predictable Past of ESG Ratings, *ECGI Working Paper* Series in Finance N° 708/2020.

Boffo, R., Marshall, C., & Patalano, R. (2020). ESG investing: Environmental pillar scoring and reporting, OECD Paris.

Broadstock, D., Chan, K., Cheng, L. T., & Wang, X. W. (2021). The role of ESG performance during times of financial crisis: Evidence from COVID-19 in China, *Finance Research Letters*, 38(C). [101716]

Capasso, G., Gianfrate, G., & Spinelli, M. (2020). Climate change and credit risk, EDHEC-Risk Institute.

Climate Watch and the World Resources Institute. (2016). World Greenhouse Gas Emissions in 2016.

Crifo, P., Diaye, M., & Oueghlissi, R. (2017). The effect of countries' ESG ratings on their sovereign borrowing costs, *The Quarterly Review of Economics and Finance*, 66, pp. 13-20.

DiMaggio, P. J., & Powell, W. W. (1983). The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields, *American Sociological Review*, 48(2), pp. 147-160.

Eliwa, Y., Aboud, A., & Saleh, A. (2019). ESG practices and the cost of debt: Evidence from EU countries, *Critical Perspectives on Accounting*. [102097]

Erragragui, E. (2018). Do creditors price firms' environmental, social and governance risks? *Research in International Business and Finance*, 45, pp. 197-207.

Financial Stability Board. (2021). The availability of data with which to monitor and assess climate-related risks to financial stability.

Fonseka, M., Tian, G., & Al Farooque, O. (2019). Impact of environmental information disclosure and real estate segments on cost of debt: Evidence from the Chinese real estate industry, *Economics of Transition and Institutional Change*, 28(1), pp. 195-221.

Ge, W., & Liu, M. (2015). Corporate social responsibility and the cost of corporate bonds, *Journal of Accounting and Public Policy*, 34(6), pp. 597-624.

Goss, A., & Roberts, G. S. (2011). The impact of corporate social responsibility on the cost of bank loans, *Journal of Banking & Finance*, 35(7), pp. 1794-1810.

Gracia, O., & Siregar, S. V. (2020). Sustainability practices and the cost of debt: Evidence from ASEAN countries, *Journal of Cleaner Production*, 300. [126942].

Hasan, I., Hoi, C. K., Wu, Q., & Zhang, H. (2017). Does social capital matter in corporate decisions? Evidence from corporate tax avoidance, *Journal of Accounting Research*, 55(3), pp. 629-668.

Hoepner, A. G., Oikonomou, I., Sautner, Z., Starks, L. T., & Zhou, X. Y. (2019). ESG shareholder engagement and downside risk, European Corporate Governance Institute.

Ilhan, E., Krueger, P., Sautner, Z., & Starks, L. T. (2019). Institutional investors' views and preferences on climate risk disclosure, *Swiss Finance Institute Research Paper No. 19-66.*

Jung, J., Herbohn, K., & Clarkson, P. (2018). Carbon risk, carbon risk awareness and the cost of debt financing, *Journal of Business Ethics*, 150(4), pp. 1151-1171.

OECD (2020), OECD Business and Finance Outlook 2020: Sustainable and Resilient Finance, September.

Palea, V., & Drogo, F. (2020). Carbon emissions and the cost of debt in the Eurozone: The role of public policies, climate-related disclosure and corporate governance, *Business Strategy and the Environment*, 29(8), pp. 2953-2972.

Polbennikov, S., Desclée, A., Dynkin, L., & Maitra, A. (2016). ESG ratings and performance of corporate bonds, *The Journal of Fixed Income*, 26(1), pp. 21-41.

Seltzer, L., Starks, L. T., & Zhu, Q. (2021). Climate regulatory risks and corporate bonds. *Nanyang Business School Research Paper No. 20-05.*

Stellner, C., Klein, C., & Zwergel, B. (2015). Corporate social responsibility and Eurozone corporate bonds: The moderating role of country sustainability, *Journal of Banking & Finance*, 59, pp. 538-549.

Ye, K., & Zhang, R. (2011). Do lenders value corporate social responsibility? Evidence from China, *Journal of Business Ethics*, 104(2), pp. 197-206.

Appendix A

Table A1. Explanatory Variables used in the estimation

Variables	Interpretations	Expected sign
ESG Variables		
Country level ESG-score		Indeterminate
Firm level ESGC-score	**Positive sign:** Investment in ESG related activities may be regarded as a waste of resource ("Overinvestment view") which may result in higher OAS. **Negative sign:** In contrary, investment in ESG related activities may also be regarded as improving the risk profile of a company ("risk mitigation view") and thus result in lower OAS. Our research investigates which of the views holds.	Indeterminate
Firm level E-score		Indeterminate
Firm level S-score		Indeterminate
Firm level G-score		
Firm level Variables		
Profitability Return on Invested Capital (ROIC)	ROIC = $\frac{Trailing\ 12\ Month\ Net\ Operating\ Profit\ after\ Tax}{Average\ invested\ capital} \times 100$ Higher profitability reduces the default risk and therefore results in lower OAS.	Negative
Leverage $\frac{Total\ debt}{Total\ capital} \times 100$	A higher value suggests that the firm relies more on debt-financing, hence higher OAS.	Positive
Interest coverage ratio $\frac{EBITDA}{Interest\ expense}$	More leveraged companies with lower interest coverage ratio should be subject more to default risk and have higher OAS.	Negative
Volatility The annualised standard deviation of the stock closing price change for the 30 most recent trading days	Higher equity volatility should be related to lower ratings and higher OAS.	Positive
Rollover risk The amount of CPLTD, divided by the sum of CPLTD and total long term debt outstanding	This variable measures the need of a company to refinance its maturing long-term debts. A higher value indicates that the portion of maturing long term debt (to	Positive

	be due within one year) is higher, i.e. a higher rollover risk.	
Firm size $\log(Total\ asset)$	A higher value implies that the firm has a larger total asset, thus more resilient during market illiquidity.	Negative
Other variables		
Sovereign CDS spread	A higher value implies there is a higher default risk in the overall market.	Positive
Dummy for stress periods (CVol90)	Dummy variable taking value of ‘‘1’’ if the stock market volatility of the country is above its 90^{th} percentile over the sample period and zero otherwise.	Indeterminate

Table A2. Descriptive statistics of OAS and explanatory variables

Variables	Original frequency	Unit	Min	Median	Mean	Max	SD	N
OAS	Daily	b.p.	-1.58	32.47	61.12	948.42	92.25	34,050
Country ESG-score	Yearly	Index	0.00	8.50	8.29	9.94	1.01	39,650
Firm ESGC-score	Yearly	Index	1.76	51.86	48.85	90.19	19.97	32,922
Firm E-score	Yearly	Index	0.00	58.84	53.96	97.28	26.72	32,922
Firm S-score	Yearly	Index	0.26	45.26	24.53	97.14	24.53	32,922
Firm G-score	Yearly	Index	0.43	53.39	51.70	99.15	23.59	32,922
Profitability	Quarterly	%	-1088.03	3.25	3.61	75.23	8.76	29,731
Leverage	Quarterly	%	3.02	54.96	53.95	89.66	17.87	30,930
Interest coverage ratio	Quarterly	Ratio	-8.50	9.97	18.30	349.55	28.25	28,452
Volatility	Quarterly	%	0.18	26.44	29.21	112.73	13.47	30,790
Rollover risk	Quarterly	Ratio	0.00	0.11	0.14	1.00	0.10	19,868
Firm size	Quarterly	$US mn	337.68	24952.70	40663.86	495000.00	47785.82	30,974
Sovereign CDS spread	Quarterly	b.p.	0.02	0.45	1.22	130.00	6.12	39,621
Country Volatility Index	Daily	Index	5.07	14.15	16.73	59.74	8.17	39,650

Notes:
1. The statistics are based on panel year-end data between 2008 and 2019.
2. For some variables, including OAS, leverage, and interest coverage ratio, the bottom 0.5% and the top 0.5% observations are removed to avoid outlier issue.
3. Linear interpolation of individual bond is employed for the following variables after the above cleaning process: OAS, country ESG-score, ROIC, leverage, interest coverage ratio, and equity volatility.
Sources: Dealogic, Refinitiv and authors' calculations.

Appendix B. Refinitiv Firm Level ESG Scores in EMEAP Region

This appendix introduces the methodology regarding firm level ESG scores and highlights the development and key observations of the ESG performance of firms in the EMEAP economies based on data provided by Refinitiv. [23] [24]

In this study, we obtain firm-level ESG-scores directly from Refinitiv.[25] The Refinitiv rating universe provides a comprehensive scoring of a firm's ESG performance using over 450 metrics based on verified publicly reported information. The dataset covers 80% of global market cap and can be dated back to 2002. In Refinitiv, the 450 metrics are grouped into 10 categories and then assigned into three pillars, namely the environmental pillar (E-score), the social pillar (S-score) and the governance pillar (G-score).

The environmental pillar consists of three categories -- emission reduction, innovation and resource use. The social pillar comprises four categories -- workforce, human rights, community and product responsibility. The remaining three categories, management, stakeholders and corporate social strategy are assigned to the governance pillar. Each pillar score is the relative sum of the category weighted scores where the weights vary across industry for the Environmental and Social categories; while the weights for the Governance pillar are the same across industry.

In addition, Refinitiv also provides the combined score (ESGC-score), which is the sum of the three pillar scores with adjustment to ESG related controversies captured from global media (e.g. lawsuits over pollution). These controversies are captured continuously. All progress will be recorded and the impact of the event may still be seen over the next few years if there are new developments related to the event. ESG scores range from 0 to 100, with the first quartile indicating relatively poor ESG performances and an insufficient degree of transparency in reporting material and the fourth quartile indicating excellent ESG performance and a high degree of transparency in ESG data reporting. It is essential to understand the score is in a relative sense. A higher score implies a higher ranking relative to its peer in the same industry.

With growing interest in sustainable development, firms in the EMEAP economies have started taking action to improve their ESG disclosures and performance. Chart A1 shows the number of firms disclosing their ESG performance. As a result, the number of assigned ESG-scores from Refinitiv has increased significantly from 33 in

[23] Refinitiv mentions that their ESG data should be treated as fundamental data. There needs to be a recognition of the still-maturing approach to company disclosures and a need for industry-wide standards. Source: https://www.refinitiv.com/perspectives/future-of-investing-trading/understanding-how-esg-scores-are-measured-their-usefulness-and-how-they-will-evolve/.

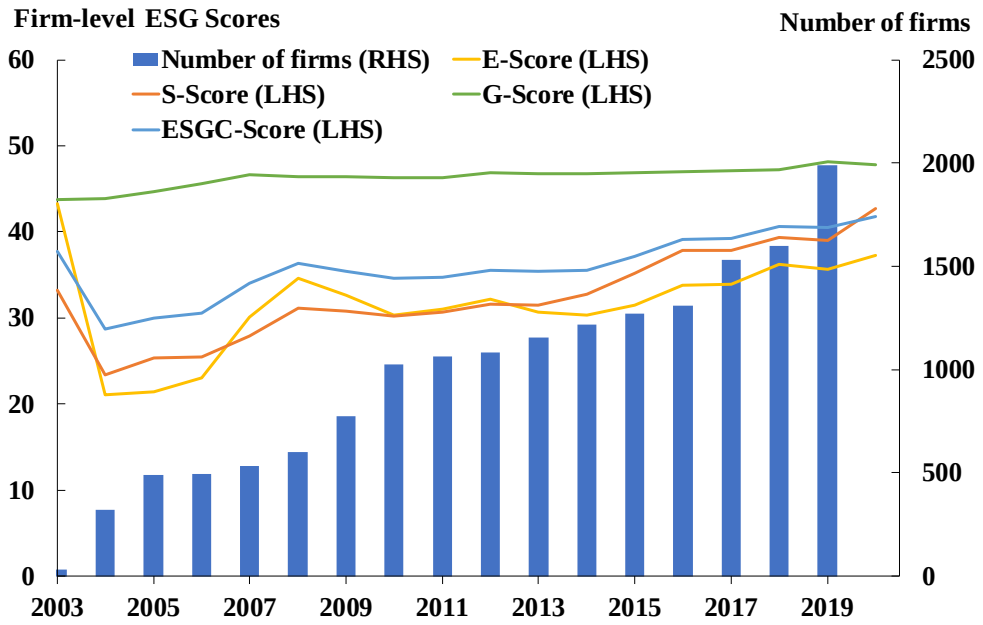
[24] With the rising interest in ESG-related studies, the number of data providers has increased substantially in recent years. Compared to Refinitiv, however, other accessible data providers have relatively shorter historical data available or narrower coverage for firms in the EMEAP economies and hence are not considered here.

[25] Source: https://www.refinitiv.com/en/sustainable-finance/esg-scores.

2003 to 1,989 in 2019, reflecting a stronger interest from firms in the EMEAP economies to report their ESG performances compared with the rest of the world.[26]

One should note that there are limitations of the Refinitiv ESG data. In most cases, reported Refinitiv ESG data are updated once a year, which is in line with companies' own ESG disclosures. The ESG scores of some firms were missing in the database and some firm ESG performances show little change over time. For the individual pillar, the average firm-level E-score and S-score improved from slightly above 20 in 2004 to 35-40 in 2019, moving away from an unsatisfactory range, while the G-score remained steady over time at a relatively high mid-40 level. As a result, the average firm-level ESGC-score improved mildly from 28.7 in 2004 to 41.8 in 2020. More descriptive statistics of firm-level ESG scores can be found in Table B1.

Chart B1. Firm-level ESG scores over time



Note: Simple average of firm ESG related scores for non-financial firms in EMEAP economies from January 2003 to December 2020. Some of the firms might not issue bonds. As the number of firms with ESG Scores available differs each year, the figures should be interpreted with caution when compared across years.
Sources: Refinitiv and authors' calculations.

Table B1. Descriptive statistics of firm-level ESG-scores

ESG-scores	Min	Median	Mean	Max	SD	N
ESGC-score	0.4	34.9	37.0	91.7	19.5	17,210
Environmental Pillar score	0.0	27.0	32.3	99.1	28.2	17,193

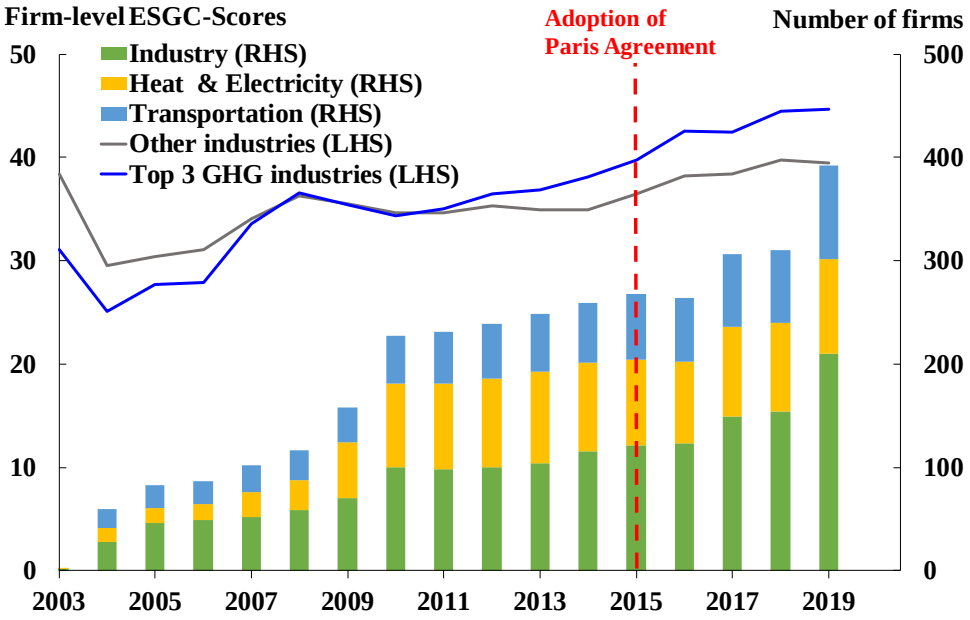
[26] As of January 2021, only 669 firms had ESG-scores for 2020 as there is a time lag for firms to report their ESG related performances.

Social Pillar Score	0.1	30.6	34.2	97.4	22.5	17,193
Governance Pillar Score	0.1	46.8	46.8	99.1	22.6	17,210

Sources: Refinitiv and authors' calculations

Looking specifically at how firms in the high GHG sectors behave in the EMEAP region, we first classify firms operating in the top three emission sectors by using the Thomson Reuters Business Classification standard from Refinitiv.[27] As shown in Chart B2, more firms in the high GHG industries are found to disclose their ESG practices over time, with the number jumping from 3 in 2003 to 392 in 2019.[28]

Chart B2. Average ESGC scores for firms in the top three GHG emission sectors



Sources: Refinitiv and authors' calculations

How do firms in EMEAP economies adjust their behaviour, especially with their environmental related practices after the adoption of legally binding international treaties, such as the Kyoto Protocol from 2005 and the Paris Agreement adopted in 2015? [29] There is no doubt that the introduction of international treaties has raised public awareness regarding sustainability issues, including those in EMEAP economies. This in turn imposes risks to firms, especially those high GHG emitters that are expected to face a spike in production costs or even stricter penalties and therefore under pressure to shift to greener production. In our sample, the average firm-level E-

[27] Source: https://www.refinitiv.com/content/dam/marketing/en_us/documents/methodology/trbc-business-classifcation-methodology.pdf

[28] As of January 2021, only 96 firms in the high GHG sector had ESG-scores for 2020 as there is a time lag for firms to report their ESG disclosures.

[29] Kyoto Protocol is the world's first legally binding international treaty on greenhouse gas emissions reduction. It was signed by 84 parties in Kyoto on 11 December 1997 and entered into force on 16 February 2005. More details are available at https://unfccc.int/kyoto_protocol

score in the region increases gradually from 21.1 in 2004 to 37.3 in 2020. Indeed, a pronounced improvement globally has been observed since the treaties were implemented in 2005 and 2015. In addition, the ESG performances of the high GHG sectors have also recorded greater improvements relative to other industries in the first few years following the implementation of the Kyoto and Paris agreements.

Appendix C. Methodology for Constructing the Country-level ESG Score

At the time of this research, the country-level ESG-scores were not available for EMEAP economies from any available data sources. To better fit our research interest, we had to construct country-level ESG-scores using Refinitiv Country Sustainable Development Goals (SDGs) Score dataset and referencing the sovereign ESG classification framework developed by the World Bank. [30] [31]

The SDGs Score dataset is designed to measure how extensively an economy meets the 17 Sustainable Development Goals proposed by the United Nations using 134 unduplicated sub-indicators in its measurement. We review each indicator carefully and re-classify them into Environmental, Social and Governance pillars with reference to the sovereign ESG classification framework developed by the World Bank. Among these indicators, 27 are classified under the Environmental pillar, 60 under the Social pillar and 43 under the Governance pillar. Another six indicators are classified in both the E- and G- pillar; while the remaining 10 are considered to be irrelevant and thus removed from our list. The reclassification list of sub-indicators is available upon request.

After the reclassification, we compute the individual pillar score (E-score, S-score, G-score) by combining their corresponding indicators. The median of all the indicators in the E, S, G subgroup is taken as the individual pillar score with a precondition that at least one-third of the sub-indicators are available, following the same method employed by Refinitiv in its compilation of SDGs scores. Some of the scores were missing in between, so we have to proxy them by interpolations.

With the individual pillar scores ready, we then compile the overall country-level ESG scores. We take the median of the three individual pillar scores (E-, S- and G-score) as the overall country-level ESG score, provided that at least two-thirds of the pillar scores are available. The summary statistics can be found in Table C1. In general, EMEAP economies have gradually improved their ESG performances over the past decade.

Table C1. Summary statistics of country-level ESG scores

Economies	Mean	SD
Australia	8.3	0.9
China	5.8	0.5
Hong Kong	8.0	1.6

[30] Source: https://datatopics.worldbank.org/esg/framework.html.
[31] Source:https://www.refinitiv.com/en/media-center/press-releases/2020/october/refinitiv-debuts-country-sustainable-development-scores-to-measure-how-extensively-a-country-meets-un-sdgs.

Indonesia	4.8	0.4
Japan	8.7	0.3
Malaysia	6.9	0.5
New Zealand	8.2	0.4
Philippines	5.7	0.4
Singapore	8.1	1.1
South Korea	8.2	0.4
Thailand	5.3	0.5

Sources: Refinitiv and authors' calculations

Appendix D. The Interaction Variable Approach

Table D1. Panel regressions with the high GHG emission sector dummy

Dependent variable: OAS	ESGC (1)	E-score (2)	S-score (3)	G-score (4)	E, S, G (5)
CVol90	-0.09 (2.57)	3.54 (2.32)	-2.47 (2.31)	7.32*** (2.16)	4.00* (2.20)
CVol90 * high GHG	43.19*** (10.81)	37.83*** (10.78)	31.03*** (9.22)	23.67*** (8.71)	39.34*** (10.88)
Firm ESGC-score	-0.01 (0.05)				
Firm ESGC-score * CVol90	0.14*** (0.05)				
Firm ESGC-score * high GHG	-0.70*** (0.18)				
Firm ESGC-score * CVol90 * high GHG	-0.69*** (0.17)				
Firm E-score		0.001 (0.05)			0.06 (0.05)
Firm E-score * CVol90		0.06** (0.03)			-0.03 (0.04)
Firm E-score * high GHG		-0.36*** (0.12)			-0.22 (0.14)
Firm E-score * CVol90 * high GHG		-0.53*** (0.14)			-0.40** (0.19)
Firm S-score			-0.17*** (0.05)		-0.22*** (0.05)
Firm S-score * CVol90			0.18*** (0.04)		0.32*** (0.06)
Firm S-score * high GHG			-0.33** (0.15)		-0.23* (0.14)
Firm S-score * CVol90 * high GHG			-0.50*** (0.14)		-0.26 (0.20)
Firm G-score				0.04 (0.05)	0.06 (0.05)
Firm G-score * CVol90				-0.004 (0.04)	-0.19*** (0.06)

Firm S-score * high GHG				-0.42*** (0.12)	-0.45*** (0.13)
Firm S-score * CVol90 * high GHG				-0.45*** (0.16)	0.05 (0.17)
Profitability	0.02 (0.02)	0.02 (0.02)	0.02 (0.02)	0.02 (0.02)	0.02 (0.02)
Leverage	1.16*** (0.25)	1.16*** (0.25)	1.18*** (0.25)	1.16*** (0.25)	1.21*** (0.25)
Interest coverage ratio	-0.02 (0.02)	-0.02 (0.02)	-0.01 (0.02)	-0.02 (0.02)	-0.01 (0.02)
Equity volatility	0.54*** (0.06)	0.55*** (0.06)	0.57*** (0.06)	0.54*** (0.06)	0.53*** (0.06)
Rollover risk	38.76*** (10.69)	38.88*** (10.73)	38.38*** (10.69)	37.94*** (10.69)	38.06*** (10.67)
Firm size	-9.58*** (2.65)	-9.60*** (2.66)	-8.99*** (2.66)	-10.12*** (2.68)	-8.99*** (2.65)
CDS	1.00*** (0.32)	1.03*** (0.32)	0.92*** (0.32)	1.06*** (0.32)	0.99*** (0.32)
Observations	13,898	13,898	13,898	13,898	13,898
R^2	0.07	0.07	0.07	0.07	0.08
F Statistic	58.46*** (df = 13; 9970)	55.94*** (df = 13; 9970)	56.21*** (df = 13; 9970)	55.92*** (df = 13; 9970)	39.59*** (df = 21; 9962)

Note: ***, **, and * denote statistical significances of 1%, 5%, and 10% respectively given that the standard errors shown in parenthesis are single-clustered at the cross-section dimension.
Source: Authors' calculations

Table D2. Panel regressions with the Paris Agreement dummy

Dependent variable: OAS	Firm ESGC-score	Firm E-score
Firm ESGC-score at t	-0.03 (0.06)	
Firm ESGC-score at t-1	-0.09 (0.07)	
Firm ESGC-score at t-2	-0.09 (0.06)	
Firm ESGC-score at t * PA	0.001 (0.09)	
Firm ESGC-score at t-1 * PA	0.05 (0.10)	
Firm ESGC-score at t-2 * PA	-0.14* (0.08)	
Firm E-score at t		-0.07

		(0.05)
Firm E-score at t-1		-0.14*** (0.05)
Firm E-score at t-2		-0.01 (0.05)
Firm E-score at t * PA		0.41*** (0.08)
Firm E-score at t-1 * PA		-0.0002 (0.07)
Firm E-score at t-2 * PA		-0.30*** (0.07)
Profitability	0.02 (0.02)	0.01 (0.02)
Leverage	1.18*** (0.26)	1.17*** (0.26)
Interest coverage ratio	-0.02 (0.02)	-0.02 (0.02)
Equity volatility	0.62*** (0.06)	0.65*** (0.06)
Rollover risk	37.03*** (10.94)	35.28*** (10.78)
Firm size	-8.49*** (2.53)	-8.27*** (2.50)
CDS	1.12*** (0.32)	1.18*** (0.33)
Observations	13,508	13,508
R^2	0.07	0.07
F Statistic	54.10*** (df = 13; 9661)	56.96*** (df = 13; 9661)

Note: ***, **, and * denote statistical significances of 1%, 5%, and 10% respectively given that the standard errors shown in parenthesis are single-clustered at the cross-section dimension.
Source: Authors' calculations