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Sustainability and Credit Spreads in Japan

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Keywords

Corporate bond spread, ESG investing, Sustainability

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G12, M14, Q56

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Sustainability and credit spreads in Japan*

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1 Introduction

The rapid expansion of environmental, social, and governance (ESG) investing raises a question vis-à-vis if the asset prices reflect the firm's ESG performance. Early empirical research related to the relationship between corporate social responsibility (CSR) and financial performance shows mixed results. For example, Derwall et al. (2005) report that the stock retunrs of companies with higher CSR standards tends to be higher. Similarly, Eccles et al. (2014) report that higher-CSR companies significantly outperform their counterparts over the long term, both in terms of stock market and accounting performance. In contrast, Humphrey and Lee (2011) find no significant difference in performance between socially responsible investment (SRI) funds and conventional funds in Australia. Likewise, Managi et al. (2012) confirm the quite similar performance of the SRI and conventional indexes for the US, UK, and Japan, even if bear and bull markets are distinguished. In addition, Kitzmueller and Shimshack (2012) state that there is sparse evidence that environmental performance enhances financial performance.

Despite the mixed empirical findings of the performance of ESG investments, recent research highlights instances of outperformance for stocks/portfolios aligned with higher CSR/ESG standards during periods of crisis. Notably, Nofsinger and Varma (2014) document that the ESG equity funds perform relatively better than matched conventional mutual funds during market crisis periods. Correspondingly, Lins et al. (2017) demonstrate that US firms with higher CSR profiles attain higher stock returns during financial crises. Following these studies, Rjiba et al. (2020) unveil the efficacy of social capital from CSR activities in mitigating negative financial shocks in times of economic uncertainty, suggesting the increased value of CSR in turmoil periods.

Also, recent studies on ESG investing provide extensive evidence to recognize the importance of ESG engagement and ESG-related risk in asset prices, returns, and portfolio choices. Several studies empirically analyze this issue in the response of stock prices to the ESG-related risk, focusing on "sin" stocks (alcohol, tobacco, and gaming). For example, Hong and Kacperczyk (2009) study the stock prices and returns of sin stocks and find that sin stocks receive less coverage from analysts and have higher returns than otherwise comparable stocks. Similarly, Borgers et al. (2015) show the positive relation between mutual fund returns and sin stock exposure using the performance of US equity mutual funds between 2004 and 2012. Furthermore, a theoretical model in Colonnello et al. (2019) introduces an ethical preference-based model to study the sin-

stock anomaly and discloses the non-pecuniary factors in the formation of investment decisions and asset prices.

Another strand of literature discusses the various aspects of the risk related to ESG investments. For example, Gibson Brandon and Krüger (2018) measure the portfolio-level environmental and social characteristics of institutional investors and show that the environmental and social portfolio policies can reduce the portfolio risk. Similarly, Fan and Michalski (2020) analyze the Australian stock market, demonstrating that portfolios with reduced risk can be constructed by considering ESG scores. Suto and Takehara (2020) also report that the CSR intensity stabilizes stock returns for high-CSR firms in the long run and moderates management disclosure bias in the short run based on the Japanese stock market. Moreover, Dunbar et al. (2020) find that CSR activities can lead to greater risk reduction for firms with governance characteristics indicating stronger information intensity/transparency and corporate social performance alignment. On the other hand, Hong and Kostovetsky (2012) reveal a connection between political value/bias and SRI fund management that explicit SRI funds are more likely to be managed by Democratic managers, highlighting a possible political bias in ESG investments. Additionally, Dunbar et al. (2021) provide strong evidence that as a firm's CSR status improves, increasing its risk-taking capacity, the firm responds by adjusting compensation contracts to increase CEO risk-taking incentives.

As can be seen, a growing number of studies document diverse pieces of evidence on the relationship between the asset prices and the firm's ESG performance. However, several research questions remain. The first is whether ESG performance is reflected in the pricing of bonds, which are less affected by growth options than stocks. Second, to what extent does each ESG issue affect corporate bond pricing through a firm's risk component? The third is whether the impact of ESG performance on asset pricing is constant across a firm's credit quality and over time. The primary objective of the paper is to engage with these questions to make important contribution to the current literature.

An investigation of these questions necessitates the firm-level corporate bond credit spreads. Thus, our first contribution is to construct the firm-level corporate bond credit spreads and explore the impacts of a firm's ESG performance on corporate bond credit spreads in Japan. The corporate bond credit spread is considered to reflect the default risk of the corporate bond issuing firms; Longstaff et al. (2005) find that the majority of credit spreads are due to default risk. In this study, we construct firm credit spreads based on the "bottom-up" approach according to Gilchrist et al.

(2009) and Gilchrist and Zakrajšek (2012). This method makes our firm-level credit spread data less contaminated by a small number of issuers with large outstanding corporate bonds compared to the individual bond issue level data. Consequently, this allows us to directly quantify the impact of a firm's ESG performance on its credit spreads to examine whether the market evaluates the risk of firms that differ in the sustainability associated with their ESG activities. There are several recent empirical studies on firms' ESG performances and individual corporate bond pricing, e.g., Stellner et al. (2015) on Eurozone corporate bonds and Jang et al. (2020) on ESG scores and bond returns in Korea. Our direct assessment reveals that ESG performance significantly reduces the corporate credit spreads, particularly for firms with the lower credit rating categories. Given that the engagement on ESG issues possibly enhances sustainability and decreases a firm's downside risk, as shown by Hoepner et al. (2020) using firms' stock return, it is quite sensible that lowly-rated issuing firms benefit more from the engagement on ESG issues.

Our second contribution is to investigate whether the impacts of ESG scores on corporate credit spreads are constant over time. Over the last decade or so, ESG investing developed considerably all over the world. Japan is not an exception. Particularly, ESG issues have become critical criteria for investment decisions in Japan since Japan's Government Pension Investment Fund (GPIF), the world's largest pension fund, became a signatory to the United Nation's Principles for Responsible Investment (PRI) on September 16, 2015. In addition, OECD (2020) documents the strong growth potential of Japan's sustainable investing (third largest center behind the EU and US) notwithstanding comparatively modest assets under management of approximately USD 2 trillion according to OECD (2020). As it took a longer time in the Japanese market than in the EU or US market before ESG investing sank in, the assumption relating to the constant impacts of ESG performance during our sample period might be unreasonable.[1] Therefore, it is instructive to examine possible increasing impacts of ESG performance on corporate credit spreads as the development of ESG investing. Specifically, we consider the recent upward momentum of ESG investing in the empirical analysis

[1] It has also been motivating research with respect to environmental innovation, such as Acemoglu et al. (2018) who develop a microeconomic model of the transition to clean technology and find that both carbon taxes and research subsidies encourage production and innovation in clean technologies. In ESG investing, the research on green assets is enhanced; Pastor et al. (2020) theoretically model ESG criteria and find that investors enjoy holding green assets that hedge climate risk, resulting in having low expected returns; Krueger et al. (2020) explore the climate risk perceptions among institutional investors and their survey's findings indicate that institutional investors believe that equity valuations do not fully reflect the risks from climate change and consider climate risks as important investment risks; while Baker et al. (2018) and Wang et al. (2020) estimate the green bond issuance premium in the US and China, respectively.

by employing the number of signatories to the PRI as a proxy for recognition of the importance of ESG investing globally. The findings indicate that the negative impacts of ESG scores on credit spreads have been increasing with the development of ESG investments. This result is independent of the sustainability measures and bond credit rating groups. However, our results also demonstrate that the increasing rates of the negative impacts for the lowly-rated firm group are much larger than those for the highly-rated firm group.

Our final contribution is to estimate the differential impacts of ESG categories on the corporate credit spreads, offering possibilities for a better understanding of the individual risk element of corporate ESG strategies in Japan. For the US, Bouslah et al. (2013) suggest positive/negative impacts of the individual dimensions of social performance on firm risk using the equity data. Our study contributes to the previous literature on the links between ESG engagements and corporate bond credit spreads by including the findings from the Japanese market. While our results show the lowering effects of ESG scores on corporate credit spreads, the significance and the magnitude of reduction in corporate spreads depend on the credit quality of issuing firms regardless of the ESG category scores. In addition, our results indicate that the resource use in the environment pillar, human right in the social pillar, and management categories in the governance pillar are the most influential in lowering the credit spreads.

Our main findings that corporate ESG performance is a significant determinant of corporate bond credit spreads also add to the literature on the determinants of corporate bond credit spreads. Our method to construct the firm-level credit spreads builds on Gilchrist and Zakrajšek (2012), who propose the "bottom-up" approach, and the results indicate that better ESG performance tends to lower credit spreads, even after controlling the issuing firm's financial health, credit rating, and three macroeconomic fundamental risk dimensions documented by Wu and Zhang (2008). Moreover, this result appears to be stronger for lowly-rated firms. To check the robustness of our results, we consider the potential endogeneity concern. Specifically, we address endogeneity concerns that could be due, for example, to the confounding factors that firms could achieve better ESG performance based on *ex ante* knowledge about risk surrounding. That could also affect the corporate default probability and hence corporate credit spreads. The instrumental variable (IV) results show that corporate ESG performance remains a significant factor for corporate bond credit spreads. This could be because the corporate bond credit spread in the secondary market is inherently forward-looking, see, e.g., Stock and Watson (2003), Gilchrist and Zakrajšek (2012),

Faust et al. (2013), and Favara et al. (2016); in this sense, the reverse causality between credit spreads and ESG scores seems unlikely to be present, and we could reasonably overlook this issue. Our results of the stronger impacts of ESG scores on the credit scores for the lowly-rated firms further support this view.

The remainder of the paper is organized as follows: in Section 2, we describe the empirical strategy, construction of firm-level credit spread data and sample for our dataset, specifications to be estimated, and provide summary statistics. In Section 3, we present the main results, robustness check by employing the IV approach based on the two-stage least squares (2SLS), and results by a firm's credit quality. We investigate the impacts of ESG performance on corporate credit spreads across a firm's credit quality and over time in Section 4. The conclusions are presented in the final section.

2 Empirical Strategy

We investigate the relationship between a company's ESG performance and its credit spread in Japan. In response to the society's increasing demand for pro-social behavior, firms voluntarily provide relevant information to stakeholders. However, this type of information published by the firm may not be credible in nature, see Tirole (2017). Hence, we use the sustainability metrics at the firm-level provided by the ESG ratings provider and observable to the investor. Notwithstanding the shortcomings already reported by Boffo and Patalano (2020) regarding the strong variation of ESG ratings among providers owing to the different frameworks, measures, and data use, the growing use of ESG scores as a benchmark for ESG investing indicates that they provide useful reference points.

To address the research question relating to whether a firm's pro-social behavior decreases the perception of its risk as measured by corporate bond credit spreads, we construct the individual issuer's credit spreads in the following subsection. Thereafter, we discuss the empirical specification controls for the firm's financial and macroeconomic factors.

2.1 Data and Sample

We use a comprehensive dataset of individual corporate bond prices obtained from the Japan Standard Bond Price database, which includes such information as the interest rates, coupon rates,

redemption dates, and issue dates of public and private offerings of domestic bonds, foreign bonds, and Eurobonds. This data source provides the most extensive coverage of secondary market prices of corporate bonds publicly issued in the Japanese market. To construct the individual firm's credit spreads, we limit our sample to only straight corporate bonds that are publicly issued in Japan by Japanese corporations. We exclude subordinated corporate bonds and Fiscal Investment and Loan Program agency bonds that are guaranteed by the central government. To ensure that we measure the borrowing costs of firms at the same point in their capital structures, we limit the sample to only senior issues with fixed coupon schedules, following prior studies. The original yield data have a daily frequency, and we use the last observed yield data in December to construct a dataset of year-end compound yields for individual corporate bond issues to match the ESG annual data.[2]

We use these data and those on the government bond zero curve to calculate the credit spread. The government bond yield data are obtained from Thomson Reuters Eikon, which collects market data on Japanese government bonds from Tradeweb and calculates the zero curve. Thomson Reuters Eikon offers government bond zero curve data with different maturities, ranging from one month to forty years. If the government bond zero curve is missing for a particular corporate bond maturity, it is filled via cubic spline interpolation.

We employ the "bottom-up" approach proposed by Gilchrist et al. (2009) and Gilchrist and Zakrajšek (2012) to construct the firm-level credit spread index. With individual corporate and government bond data, credit spreads are calculated as differences between corporate and government bond yields of the same maturity. Thus, we calculate credit spreads using corporate and government bond yields with exactly the same maturity. Thereafter, for the estimation, we obtain the year-end credit spreads of outstanding corporate bonds traded in the secondary market between 2007 and 2018. Our estimation sample of credit spreads is limited to corporate bonds with fixed coupon schedules and bullet bonds with no embedded options.

Specifically, the credit spread for corporate bond k with maturity m issued by firm i at time t is given by:

$$S_{imt}[k] = y_{imt}[k] - y^{f}_{mt}[k],$$

and $y_{imt}[k]$ is the yield of corporate bond k with maturity m at year t, while $y^{f}_{mt}[k]$ is the corresponding government bond yield of the thereafter same maturity at time t.

[2]Because of this treatment, if a firm does not have any observed yield data in December, the firm is dropped from our dataset.

Given these credit spreads, we calculate the individual firm's credit spreads for bonds from the same firm as:

$$cs_{it} = \frac{1}{N_{it}} \sum_{k} S_{it}[k],$$

where N_{it} is the number of observations in year t of corporate bonds issued by firm i. That is, an individual firm i's credit spread in a given year is the arithmetic average of the firm's year-end credit spreads for its outstanding bonds.

We eliminate extreme observations including bond and month observations with credit spreads greater than 2,000 basis points following previous studies, such as that of Gilchrist and Zakrajšek (2012). As a lower bound, we eliminate observations with credit spreads below zero basis points to avoid including negative credit spreads which are economically nonsensical.

For the company's corporate responsibility commitments, we use four ESG scores provided by the Refinitiv (Thomson Reuters)—one of the largest ESG information providers—including MSCI, Sustainalytics, Bloomberg, and RobecoSAM (Boffo and Patalano (2020)) and have been employed in academic research, for example Stellner et al. (2015). The Refinitiv ESG scores are based on more than 500 different ESG metrics and simple to understand percentile rank scores benchmarked against TRBC Industry Group for all Environmental and Social categories, and against the Country for all Governance categories.[3] That is, these ESG scores control industry features. We use scores related to 10 main important categories: emission, innovation, resource use, CSR strategy, management, shareholders, community, human rights, product responsibility, and workforce. Of the 10 main categories, emission, innovation, and resource use are bunched into environmental score, while CSR strategy, management, and shareholders (community, human rights, product responsibility, and workforce) are rolled up into governance (social) score. We collect these ESG scores of Japanese listed firms from Datastream: ESG score and its three pillar scores, i.e., environmental, social, and governance scores, and 10 categorie scores.

According to the Refinitiv (Thomson Reuters) ESG scoring methodology, which produces a score between 0 and 100, the ESG score measures a company's ESG performance based on verifiable reported data in the public domain. Hence, we use this ESG score as a variable for the company's ESG performance. We also use three pillar scores, environmental, social, and governance scores, as variables for the company's performance in each important area. While we use

[3]The details of the data process, global coverage, scores structure, and calculation methodology are explained in "Environmental, Social and Governance (ESG) scores from Refinitiv February 2021."

four ESG scores in our estimation, Table 1 shows that these scores are highly correlated among themselves. That is, firms that receive a high score in one of the four variables tend to also receive high scores in the other variables. Hence, we do not use all four variables in the estimation simultaneously, but use each variable by itself.

[Table 1 around here]

We match the credit spread data and ESG scores with the firm's dataset, which includes credit rating and financial indicators, to control the firm's financial health and credit quality. Following previous studies, e.g., Stellner et al. (2015), financial indicators include firm's total revenue, earnings before interest and taxes (EBIT) margin (EBIT/total revenue), debt/capital, capital expenditure (CapEx)/total revenue, return on invested capital (ROIC), and equity volatility. Furthermore, the issuer's credit rating information is used to control the credit quality of the issuer. The firm's information is also taken from the Thomson Reuters database and is as of immediately prior to the year-end credit spread point.

Finally, we incorporate three macroeconomic factors that Wu and Zhang (2008) identify three fundamental risk dimensions underlying an economy: inflation, real output growth, and financial market volatility. The growth rate (year-on-year) of the consumer price index (CPI) is used as an inflation factor. These data are obtained from the Statistics Bureau of Japan. As a real output growth variable, we use the real gross domestic product (GDP) growth (year-on-year) published by the Cabinet Office, Government of Japan. Lastly, we include the percent change in Nikkei Volatility Index (year-on-year) as a measure of the financial market volatility to capture the compound effect of business risk throughout the economy and financial leverage following Wu and Zhang (2008). This factor is considered to affect the pricing of corporate bond, as in Merton (1974).

The final sample is the unbalanced panel data that consist of 245 firms. The sample period is from 2007 to 2018.

2.2 Empirical Specification

Do well-performed ESG activities help hedge against ESG risks and lower a company's default risk? To address this question, we examine whether and how a company's ESG performances influence its credit spread, i.e., the cost of fundraising, after controlling for other characteristics of

the credit spread determinants. To capture this effect, we estimate the following model:

$$Credit\ spread_{it} = \alpha_i + \delta ESG\ score_{it} + \gamma Controls_{it} + \beta Macro_t + \epsilon_{it} \quad (1)$$

where the dependent variable throughout our analysis is the year-end credit spread in basis points of a company i at time t. Using the year-end credit spreads minimizes the simultanity issues, making many of the explanatory variables predetermined. The explanatory variable of interest is the company's ESG performance measured in terms of the (i) ESG, (ii) environmental, (iii) social, and (iv) governance scores of company i at time t. Depending on the specification, we use one of the four ESG scores at a time due to their high correlation.

We include control variables, specific to company i, commonly used in the literature on credit spread determinants. These are credit rating and financial indicators: issuer's credit rating, logarithm of total revenue, EBIT margin (EBIT/total revenue), debt/capital, CapEx/total revenue, ROIC, and equity volatility. Based on a long strand of literature on the bond credit spread, we include a control for credit rating, as it directly affects bond credit spreads. For example, Ederington et al. (1987) and other subsequent papers show that credit ratings explain cross-sectional differences in bond credit spreads even after controlling for firm and issue characteristics, with a clear negative relation between changes in a bond's rating and changes in its credit spread. Therefore, we use the credit rating dummies to control the differences in adition to financial indicators. We also include a set of three macroeconomic variables at time t to capture the macroeconomic fluctuations that affect the movement of the credit spreads: the (year-on-year) growth rates of CPI and GDP, as well as the Nikkei Volatility Index. These are time series variables that are not specific to the company. Moreover, the model specification contains firm-fixed effects, α_i.[4]

The coefficient of interest is δ. The ESG scores take values between 0 and 100, meaning that the higher the better. While we use four different ESG scores as the explanatory variable, it holds in all four scores that the higher the better. If we find that δ is statistically significant and negative, then the ESG performance of a company is an important driver of credit spreads as well as beneficial to lowering the company's financing cost. We do not necessarily assume that each ESG factor, "E," "S," or "G" has a homogeneous impact on credit spreads. Their impacts or relevance to the economy may change over time during the sample period. We will consider the heterogeneity in

[4]We have also tried to include the short-term Japanese government bond yield and the time-fixed effects to take the possible effect of monetary easing policy, they are not statistically significant for many cases. Therefore, we decided not to include them.

impacts following the main results.

In specification (1), we assume that the ESG performance has a constant impact over time. This implies that the recent expansion of ESG investing is ignored in estimating the impacts. We extend the basic model to explore whether the impact of ESG scores on corporate credit spreads reflects the global trend toward facilitating ESG investment. Consequently, we modify (1) as follows:

$$Credit\ spread_{it} = \alpha_i + \delta_1 ESG\ score_{it} + \delta_2 PRI_t ESG\ score_{it} + \gamma Controls_{it} + \beta Macro_t + \epsilon_{it}. \quad (2)$$

In addition to the inclusion of $ESG\ score_{it}$, we add an interaction term, $PRI_t ESG\ score_{it}$, between the number of signatories to the PRI published by the PRI and an ESG score to capture a global trend of sustainable finance. Since PRI_t can be a proxy for a global trend toward expanding sustainable finance, the interaction term allows for a differential effect on each ESG score on which the investor places emphasis during our sample period.[5]

2.3 Summary Statistics

The summary statistics for firm-specific variables to be used in the analysis are reported in Table 2, which decomposes the variables into between and within outputs. Our dataset is the unbalanced panel data from 2007 to 2018. The overall and within outputs are calculated over 2,353 firm-years of data. The rows labeled "overall" show the summary statistics calculated for the entire dataset; the "between" is calculated over 245 firms (firm-level means). The average number of years a firm is observed in our data is approximately 10. The rows labeled "within" provide the information within each firm. The within output refers to the deviation from each firm's average, thus some of these deviations are naturally negative.[6]

[Table 2 around here]

As explained in Subsection 2.1, we eliminate extreme observations such that bond and month observations with credit spreads greater than 2,000 basis points or below zero basis points to avoid including negative credit spreads. We see that the average credit spreads for each firm vary between

[5]Note that the coefficients of variation of PRI and ESG are 0.48 and 0.45, respectively, indicating that neither variables are a dominant factor of the interaction. We conduct a robustness check using an alternative proxy, e.g., a dummy for the period after GPIF becomes a signatory to the PRI, and confirm that the results are qualitatively similar. The results are not reported to conserve space.

[6]The definition of "within" here is $x_{it} - \bar{x}_i + \bar{\bar{x}}$. The global mean $\bar{\bar{x}}$ is added back in so that the results are comparable.

15.2 and 1040.4. The figures within this range show that some firms significantly deviate from their average. The firm credit spread indicators have sufficient variation and reflect fluctuation over time because our sample period includes the global financial crisis period.

Note that the mean ESG score is 47.8. Similarly, the mean environmental and governance scores are 51.5 and 52.1, respectively. These scores take values between 0 and 100, thus our sample mean suggests that our dataset is not biased toward high- or low-performance firm groups. The mean social score is 40.3, which is slightly lower than that of the other scores. The "between" minimum and maximum values indicate that the firm-level means for the social score are not biased toward the low-performance groups.

In addition to the financial indicators in Table 2, the credit rating information is used in the estimation. The rating categories in the estimation sample range from AAA (approximately 1%) to CCC (approximately 0.2%). The average rating of the sample firms is the A rating category (approximately 59%).

3 Results

3.1 Benchmark results

In this subsection, we report our benchmark results based on Equation (1). One of the main contributions of this study is to examine whether and how a company's ESG performances influence its credit spreads, i.e., the cost of fundraising, after controlling for other characteristics of the credit spread determinants. Another contribution of our study is to separately investigate the impacts of ESG components on corporate spreads for the Japanese corporate bond market.

To measure the impacts of firm's ESG performance on corporate spreads, we estimate Equation (1) via the panel fixed effects ordinary least squares (OLS) using the clustered standard errors by firms. We present the results for four sets of regressions. Each set uses a different sustainability measurement variable: ESG, environmental, social, or governance score. The estimation results are reported in Table 3. As evident in column (1) of Table 3, the coefficient of the ESG score, which is our main interest, is significantly negative, with an estimate of -0.65. This indicates that if the firm's ESG score increases by 1 point, the credit spread of the firm tends to decrease by 0.65 basis points. This means that the ESG score could affect credit spread by 65 basis points at the maximum, as the ESG scores take values between 0 and 100. Given the extremely low interest rate

environments in Japan over the last two decades or thereabouts, this can be considered a relatively significant impact.

[Table 3 around here]

Many control variables are significant with most of them showing expected relationships. For example, the credit rating dummies indicate that credit spreads approximately increase monotonically as the credit rating worsens. The only exception is the relation between AAA and AA ratings, where the results indicate that both ratings essentially have the same credit spreads on average. This is because Japanese corporate bonds with AA ratings are considered to have almost no default risk with no significant difference from those with AAA ratings. The logarithm of total revenue is significantly positive, which is highly contrary to the results of Stellner et al. (2015), showing an interesting difference between Japanese and European corporate bond markets. One possible reason for the difference is that in Japan, firms with larger revenues tend to issue more corporate bonds, thereby paying more premia. Another significant firm variable is the ROIC with a negative sign, which is consistent with Stellner et al. (2015), reflecting lower default risk. All macroeconomic control variables are significant with expected signs. Specifically, GDP growth rates have negative signs, suggesting that good economic conditions generally lower credit spreads. Similarly, inflation tends to decrease credit spreads, as higher inflation is associated with the better economic condition for our sample period in Japan. Finally, stock price volatility changes have positive signs because higher uncertainty in the stock market generally reduces risk appetite in financial markets.

To investigate the impact of ESG pillars on corporate spreads separately, we re-estimate Equation (1) using the score of each pillar rather than the ESG score.[7] The estimation results are summarized in the last three columns of Table 3, showing a clear difference between the environmental pillar and the other two pillars. While the environmental score shows no significant impact on credit spreads, the social and governance scores have significantly negative effects on credit spreads. In other words, firms with higher social and governance scores can enjoy lower credit spreads, but firms cannot benefit from the higher environmental score. Against the backdrop of the global trend for tackling climate change, the insignificant impact of the environmental score

[7]The high correlation among these scores can cause the multicollinearity problem; thus, we conduct estimations separately throughout this study.

on credit spreads seems counterintuitive. Notably, Japanese companies own more environment-related technologies than those in other countries; Haščič and Migotto (2015) shows that Japan has the highest ratio of the world's high-value inventions among foremost inventor countries globally in environment-related technologies between 2009 and 2011. Judging from the fact that Japan is at least one of the top performers in environmental-related technologies in Haščič and Migotto (2015), Japanese companies are considered sensitive to environmental issues. But at the same time, this implies that those companies with higher environmental scores might overinvest in environmental issues, possibly offsetting the lowering impact of higher environmental scores on credit spreads. In addition, it is ambiguous whether the estimated impact of the environmental score incorporates the recent social preference to aggressively tackle the environmental issue. In other words, the results of this section could underestimate the impact of ESG scores, particularly for the environmental score, due to the ignorance of the recent increasing attention on ESG issues, including the carbon efficiency and climate change risk. We will investigate this aspect in the next section.

3.2 Instruments and 2SLS

We so far show the empirical results that the better ESG performance reduces the corporate credit spreads. However, the causal relationship between credit spreads and ESG performance is not addressed. With regard to the reverse causality between credit spread and ESG performance, we are less concerned about this issue because we use the end-of-year corporate credit spreads, making the most of explanatory variables predetermined, and corporate bond credit spreads in the secondary market are inherently forward-looking, see, e.g., Stock and Watson (2003), Gilchrist and Zakrajšek (2012), Faust et al. (2013), and Favara et al. (2016). It seems unlikely that the past corporate ESG activities are determined by corporate credit spread, a forward-looking variable. Therefore, it is not unreasonable to assume no reverse causality.

With regard to the omitted variables problem, we include control variables as many as Stellner et al. (2015) and three macroeconomic fundamental risk dimensions in Wu and Zhang (2008). Hence, it is also not unreasonable to assume that our principal results are not driven by omitted variables about economic conditions or firm-specific factors.

To rule out endogeneity issues, we include the independent variables prior to the year-end credit spread point. In this subsection, we further address any remaining endogeneity concerns.

To alleviate any possible endogeneity concern about the causal impact of ESG performance on credit spreads, we now employ an IV approach based on the 2SLS. We need variables that have a significant correlation with company ESG performance but do not affect company credit spreads. Literature on firm ESG performance and credit risk enables us to identify a possible instrument for corporate ESG performance: the average company score for each sustainability measurement of all other companies in the same sector and the same year (Jiraporn et al. (2014)). The idea is that the credit spreads may be related to firm-level ESG performance, however, it is less likely to the sector-level ESG performance. Taking into account that there are many firms in a sector, changes in ESG performance at the sector-level are more likely exogenous. The results of the first stage regression, though not reported to save space, show that an instrument has significant explanatory power as indicated by its positive and highly significant coefficient.

Table 4 reports the estimation results of Equation (1) from the IV approach based on 2SLS which includes each sustainability measurement instrumented with its corresponding average sustainability measurement of all other companies in the same sector and in the same year. The 2SLS results are restricted to those on the second stage to save space.[8] The relationship between ESG performance and credit spreads remains unchanged with an instrument, mitigating the concerns that our results are driven by the endogeneity.

[Table 4 around here]

Note that the test for exogeneity of the environmental score as an ESG measure in column (2) of Table 4 fails to reject the null hypothesis that the environmental score is exogenous. The environmental score coefficient in our main results in Table 3 is not significant, and it remains insignificant in Table 4. Hence, our main results remain qualitatively the same. The ESG pillar scores in columns (1) - (4) of Table 4 bear negative coefficients. Each of them is statistically significant in all specifications, except for column (2), which is also insignificant in Table 3. Overall, the corresponding effect is higher, and the IV results are stronger in terms of the magnitude of the estimated effects relative to the OLS results, but the statistical significance is similar. In line with Stellner et al. (2015), we confirm our results with another instrument variable that is the average company score for each sustainability measurement of all other companies in the same year, assuming that the country-level ESG performance in the same year is more likely to exogenous. The

[8]The first stage results are available upon request.

results are not reported, however, they are qualitatively similar. The results demonstrate that the endogeneity issue is not a serious concern, as we predicted. Therefore, we will use the OLS for the rest of the analysis.

3.3 Credit quality

The previous subsections provide clear evidence of a negative relationship between ESG scores and credit spreads. That is, the firm that attains a better ESG performance can enjoy a lower financing cost. Additional analysis indicates that the social and governance scores play a more important role in this negative relationship than the environmental score. One of the key assumptions for the analyses so far is that the effects of ESG scores are homogeneous across firms regardless of their credit quality. However, it could be possible that higher ESG scores can provide stronger signals for corporate bonds in lower credit rating categories. This is because one possible reason why higher ESG scores lower credit spreads is that the former is closely related to the firm's sustainability. If this is the case, it is reasonable that there is a negative relationship between ESG scores and the credit risk of firms. Consequently, high ESG scores could reduce firms' credit spreads. However, this also suggests that firms with little credit risk should not be considerably affected by ESG scores, making additional information on higher sustainability due to the higher ESG scores less informative. On the other hand, for those firms with lower credit ratings, higher ESG scores could have precious information on higher sustainability from the non-financial information perspective. In other words, only firms whose credit risk is non-negligible can comparatively benefit from higher ESG scores. Therefore, in this subsection, we will relax the homogeneity assumption across credit quality to determine whether our results are robust for the assumption and provide more precise insights if some heterogeneity exists.

To examine the possible differences in the effects of ESG scores on credit spreads between low and high credit risk firms, we divide the sample based on the credit rating information. In Japan, firms with A rating or above are considered to have little default risk in general. Notably, firms with AAA and AA ratings have rarely failed over the last 20 years in Japan, and the default risk of A rating is generally considered to be less than 1%. However, the default risk of firms with BBB rating or below is typically regarded as non-negligible, although the defaults of BBB-rated firms are still rather seldomly observed in Japan, except in 2009 when two defaults of BBB-rated firms have been reported, according to the Moody's rating. Therefore, it is fair to say that there is little

credit risk for the firms with A rating or above in Japan, but there exists some credit risk for firms with BBB rating or below. Given this observation, we split the sample into two groups depending on whether the firm's rating is A or above, or BBB or below, whereafter we re-estimate model (1) using each subsample.

Table 5 presents the estimation results for each subsample, and we can find noticeable differences between the two subsamples. Specifically, for the A-rated or above firm group, although the ESG score shows a significantly negative impact on credit spread, each pillar's score is insignificant. Moreover, the magnitude of the significant impact of the ESG score is estimated as -0.17 bps, which is less than one-third of that of the previous subsection. Similar tendencies can be observed in macroeconomic variables, meaning that the effects of the macroeconomic variables are significant but generally weaker for this group. These observations are consistent with our prediction that those variables implying lower credit risk have smaller effects on credit spreads for small credit risk firms.

[Table 5 around here]

Nonetheless, for the BBB-rated or below firm group, the ESG scores have a significantly negative impact on credit spreads with a much larger magnitude than that of the previous subsection and the A-rated or above firm group. For the BBB-rated or below firm group, if the ESG score increases by one point, the credit spread tends to be lower by 3.25 bps, which is approximately five times that presented in Table 3 and more than 20 times the impact compared to the A-rated or above firm group. Furthermore, for the BBB-rated or below firm group, the social and governance pillar scores show significantly negative effects on credit spreads with estimates of -2.59 and -2.63, respectively. This result is consistent with that of the previous subsection in terms of significance but also indicates an interesting difference in the magnitude. The magnitudes of the impacts of the macroeconomic variables also indicate the same tendencies. These results are reasonable, as those variables that can be a signal for the lower credit risk should have larger impacts on credit spreads for higher credit risk firms.

In sum, the results in this subsection clearly show the greater impacts of ESG scores on lowering credit spreads for lower graded firms. In other words, the information on higher ESG scores is more informative for those firms that are considered to have higher default risk from the financial information. The results also imply that the reverse causality from lower credit spreads to

higher ESG scores is not an issue in our analysis. If it captures the reverse causality from credit spreads to ESG scores, the results in this subsection should be the opposite, as those firms with higher credit ratings should have more capability to have higher ESG scores. Thus, there should be a stronger relationship between credit spreads and ESG scores for the A-rated or above firms. However, the results in this subsection indicate that this is not the case, providing further evidence that the reverse causality is not an issue in the analysis of this study.

4 Global trends of responsible investment

In this section, we study possible mechanisms through which ESG performance has an impact on credit spreads by exploring how the global trends of responsible investment affect credit spreads over time. Another key assumption for the analyses so far is that the effects of ESG performance are stable over time. However, the role of ESG performance can be more important in the market, as ESG investing develops in more recent years. Therefore, we will relax this homogeneity assumption across time to determine whether company ESG performance can affect corporate bond credit spreads more through the growing pressure from the investors who are concerned about the responsible investment.

4.1 Effects of PRI Signatories

Over the last decade, ESG investing has been attracting considerable attention. As a natural consequence, the level of ESG investment has grown significantly over the past 10 years. This suggests that investors have begun to pay more attention to the ESG performance of firms when they make investment decisions. One possible implication of this fact is that ESG scores might play a more important role in financial markets with the development of ESG investments. We focus on this channel, which gains little attention in the previous works. With a concrete indicator, the number of PRI signatories, we examine whether ESG scores should have larger impacts on credit spreads more recently under the growing pressure from such investors. Put differently, the increase in the number of PRI signatories should increase the impact of higher ESG performance on corporate sustainability, which should translate into lower credit risk, then lead to the reduction in credit spreads.

The goal of the analysis in this subsection is to examine whether the impact of ESG scores

on credit spreads has been stronger with the development of ESG investments. Thus, we modify the benchmark regression model (1) to capture the possible time-varying effects of ESG scores, thereby reflecting the development of ESG investments. Specifically, our new regression model is given by Equation (2) by adding an interaction term between the ESG score and a measure of the development of ESG investments evaluated by the number of PRI signatories. In this specification, the effects of the ESG score will change with the number of PRI signatories. More specifically, the impact can be calculated as: $\delta_1 + \delta_2 PRI_t$.

Table 6 reports the estimation results of Equation 2 based on the full sample. An important result of this table is that, with this specification, the coefficient on the ESG measure is not significant anymore regardless of the ESG measures. Conversely, the coefficient on the interaction term is highly significant for all ESG measures, including the environmental score. This is a great contrast to the results of the previous section, where we could not find any significant evidence of a negative relationship between the environmental score and credit spreads. More importantly, this result indicates that the effects of ESG scores on credit spreads have been increasing with the development of ESG investments, as measured by the number of PRI signatories. For example, if the number of PRI signatories increases by 1, the negative impact of the ESG score on credit spreads increases by 0.0002. Given that the number of PRI signatories has exceeded 3000 in 2020, the total effects could be substantial. To elucidate this point clearly, we plot the evolution of the impact of ESG scores on credit spreads based on the estimation results of Table 6 in Panel (a) of Figure 1. Apparently, the impacts of the ESG scores increase rather linearly with the development of ESG investments. As of 2020, the negative impacts range from 0.24 to 0.50 basis points, depending on the ESG measures.

[Table 6 around here]

[Figure 1 around here]

To accommodate the possible difference in the effects of ESG scores between the credit ratings, we also estimate Equation (2) using the subsamples, namely the A-rated or above, and BBB-rated or below firm groups. The estimation results are shown in Table 7. Evidently, although none of the coefficients of the ESG measure is significant, that of the interaction term is highly significant for all cases. These results are consistent with those of the previous section, but they also show a clear tendency that the magnitude of the coefficient on the interaction term is strikingly larger for the

BBB-rated or below firm group. This result is similar to the finding of the previous sections, but the current result means that the increasing rates in the impacts of ESG scores for the BBB-rated or below firm group are considerably higher than those for the A-rated or above firm group. To see this graphically, Panels (b) and (c) of Figure 1 plot the evolution of the impact of ESG scores on credit spreads based on the estimation results of Table 7. The graphs suggest that the negative impact of ESG scores increases rather linearly with the development of ESG investments for both groups, but the increasing rates for the BBB-rated or below group are much larger. Therefore, as of 2020, the negative impacts range from 0.17 to 0.23 basis points for the A-rated or above group, but the corresponding range is from 2.0 to 4.3 basis points for the BBB-rated or below group.

[Table 7 around here]

In sum, the results in this subsection are clear cut and consistent with the expected relationship that the negative impacts of ESG scores on credit spreads have been increasing with the development of ESG investments. This result is independent of the sustainability measures and bond credit rating groups. The results can be considered as another evidence that the endogeneity is not a serious issue in our analysis. Otherwise, the investors ESG awareness cannot strengthen the impact of ESG scores on the credit spreads. Furthermore, our results also demonstrate that the increasing rates of the negative impacts for the BBB-rated or below firm group are much larger than those for the A-rated or above firm group. Thus, investors tend to see more value on the information about higher ESG scores for lowerly rated firms, as the development of ESG investments.

4.2 Effectiveness of ESG categories

Thus far, we have estimated our specification using ESG pillar scores. However, each pillar covers the broad ESG categories impacting corporations.[9] In this subsection, we further investigate the impacts of each ESG category that formulates the three ESG pillars to examine which ESG categories drive the lowering effect on credit spreads. The underlying categories are as follows: resource use, emission, and innovation, for the environmental; workforce, human rights, community, and product responsibility, for the social; and management, shareholders, CSR strategy, for the governance.

[9] In fact, the ESG category score is a weighted average of each category based on the category weights which vary per industry for the environmental and social categories and remain the same across industries for governance.

We employ the approach in the last subsection to consider the time-varying ESG effect and estimate Equation (2) using the ESG category score for an ESG score. Figure 2 presents the annual effects of the underlying ESG categories that formulate the three ESG pillars by issuer's credit quality. The annual effect is calculated as in the last subsection to vary with the number of PRI signatories. Panels (a)–(c) are for the highly-rated issuer, i.e., A-rated or above firm group, while those of (d)–(f) are for the lowly-rated issuer sample, i.e., BBB-rated or below firm group. The estimates of the coefficients on the interaction term between the ESG category score and the number of PRI signatories are mostly statistically significant, but even at a 10% significance level, a few are not; the human rights category for highly-rated issuers and CSR strategy category for lowly-rated issuers.

It is evident from Figure 2 that the magnitude of the reduction of credit spread by an increase in ESG scores has become larger recently for all ESG categories. This is consistent with the pattern presented in the last subsection. Moreover, Panels (d)–(f) show a larger magnitude of the reduction in credit spreads than Panels (a)–(c). For instance, the estimated reduction in credit spreads by an increase in the emission category score in 2018 is -0.116 basis points for the highly-rated issuer, while it is -2.089 basis points for the lowly-rated issuer. Thus, the reduction in credit spreads depends on the issuer's credit quality for all ESG categories, where the larger reduction is observed for the BBB-rated or below firm group.

[Figure 2 around here]

An important finding is that the results for highly-rated issuers show a similar pattern in Panels (a)–(c), where the annual lowering effect on the credit spread is more or less uniform across categories; however, for lowly-rated issuers, it varies substantially across categories within each ESG pillar, as can be seen in Panels (d)–(f). When we investigate each category's credit spread lowering effect, a similar pattern emerges. In Panel (d), i.e., the environment pillar, the resource use category's lowering effect on credit spreads exceeds that of innovation. Especially in the social pillar, the human rights category's credit spread lowering effect is noticeable, exceeding that of all other categories. Likewise, in the governance pillar, the management category shows a larger impact on credit spreads than the other two categories.

Overall, the analysis of the ESG category indicates the heterogeneous pattern of the negative effects of the ESG scores on credit spreads across the issuer's credit quality. For the A-rated or

above firm group, the emission, workforce, and CSR strategy categories are the most influential in lowering the credit spreads in the E, S, and G pillars, respectively. On the other hand, for the BBB-rated or below firm group, the resource use, human right, and management categories are distinctly emerging in each ESG pillar, respectively.

5 Conclusions

This study presents evidence suggesting that ESG performance can be an important determinant of corporate bond credit spreads, an association that has not yet been well investigated in the literature. The sustainable finance product market is rapidly growing amid the coronavirus disease (COVID-19) pandemic, and new types of debt instruments have emerged: green, social, sustainability, and transition bonds. However, it is unclear how the market values corporate ESG performance and firms' credit risk.

An important feature of this study is the use of the firm-level credit spreads constructed from individual bond-level data by employing the bottom-up approach, which allows us to directly measure the link between corporate ESG performance and corporate bond credit spreads. The results in this study indicate that the higher corporate ESG performance significantly decreases corporate bond credit spreads, especially for lowly-rated firms. These results have potential implications for firms in connection to new issues of sustainable finance products in the bond market: lowly-rated firms can highlight their risk management and/or resilience to hedge ESG risks by attaining better ESG performance and may benefit from the lower fund-raising costs.

We also explore possible mechanisms through which company ESG performance affects corporate bond credit spreads. Results indicate heterogeneous impacts among ESG pillars as ESG investing develops in more recent years, particularly for the environmental issue, and it is more pronounced for lowly-rated firms. This finding is important for understanding the trend and characteristics of ESG investing. We acknowledge the role of the governance that is the core of corporate management; however, the market less evaluates governance issues, contrariwise, while the environmental issue arises from the recent global challenges against climate change. Regarding the time-varying impacts, the increasing rates of the negative impacts are considerably larger for lowly-rated firms than those for highly-rated firms. The results are also confirmed by the analysis using ESG category scores.

The findings of this study provide broad insights not only for asset pricing but also for macroeconomic policy. In September 2020, the European Central Bank stated that they would support sustainable finance and confront the climate change menace by accepting green bonds as collateral with payouts linked to sustainability targets and include them in its asset purchase schemes. This fast-growing green finance is irreversible, and COVID-19 is driving ESG investing in a social as well as a green agenda. This study documents the heterogeneous impacts of ESG performance on asset prices. Moreover, the impacts are shown to have become greater recently, and this trend is expected to grow. Therefore, our results relating to which of the ESG categories plays a key role in the market can be attributed to the different needs of the policymakers as well as market participants.

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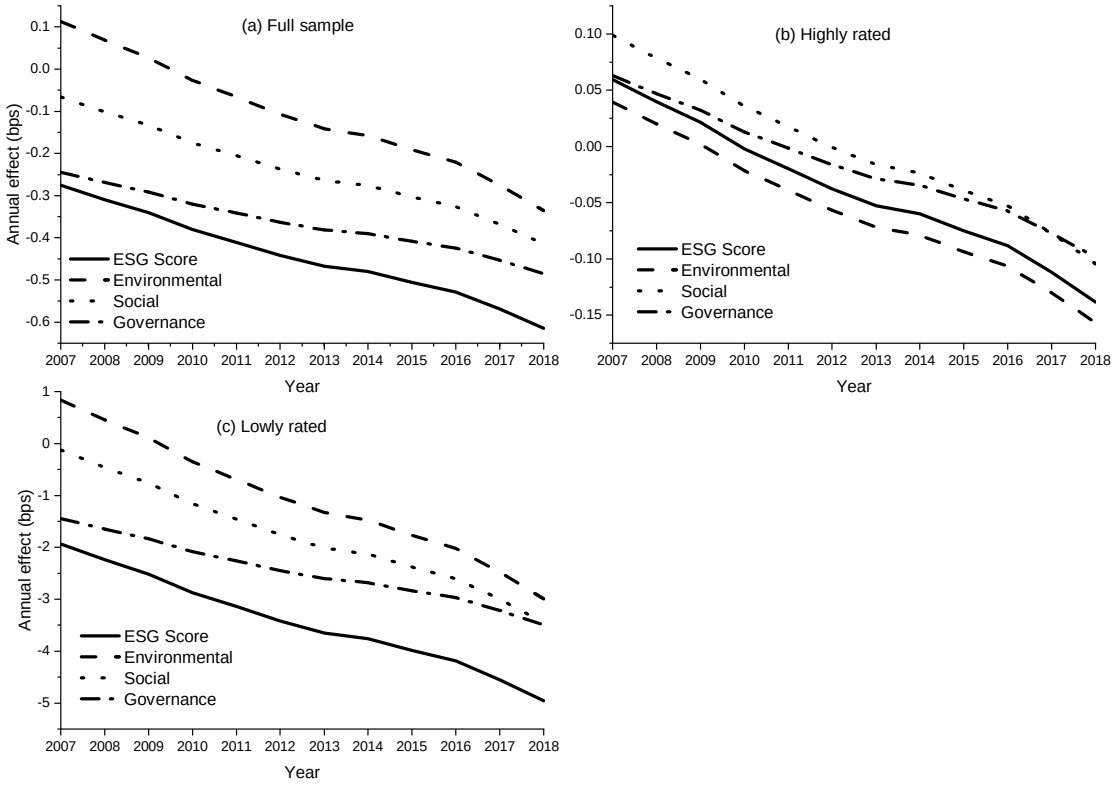
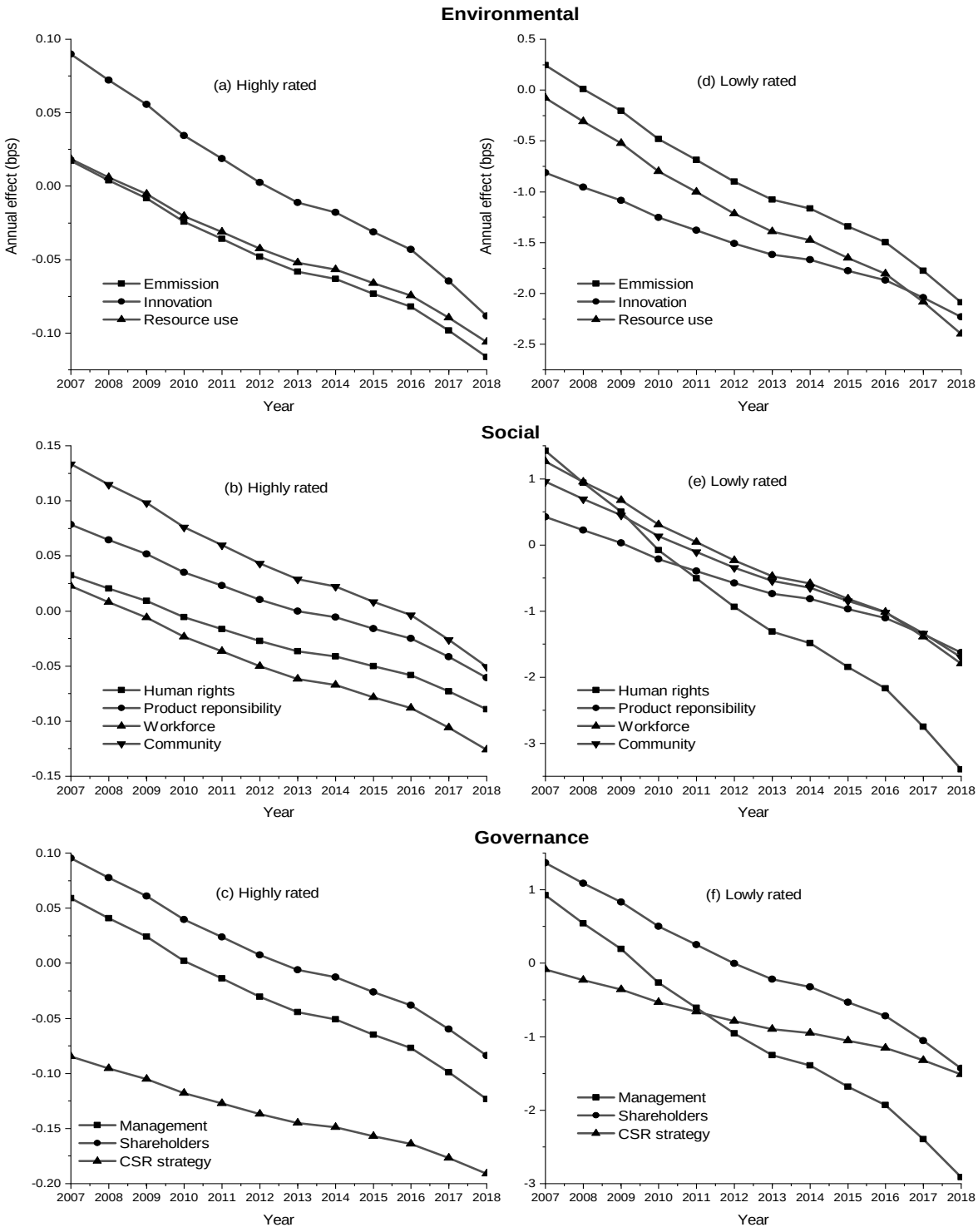
Figure 1: Time-varying annual effects of each ESG score by rating grade



Notes: Figures illustrate the time-varying annual effects of each ESG score on credit spreads induced by the development of ESG investments measured by the number of PRI signatories using the full sample (a), highly-rated issuer sample, i.e., above A-rated categories (b), and lowly-rated issuer sample, i.e., below BBB-rated categories (c). The annual effects of each ESG score are drawn as solid lines; while the dashed, dotted, and chain lines represent the environmental, social, and governance scores, respectively.

Figure 2: Time-varying annual effects by rating grade and underlying ESG categories



Notes: Figures show plots of the time-varying annual effects of the underlying ESG categories that formulate the three ESG pillars: environmental, social, and corporate governance. The sample of Panels (a)–(c) is the A-rated or above firm group, and that of Panels (d)–(f) is the BBB-rated or below firm group.

Table 1: Correlations of ESG score variables

	ESG Score	Environmental	Social	Governance
ESG Score	1			
Environmental	0.723***	1		
Social	0.890***	0.508***	1	
Governance	0.844***	0.392***	0.662***	1

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

$Notes$: The table presents the correlations of the company's ESG performance: *ESG score*, *Environmental*, *Social*, and *Governance* scores.

Table 2: Descriptive statistics

		Mean	Std. Dev.	Min	Max	N/n/$\bar{T}$
Credit spread (bp)	overall	46.1	91.7	7.1	1864.1	2353
	between		75.8	15.2	1040.4	245
	within		65.5	-793.3	1083.8	10
ESG score	overall	47.8	20.0	2.2	89.9	2353
	between		18.9	3.8	82.6	245
	within		7.7	0.5	87.2	10
Environmental score	overall	51.5	23.7	2.1	98.4	2353
	between		21.1	6.7	95.7	245
	within		11.8	-5.6	90.4	10
Governance score	overall	52.1	27.2	0	97.4	2353
	between		25.6	0	92.9	245
	within		10.7	-26.2	115.1	10
Social score	overall	40.3	22.4	0.26	93.9	2353
	between		20.5	2.0	85.6	245
	within		10.2	-6.0	86.4	10
Revenues (JPYbn)	overall	1713.5	2525.5	15	29000	2353
	between		2359.8	32.1	24000	245
	within		493.5	-3286.5	6713.5	10
EBIT margin	overall	0.08	0.09	-1.0	0.65	2353
	between		0.08	-0.03	0.61	245
	within		0.06	-0.89	0.57	10
Debt/Capital	overall	0.55	0.42	0	12.0	2353
	between		0.34	.002	2.31	245
	within		0.26	-1.39	10.2	10
Capex/Revenue	overall	0.07	0.08	0	1	2353
	between		0.07	0.001	0.67	245
	within		0.03	-0.18	0.56	10
ROIC	overall	4.2	4.5	-34.7	25.8	2353
	between		2.9	-7.1	19.1	245
	within		3.7	-27.4	21.9	10
Equity volatility	overall	26.4	6.9	10.8	55.0	2353
	between		6.3	13.4	49.5	245
	within		3.1	11.7	41.6	10

Notes: The table presents the summary statistics for the unbalanced panel data from 2007 to 2018. N, n, and $\bar{T}$ refer to the observations with firm-year data, the number of firms, and the average number of years per issuing firm, respectively.

Table 3: Credit spreads and sustainability measures: Panel OLS results

	(1) ESG score	(2) Environmental score	(3) Social score	(4) Governance score
Sustainability measurement	-0.65**	-0.11	-0.39**	-0.45**
	(0.279)	(0.124)	(0.172)	(0.189)
AAA rating	-1063.88***	-1063.89***	-1062.93***	-1069.27***
	(101.768)	(101.868)	(102.112)	(102.600)
AA rating	-1065.40***	-1063.53***	-1063.68***	-1070.40***
	(101.266)	(101.124)	(101.320)	(102.088)
A rating	-1050.07***	-1048.13***	-1048.08***	-1054.76***
	(100.624)	(100.458)	(100.666)	(101.370)
BBB rating	-1010.59***	-1007.96***	-1008.39***	-1016.31***
	(96.742)	(96.498)	(96.838)	(97.358)
BB rating	-660.39***	-664.31***	-660.46***	-668.76***
	(128.155)	(126.618)	(129.647)	(126.833)
B rating	-553.36***	-557.09***	-551.21***	-560.73***
	(123.684)	(124.189)	(125.117)	(123.812)
ln(Revenue)	49.32*	45.64*	47.76*	49.79*
	(26.067)	(25.698)	(25.919)	(26.038)
EBIT margin	-71.81	-73.62	-71.50	-74.88
	(96.934)	(96.879)	(97.302)	(97.303)
Debt/Capital	-1.36	-0.57	-1.25	-1.11
	(10.160)	(10.678)	(10.267)	(10.243)
Capex/Revenue	113.49	111.94	108.74	113.62
	(69.231)	(68.432)	(69.607)	(71.174)
ROIC	-2.54*	-2.53*	-2.50*	-2.56*
	(1.388)	(1.400)	(1.382)	(1.392)
Price volatility	0.33	0.39	0.27	0.35
	(0.823)	(0.819)	(0.837)	(0.812)
Δ GDP	-3.62***	-3.74***	-3.70***	-3.58***
	(0.573)	(0.568)	(0.571)	(0.576)
Δ CPI	-7.08***	-7.35***	-7.14***	-7.02***
	(2.502)	(2.530)	(2.512)	(2.487)
Δ NVIX	0.28***	0.30***	0.29***	0.28***
	(0.029)	(0.031)	(0.030)	(0.028)
Firm Fixed Effects	YES	YES	YES	YES
Observations	2353	2353	2353	2353
Adjusted R^2	0.60	0.60	0.60	0.60

Notes: The table presents the estimation results of Equation (1),

$$Credit\ spread_{it} = \alpha_i + \delta ESG\ score_{it} + \gamma Controls_{it} + \beta Macro_t + \epsilon_{it},$$

based on sustainability measurements (1) ESG, (2) Environmental, (3) Governance, and (4) Social scores of issuing firms, their financial indicators, and macroeconomic controls. Baseline rating category is below CCC. Standard errors (SE) clustered at the firm level in parenthesis. *** significant at 1%, ** significant at 5%, * significant at 10%.

Table 4: Credit spreads and sustainability measures: 2SLS results

	(1) ESG score	(2) Environmental score	(3) Social score	(4) Governance score
Sustainability	-1.82***	-2.28	-1.24***	-1.06***
measurement	(0.592)	(1.927)	(0.419)	(0.381)
AAA rating	-520.38***	-524.16***	-519.64***	-514.76***
	(137.460)	(133.123)	(140.258)	(136.691)
AA rating	-525.71***	-525.46***	-523.22***	-518.33***
	(137.624)	(129.951)	(140.064)	(136.475)
A rating	-511.65***	-514.24***	-508.38***	-503.45***
	(139.289)	(131.568)	(141.613)	(138.156)
BBB rating	-470.41***	-466.16***	-466.67***	-464.39***
	(139.135)	(131.277)	(141.443)	(137.934)
ln(Revenue)	48.56**	40.28*	45.03**	47.79**
	(21.858)	(21.176)	(21.385)	(20.133)
EBIT margin	-15.99	-18.01	-14.41	-22.42
	(56.549)	(54.816)	(56.920)	(56.200)
Debt/Capital	-0.63	-1.32	-0.05	0.36
	(8.127)	(8.453)	(8.104)	(8.113)
Capex/Revenue	118.35*	151.49**	104.27	117.11
	(68.023)	(68.451)	(69.579)	(71.869)
ROIC	-2.68**	-2.76**	-2.58**	-2.72**
	(1.321)	(1.371)	(1.301)	(1.342)
Price volatility	0.44	0.66	0.24	0.53
	(0.824)	(0.866)	(0.885)	(0.796)
Δ GDP	-3.65***	-3.95***	-3.82***	-3.59***
	(0.623)	(0.667)	(0.616)	(0.639)
Δ CPI	-6.56***	-7.64***	-6.64***	-6.52**
	(2.513)	(2.846)	(2.522)	(2.578)
Δ NVIX	0.25***	0.29***	0.26***	0.25***
	(0.029)	(0.035)	(0.029)	(0.030)
Firm Fixed Effects	YES	YES	YES	YES
Observations	2347	2347	2347	2347
Kleibergen-Paap underid.	56.80	4.08	72.96	58.80
p-val	0.00	0.04	0.00	0.00
Kleibergen-Paap weak id.	96.54	4.20	135.95	81.80

Notes: The table presents the estimation results of Equation (1),

$$Credit\ spread_{it} = \alpha_i + \delta ESG\ score_{it} + \gamma Controls_{it} + \beta Macro_t + \epsilon_{it},$$

based on 2SLS. Reported coefficients and standard errors are from second stage regressions from a 2SLS regression analysis of the influence of each sustainability measurement on corporate bond credit spreads which include the instrumented values of sustainability measurement as independent variable. Each sustainability measurement is instrumented with its corresponding average sustainability measurement of all other companies in the same sector and in the same year. Baseline rating category is below the BB-rated categories. SE clustered at the firm level in parenthesis. *** significant at 1%, ** significant at 5%, * significant at 10%.

Table 5: By credit rating levels

	High (above A rating)				Low (below BBB rating)			
	ESG score	Environmental score	Social score	Governance score	ESG score	Environmental score	Social score	Governance score
Sustainability measurement	-0.17*	-0.06	-0.09	-0.07	-3.25**	-0.57	-2.59**	-2.63**
	(0.086)	(0.052)	(0.057)	(0.062)	(1.324)	(0.634)	(1.126)	(1.159)
AAA rating	-5.07	-5.49	-5.36	-5.37				
	(4.775)	(4.643)	(5.372)	(5.112)				
AA rating	-8.97***	-8.91***	-9.02***	-9.00***				
	(2.715)	(2.682)	(2.691)	(2.687)				
BBB rating					-294.09***	-274.49***	-274.14***	-296.35***
					(30.764)	(29.664)	(28.810)	(32.558)
ln(Revenue)	4.13	3.04	3.68	3.70	175.02	183.34*	166.90	194.18*
	(6.593)	(6.573)	(6.645)	(6.801)	(106.024)	(105.532)	(107.306)	(105.807)
EBIT margin	38.21	37.85	38.18	37.44	-391.05	-358.42	-393.01	-385.53
	(67.001)	(66.813)	(67.042)	(67.154)	(411.465)	(416.650)	(404.242)	(415.197)
Debt/Capital	21.02**	22.04**	21.28**	21.61**	-12.59	-12.98	-12.57	-11.10
	(10.319)	(10.108)	(10.459)	(10.243)	(11.266)	(11.665)	(10.413)	(10.966)
Capex/Revenue	92.46	92.23	90.97	91.78	514.74**	600.16**	555.89**	510.46*
	(60.610)	(60.386)	(60.832)	(60.723)	(242.274)	(248.722)	(261.581)	(256.804)
ROIC	-0.71*	-0.70	-0.70*	-0.71*	-5.15	-6.04	-5.02	-5.32
	(0.425)	(0.424)	(0.424)	(0.423)	(5.065)	(5.331)	(4.734)	(5.149)
Price volatility	0.51**	0.51**	0.49**	0.51**	-6.50	-5.73	-7.48	-6.64
	(0.224)	(0.224)	(0.225)	(0.224)	(4.407)	(4.408)	(4.672)	(4.347)
Δ GDP	-2.82***	-2.84***	-2.83***	-2.82***	-9.46***	-9.80***	-9.73***	-8.90***
	(0.352)	(0.350)	(0.352)	(0.357)	(3.083)	(3.153)	(3.061)	(3.129)
Δ CPI	-2.95***	-3.01***	-2.98***	-2.97***	-31.74**	-30.54**	-30.38**	-30.11**
	(0.364)	(0.365)	(0.357)	(0.359)	(12.280)	(12.451)	(12.482)	(12.190)
Δ NVIX	0.19***	0.20***	0.19***	0.19***	0.77***	0.78***	0.74***	0.71***
	(0.015)	(0.015)	(0.015)	(0.015)	(0.168)	(0.191)	(0.179)	(0.175)
Firm Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES
Observations	2041	2041	2041	2041	312	312	312	312
Adjusted R^2	0.55	0.55	0.55	0.55	0.68	0.68	0.68	0.68

Notes: The table shows OLS estimations of Equation (1),

$$Credit\ spread_{it} = \alpha_i + \delta ESG\ score_{it} + \gamma Controls_{it} + \beta Macro_t + \epsilon_{it},$$

by issuer's credit rating levels. The first four columns present results using the firm-level credit spreads for highly-rated issuers, while the last four columns for lowly-rated issuers. SE clustered at the firm level in parenthesis. *** significant at 1%, ** significant at 5%, * significant at 10%.

Table 6: Effects of signatory to the United Nation's Principles for Responsible Investment

	(1) ESG score	(2) Environmental score	(3) Social score	(4) Governance score
Sustainability	-0.24	0.16	-0.03	-0.22
measurement	(0.356)	(0.151)	(0.227)	(0.230)
Sustainability	-0.0002**	-0.0003***	-0.0002**	-0.0001**
measurement× PRI	(0.00009)	(0.00008)	(0.00009)	(0.00006)
AAA rating	-1083.30***	-1090.26***	-1080.93***	-1082.22***
	(104.392)	(104.909)	(105.396)	(104.311)
AA rating	-1080.42***	-1086.23***	-1077.53***	-1079.67***
	(103.021)	(103.400)	(103.523)	(103.146)
A rating	-1061.02***	-1065.76***	-1058.86***	-1060.71***
	(101.908)	(102.172)	(102.346)	(102.032)
BBB rating	-1021.00***	-1025.99***	-1018.31***	-1021.60***
	(98.297)	(98.510)	(98.605)	(98.133)
BB rating	-663.26***	-669.26***	-662.65***	-667.12***
	(129.009)	(128.269)	(130.155)	(128.222)
B rating	-550.62***	-555.45***	-549.50***	-554.20***
	(122.173)	(121.804)	(123.395)	(122.918)
ln(Revenue)	55.25**	54.76**	53.49*	54.88**
	(27.437)	(27.211)	(27.437)	(27.103)
EBIT margin	-70.38	-66.80	-71.93	-74.38
	(97.298)	(97.649)	(97.436)	(97.309)
Debt/Capital	-3.19	-3.49	-2.78	-2.65
	(9.109)	(9.007)	(9.381)	(9.384)
Capex/Revenue	109.91	103.76	109.13	110.83
	(67.874)	(64.229)	(69.008)	(70.020)
ROIC	-2.51*	-2.55*	-2.47*	-2.52*
	(1.367)	(1.378)	(1.362)	(1.370)
Price volatility	0.15	0.09	0.13	0.24
	(0.861)	(0.862)	(0.873)	(0.847)
Δ GDP	-3.23***	-3.14***	-3.33***	-3.27***
	(0.602)	(0.596)	(0.604)	(0.601)
Δ CPI	-5.99***	-5.51**	-6.27***	-6.18***
	(2.290)	(2.233)	(2.318)	(2.368)
Δ NVIX	0.26***	0.25***	0.27***	0.27***
	(0.029)	(0.028)	(0.029)	(0.029)
Firm Fixed Effects	YES	YES	YES	YES
Observations	2353	2353	2353	2353
Adjusted R^2	0.60	0.60	0.60	0.60

Notes: The table presents the estimation results of Equation (2),

$$Credit\ spread_{it} = \alpha_i + \delta_1 ESG\ score_{it} + \delta_2 PRI_t ESG\ score_{it} + \gamma Controls_{it} + \beta Macro_t + \epsilon_{it},$$

based on sustainability measurements (1) ESG, (2) Environmental, (3) Governance, and (4) Social scores of issuing firms, the interaction between sustainability measurement and the number of signatories to the PRI, their financial indicators, and macroeconomic controls. Baseline rating category is the below CCC-rated categories. SE clustered at the firm level in parenthesis. *** significant at 1%, ** significant at 5%, * significant at 10%.

Table 7: By credit rating levels

	High (above A rating)				Low (below BBB rating)			
	ESG score	Environmental score	Social score	Governance score	ESG score	Environmental score	Social score	Governance score
Sustainability	0.08	0.06	0.12	0.08	-1.62	1.24	0.22	-1.23
measurement	(0.139)	(0.062)	(0.111)	(0.086)	(1.111)	(0.853)	(1.144)	(1.139)
Sustainability	-0.0001***	-0.0001***	-0.0001***	-0.0001***	-0.0017***	-0.0022***	-0.0019**	-0.0012**
measurement× PRI	(0.00004)	(0.00003)	(0.00004)	(0.00003)	(0.0005)	(0.0007)	(0.0008)	(0.0006)
AAA rating	-10.05	-9.34	-9.55	-10.06				
	(7.792)	(6.826)	(7.892)	(7.623)				
AA rating	-11.27***	-11.07***	-10.74***	-11.19***				
	(3.034)	(3.035)	(2.941)	(2.996)				
BBB rating					-337.00***	-342.76***	-326.44***	-327.30***
					(37.143)	(39.586)	(40.412)	(35.487)
ln(Revenue)	8.00	7.43	7.33	7.78	166.63	174.22*	167.90	180.48
	(6.985)	(6.702)	(7.070)	(7.150)	(104.551)	(99.510)	(105.966)	(107.993)
EBIT margin	37.62	39.40	36.56	36.85	-412.16	-358.01	-399.38	-403.29
	(67.523)	(67.515)	(67.319)	(67.484)	(409.422)	(413.652)	(407.794)	(409.293)
Debt/Capital	16.47*	16.08*	17.67*	17.30*	-13.09	-15.54	-14.91*	-12.02
	(9.573)	(9.600)	(9.802)	(9.529)	(8.469)	(9.427)	(8.679)	(9.105)
Capex/Revenue	92.89	91.84	93.70	92.19	367.85	351.66	415.96*	401.58
	(59.974)	(58.689)	(60.682)	(60.204)	(239.283)	(219.088)	(231.973)	(258.528)
ROIC	-0.70	-0.73*	-0.68	-0.70	-3.83	-4.91	-4.42	-4.52
	(0.428)	(0.428)	(0.426)	(0.426)	(4.295)	(4.660)	(4.282)	(4.588)
Price volatility	0.39*	0.38*	0.39*	0.43*	-8.79*	-9.34*	-8.94*	-8.24*
	(0.219)	(0.227)	(0.217)	(0.221)	(4.626)	(4.894)	(4.972)	(4.731)
Δ GDP	-2.59***	-2.60***	-2.63***	-2.61***	-7.84**	-7.27**	-8.41**	-7.84**
	(0.330)	(0.333)	(0.329)	(0.338)	(3.132)	(3.224)	(3.133)	(3.178)
Δ CPI	-2.40***	-2.30***	-2.56***	-2.49***	-24.46*	-19.90	-23.26*	-23.89*
	(0.376)	(0.390)	(0.363)	(0.390)	(12.767)	(11.983)	(12.753)	(13.449)
Δ NVIX	0.18***	0.18***	0.19***	0.18***	0.57***	0.47**	0.60***	0.56***
	(0.013)	(0.013)	(0.014)	(0.013)	(0.181)	(0.206)	(0.189)	(0.202)
Firm Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES
Observations	2041	2041	2041	2041	312	312	312	312
Adjusted R^2	0.56	0.55	0.56	0.56	0.68	0.68	0.68	0.69

Notes: The table shows the estimation results of Equation (2),

$$Credit\ spread_{it} = \alpha_i + \delta_1 ESG\ score_{it} + \delta_2 PRI_t ESG\ score_{it} + \gamma Controls_{it} + \beta Macro_t + \epsilon_{it},$$

based on sustainability measurements (1) ESG, (2) Environmental, (3) Governance, and (4) Social scores of issuing firms, the interaction between sustainability measurement and the number of signatories to the PRI, their financial indicators, and macroeconomic controls by issuer's credit rating levels. The first four columns present results using firm-level credit spreads for highly-rated issuers, while the last four columns show the results for lowly-rated issuers. SE clustered at the firm level in parenthesis. *** significant at 1%, ** significant at 5%, * significant at 10%.