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ISSN 1972-6643 (online)

Designed by the Printing and Publishing Division of the Bank of Italy

ESG RISKS AND CORPORATE VIABILITY: INSIGHTS FROM DEFAULT PROBABILITY TERM STRUCTURE ANALYSIS

by Fabrizio Ferriani* and Marcello Pericoli**

Abstract

We analyse the impact of ESG risks on the term structure of default probabilities of European non-financial corporations between 2014 and 2022. Our findings reveal that higher ESG scores reduce a company's inherent risk implicit in its probability of default, with more pronounced effects as the time horizon for default probability increases. The impact of ESG risks on corporate viability fluctuates over time and tends to intensify after major events relating to sustainability risks, such as the Paris Agreement or the COVID-19 pandemic. Additionally, our analysis shows that ESG considerations influence not only the objective or physical probability of default but also the credit risk premium required by investors. This aligns with heightened awareness and stronger investor concerns about sustainability, especially in recent years.

JEL Classification: C22, C58, G12, E31, E44.

Keywords: ESG scores, default probability, term structure, credit risk premium.

DOI: 10.32057/0.QEF.2024.892

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1 Introduction[1]

Traditionally, structural models of credit risk have focused on the impact of financial and accounting metrics to analyze the determinants of firm-level probability of default. The assessment of credit risk, a fundamental aspect of financial markets, has nevertheless evolved significantly over the years. Increasing attention is now being paid to the role that non-financial factors, particularly Environmental, Social, and Governance (ESG) metrics, can play in determining a firm's long-term viability and creditworthiness.

ESG factors encompass a wide range of issues, including climate change, resource management, social responsibility, corporate governance, and ethical business practices. Although there are some differences in methodological frameworks, the literature generally identifies two main channels to explain why firms may be motivated to embrace ESG objectives and how these considerations influence financial asset prices (Albuquerque et al., 2019, Pastor et al., 2021, Pastor et al., 2022, Pedersen et al., 2021 and Goldstein et al., 2022 among many others). First, ESG factors might capture risks not fully accounted for by traditional credit metrics, but which can have material impacts on corporate asset prices ("*risk channel*"). These risks include increasing compliance and operational costs due to adverse shifts in environmental regulation, risks of company assets being stranded by new low-carbon technologies, or legal and reputational costs linked to poor social performance and employee relations. As a result of these risk exposures, companies with low ESG ratings may face reputational damages, fines and penalties, investor boycotts, and divestments. This not only affects asset allocation decisions as investors strive to align with ESG criteria, but it also has significant asset-pricing implications, with poor ESG

[1]We thank Paolo Angelini, Monica Billio, Andrea Giacomelli, Fabio Natalucci, Federico Signorini, Marco Taboga, Andrea Paltrinieri, Giovanni Veronese, and participants in seminars at Banca d'Italia, Luiss, and the IMF-Banca d'Italia conference on embedding sustainability in credit risk assessment for useful comments. The views expressed in the paper are those of the authors only and do not involve the responsibility of Banca d'Italia. All errors are our own responsibility.

performance resulting in lower market value, volatile cash flows, and a greater probability of default. The second channel relates to investors' preference towards sustainable assets ("*preference channel*"). Some investors with strong ESG preferences derive utility from holding assets of more sustainable firms and decide to include highly-scored ESG firms in their portfolio allocation. They may combine this approach with or as an alternative to traditional risk-return considerations. Consequently, they may be willing to pay a premium to include these assets in their portfolio or they may engage in negative screening of firms with poor ESG performance.

In this paper, we focus on the interlink between ESG scores and corporate default risk for European listed non-financial corporations from 2014 to 2022. We conduct two main exercises. First, we include the ESG score as a systematic factor, along with company's expected P&L variables and current balance sheet indicators, and we measure its impact on firms' probability of default obtained from Moody's Expected Default Frequency (EDF), hereafter referred to as probability of default (PD). We consider four different maturities - 1 year, 3 years, 5 years, and 10 years - to investigate the impact of ESG scores on the whole term structure of corporate PDs. Importantly, Moody's PD differs differs from the so-called risk-neutral probability of default used to price corporate default swaps (CDS), which is greater than the actual (physical) probability because it includes a risk-adjustment (i.e. compensation required by investors beyond that for expected losses). In this way, we obtain an estimate of the first channel, i.e. the influence of ESG risks on firms' creditworthiness via its impact on corporate cash flows and profitability. We find that companies' ESG scores significantly affect their PDs especially at longer maturities: a one standard deviation increase in the ESG score is linked to a reduction in the PD of around 4 basis points at the 1-year horizon and up to approximately 15 basis points at the 10-year horizon. In economic terms, this corresponds to up to a 15% reduction in the average PD, depending on the specification. These results, based on a clearer identifica-

tion of firms' inherent credit risk compared to that obtained from CDS spreads, seem to confirm the idea of sustainability as a long-term risk factor for corporate viability (Gao et al., 2021, Li et al., 2022, Kanno, 2023, Edmans, 2023).

As a second exercise, we present an estimate of how ESG factors influence the credit risk premium. This part of the analysis focuses on the preference or non-pecuniary channel of ESG investing and is essential to understand how a shift in investor preferences and consumer tastes towards the so-called ESG paradigm can have significant asset pricing implications. To this purpose, we rely on CDS spreads which incorporate both firms' credit risk and investors' required compensation to hold risky assets. We filter out the intrinsic risk component implicit in corporate PDs along the methodology described in Berndt et al., 2005 and obtain a proxy of the credit risk premium. We find that corporate ESG scores are negatively related to the risk premium, suggesting that investors demand higher compensation for firms with higher sustainability risks.

Our work connects with studies focusing on the integration of ESG considerations into the credit risk pricing of non-financial firms. The literature in this field, focused especially on the US market, has analyzed the interplay between corporate sustainability and several proxies of firms' creditworthiness. Although previous results have not always been unanimous in identifying the sign and size of the impact of ESG scores on corporate asset prices, there is more evidence of a negative effect of corporate sustainability on firms' default risks, credit spreads, and ultimately cost of capital (see Matos, 2020 or Gillan et al., 2021 for comprehensive reviews). For example, Gao et al. (2021), Barth et al. (2022), Caiazza et al. (2023), and Kölbel et al. (2024) document a mitigating effect of higher ESG scores and sustainability information disclosure on corporate CDS spreads. Goss and Roberts (2011), Oikonomou et al. (2014), Chava (2014), Apergis et al. (2022), Ferriani (2023), Altavilla et al. (2023) find that firms with high ESG scores are perceived

as less risky and benefit from a lower cost of capital, either measured as corporate bond spread or loan rates. Jiraporn et al. (2014), Stellner et al. (2015), Kiesel and Lücke (2019), Carbone et al. (2021), Seltzer et al. (2022), and Michalski and Low (2024) show that high ESG scores act as a positive determinant of corporate credit ratings.

We depart from previous contributions and add to the literature along multiple lines. First, we analyse a comprehensive spectrum of corporate PDs from 1 year up to 10 years. This allows us to focus on corporate inherent credit risks and study the impact of ESG risks on a proxy of creditworthiness that is not affected by liquidity issues, contract specificities, or assumptions over a benchmark risk-free yield curve to compute credit spreads. Moreover, analyzing the whole term structure of corporate PDs allows us to tackle the interplay of sustainability and creditworthiness with a forward-looking perspective, taking into account the trade-off between the long-term benefits of corporate investments in sustainability and the corresponding short-term costs and expenses which could exert downward pressure on the firm's viability and profitability.

Second, we do not limit the analysis to an average time-invariant estimate of how ESG considerations affect firms' creditworthiness, but we also present its dynamic evolution. This aspect is crucial as both the regulatory approach towards sustainability, particularly regarding climate and the environment, as well as investors' and consumers' preferences evolve over time. Episodes of green enthusiasm and wake-up calls for ESG considerations such as the Paris 2015 agreement or the Covid-19 recovery alternate with periods of retrenchment of the green agenda such as the one resulting from the advent of the Trump Administration in the US or the more recent backlash against ESG criteria, with material impacts on the prices of financial assets and investment flows towards sustainable investments (Eskildsen et al., 2024, Financial Times, 2023, Matos, 2023, Tang et al., 2024, and Kölbel et al., 2024).

Third, while most empirical studies rely on traded securities to estimate the impact of ESG risks on firms' viability and cost of capital - implicitly accounting for investors' required compensation for sustainability risks - we provide more comprehensive evidence. Our analysis is not limited to the perspective of a representative risk-neutral investor, as the one implied by the CDS spreads we use to estimate the ESG risk premium. It also examines the credit risk for a representative risk-averse investor implied in the term structure of firms' PDs, which is equivalent to assessing the interplay between ESG risks and creditworthiness using an objective measure of risk according to the probability jargon. This distinction is not merely semantic; it is essential to disentangle the two transmission mechanisms through which sustainability affects asset prices: the *risk channel* and the *preference channel*. We generally find that the impact of sustainability profiles on corporate intrinsic credit risk has increased over time, possibly due to the enforcement of more stringent environmental regulations, although this trend is not strictly monotonic. The estimate of the ESG premium is on average negative, with investors demanding higher compensation for firms with higher sustainability risks, though the estimate of the premium is very volatile, reflecting the ebbs and flows in investors' attitudes towards ESG topics.

Fourth, our analysis utilizes multiple metrics of ESG risks, not only at the aggregate or composite level but also at the subdimensional level - specifically, the environmental, social, and governance dimensions. The use of different metrics to measure the asset pricing implications of sustainability risks is rare in empirical analyses despite numerous studies documenting ESG score misalignment across different data providers, see Berg et al. (2022), Billio et al. (2021), and Gibson Brandon et al. (2021) among many others. We document robust evidence of the mitigating effect of higher ESG scores on corporate PDs across all rating providers, with environmental and social risks exerting a major influence. Importantly, all our findings remain consistent despite various model perturbations and

sample partitions with respect to both time frame and firms' industrial sectors.

Our study underscores the critical importance of analyzing the relationship between companies' probability of default and their sustainability performance. This relationship has significant implications for the value and cost of capital of firms as well as for the asset allocation and risk management practices of investors, particularly those who prioritize long-term investment objectives (e.g. Renneboog et al., 2011, Riedl and Smeets, 2017). Policymakers, standard-setting bodies, and regulators are increasingly focused on promoting sustainable finance and developing regulatory and accounting frameworks to support the disclosure of ESG information, acknowledging that sustainability risks may have material financial impacts on firms (ISSB, 2023, EBA, 2024, G20 SFWG, 2024). As a result, rating agencies and financial institutions are taking ESG criteria into account when evaluating a firm's creditworthiness, recognizing that ESG-related risks can have material impacts on financial performance and credit risk (PRI Association, 2016, Chodnicka-Jaworska, 2021). Our study demonstrates that analyzing the impact of ESG risks across the entire term structure of corporate PDs provides a comprehensive and forward-looking assessment of a firm's risk profile, enhancing risk identification and management beyond simple reliance on traditional financial metrics.

The rest of this paper is structured as follows. Section 2 describes the dataset and presents some stylized facts, Section 3 details our empirical methodology and reviews the main results, Section 4 delves into the analysis of risk premia associated with sustainability and, finally, Section 5 concludes.

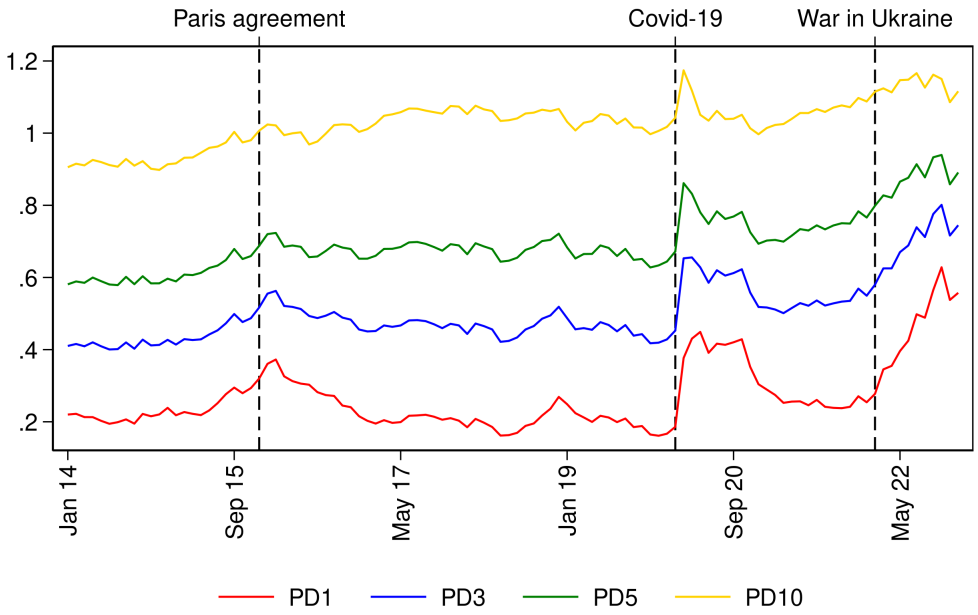

FIGURE 1: *The figure plots the sample average probability of default across different time horizons (1, 3, 5, and 10 years).*

2 Data

Our sample consists of all European non-financial companies listed in the Eurostoxx 600 index between 2014 and 2022. This time frame encompasses various sustainability-related events that could impact companies' risk profiles and profitability or influence how investors integrate ESG risks into their portfolio decisions. These events include the 2015 Paris Agreement, the US Trump administration's reneging on climate commitments, the global expansion of climate change protests through initiatives like climate strikes, the Covid-19 pandemic, Russia's invasion of Ukraine in 2022, and the subsequent European energy crisis.

We analyze the term structure of corporate default probabilities considering both short-term and long-term time horizons. Specifically, we extract the average monthly probability of default for 1-, 3-, 5-, and 10-year horizons from Moody's CreditEdge database.

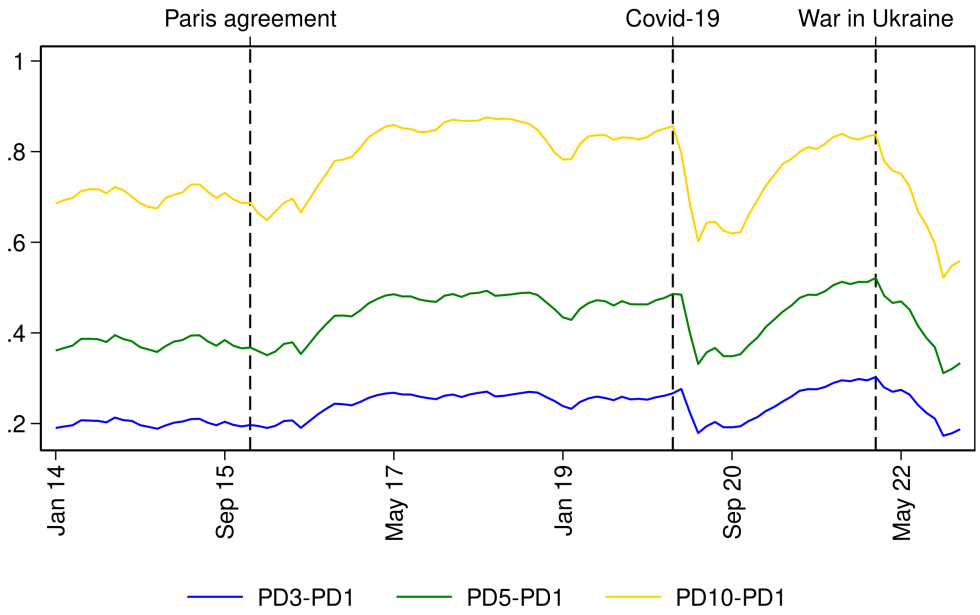

FIGURE 2: *The figure plots the slope of the term structure defined as the difference between the probability of default in 3, 5 and 10 years and the probability of default in 1 year (PD3-PD1, PD5-PD1, PD10-PD1).*

Firms' PDs can be decomposed into three components: i) a long-run central default tendency, ii) an aggregate factor capturing the state of the credit cycle, and iii) a firm-specific factor measuring the credit risk of the firm relative to the current stage of the credit cycle (Moody's, 2015). Although the PDs are available daily, we opt for a monthly frequency to better align with the lower frequency of firms' credit risk determinants, which are typically reported monthly or annually. As mentioned, using the corporate PDs at different horizons allows us to examine the whole term structure of corporate credit risks and to base the analysis on forward-looking measures that are uniformly defined across firms, enhancing comparability within the sample. Figure 1 shows the dynamics of the average PDs over the four maturities, while Figure 2 displays the slope of the term structure defined as the difference between the probability of default in 3, 5 and 10 years and the probability of default in 1 year. The term structure has a positive slope, indicating that longer horizons generally correspond to a higher probability of default. The upward slop-

ing term structure is typical of safer firms where credit risk generally increases over time. In contrast, for riskier firms, the term structure is generally downward sloping, implying that they can either default in the short run or improve, so on average, we expect credit risk to decline for these firms (Han and Zhou, 2015, Moody's, 2015, Gao et al., 2021). The slope is relatively stable across maturities, although we observe two major drops during the Covid-19 pandemic and the European energy crisis. During these periods of extreme market turbulence and financial instability, concerns about firms' short-term viability prevailed over their long-term outlook (Acharya and Steffen, 2020, ECB, 2022, Ferriani and Gazzani, 2023a). Across the entire time frame, the average PDs range from around 0.3% for the 1-year horizon to 1.0% for the 10-year horizon. While these values may seem modest at a first glance, it should be recalled that they refer to major and solid companies included in the most representative equity benchmark in Europe, so relatively higher values should not be expected[2]

Overall corporate sustainability risk exposure is evaluated using annual composite ESG ratings obtained from London Stock Exchange Group (LSEG) data and analytics, which employs a rating scale ranging from 0 to 100, with higher scores indicating better ESG performance. Figure 3 displays the distribution of firms' ESG scores over the entire sample period: most firms receive a sustainability assessment well above 50, with the score distribution showing clear negative skewness. From LSEG we also obtain firms' scores on the three individual dimensions of sustainability - environmental, social, and governance. For robustness tests, we use alternative ESG composite scores obtained from Bloomberg, Sustainalytics, and Robeco. Additionally, we utilize LSEG to gather financial and accounting data from annual company financial statements and IBES to gather monthly analysts' expectations of forward company ratios. Estimates of the ESG risk premium in Section

[2]Thresholds to distinguish non-investment grade firms are nevertheless not particularly high and equal to around 1.1% based on Moody's static mapping for the 1-year horizon.

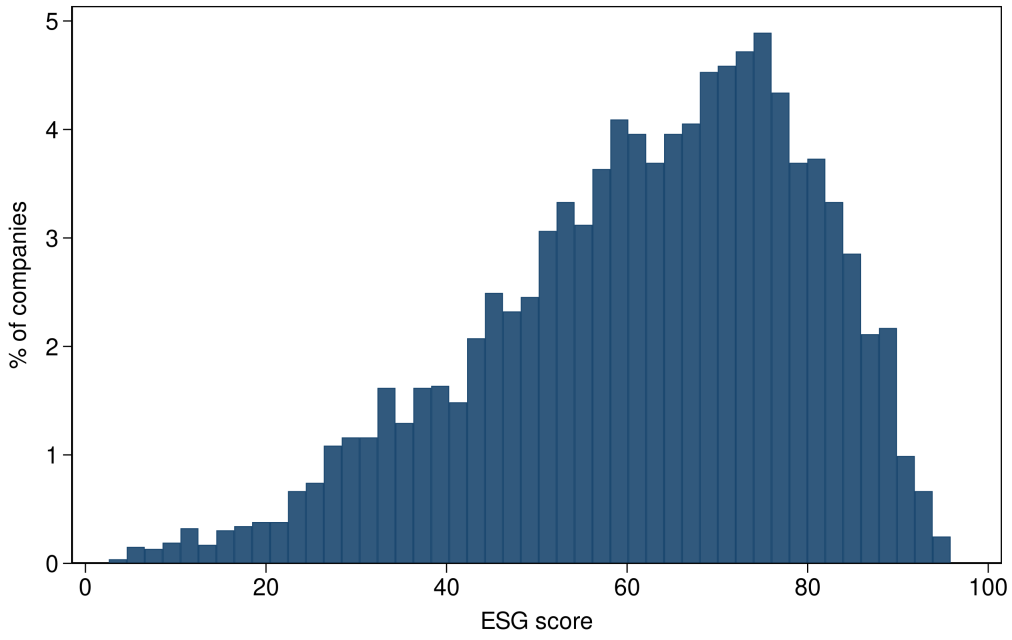

FIGURE 3: *The figure plots the frequency distribution of the LSEG ESG composite score. ESG scores range on a 0-100 scale, with higher values associated with lower sustainability risks.*

4 are based on CDS spreads obtained from LSEG. Detailed descriptive statistics for the primary variables used in the empirical analysis are presented in Table 1, whereas Table 2 displays the correlation matrix across PD horizons, LSEG ESG composite scores, and its sub-dimensions.

3 Empirical analysis

This section reviews our empirical results and it is divided into two subsections. The first one presents the pooled time-average estimates based on the entire set of observations, complementing our baseline estimates with a comprehensive set of robustness exercises. The second subsection focuses on the dynamic impact of the ESG scores on the term

	Mean	St. Dev.	25p	50p	75p
PD 1	0.3	0.1	0.2	0.2	0.3
PD 3	0.5	0.1	0.4	0.5	0.5
PD 5	0.7	0.1	0.7	0.7	0.7
PD 10	1.0	0.1	1.0	1.0	1.1
ESG score	62.0	17.9	50.8	64.5	75.5
Leverage	0.3	0.2	0.1	0.3	0.4
Buy recomm.	2.5	0.5	2.2	2.5	2.8
Total assets	16269.6	37513.1	2023.1	5101.6	12648.7
Working capital	661.9	2730.4	-54.2	230.2	809.4
PPE/Assets	0.2	0.2	0.1	0.2	0.3
ICR	60.4	614.9	4.0	8.6	21.7
EPS (fwd)	18.8	52.5	1.1	3.2	11.2
PE (fwd)	19.2	170.9	12.5	16.5	22.0
ROE (fwd)	16.9	74.5	8.6	13.7	20.2

Table 1: The Table displays descriptive statistics (mean, standard deviation, 25, 50, and 75 percentile) for the probabilities of default over 1-, 3-, 5-, and 10-year horizons (PD1, PD3, PD5, PD10), the ESG score, the leverage ratio (total debt over total assets), the LSEG analysts' buy recommendations for company stocks (higher values associated with stronger buy recommendation), total assets (millions of Euro), working capital (defined as current assets minus current liabilities in millions of Euro), the ratio between property, plant, and equipment (PPE) and total assets, the Interest Coverage Ratio (ICR), the IBES 1-year forward expected Earning Per Share (EPS fwd), the IBES 1-year forward Price Earnings ratio (PE fwd), the IBES 1-year forward Return On Equity (ROE fwd).

	PD 1	PD 3	PD 5	PD 10	ESG score	Env. score	Soc. score	Gov. score
PD 1	1							
PD 3	0.96	1						
PD 5	0.91	0.99	1					
PD 10	0.76	0.88	0.94	1				
ESG score	-0.01	-0.03	-0.06	-0.17	1			
Env. score	-0.02	-0.04	-0.06	-0.16	0.82	1		
Soc. score	-0.03	-0.06	-0.09	-0.19	0.89	0.67	1	
Gov. score	0.05	0.04	0.02	-0.03	0.66	0.29	0.38	1

Table 2: The Table displays correlation across firms' probability of default at different time horizons, LSEG ESG composite score, and its sub-dimensional counterparts (environment, social, governance).

structure of corporate PDs.

3.1 Baseline estimates

As a first exercise, we estimate a pooled regression model to assess the time-average impact of ESG scores on corporate PD:

$$PD_{i,t,y} = \alpha_0 + S_i + C_i + T_{t,y} + \beta ESG_{i,y-1} + \gamma_0 Z_{i,y-1} + \gamma_1 X_{i,t-1,y} + \varepsilon_{i,t,y} \quad (1)$$

where $PD_{i,t,y}$ is the probability of default of company i in month t at year y, S_i are industrial sector fixed-effects, C_i are country fixed-effects, $T_{t,y}$ are monthly time fixed-effects, $ESG_{i,y-1}$ is the lagged yearly ESG score, $Z_{i,y-1}$ is a vector of lagged control variables with yearly frequency, including leverage, firm size (total assets), working capital (current assets minus current liabilities), corporate liquidity proxied by the interest coverage ratio (ICR), and the amount of property, plant and equipment over the total assets (PPE/assets), $X_{i,t-1,y}$ are lagged control variables with monthly frequency, such as 1-year forward EPS, P/E ratio, ROE, and analysts' buy/sell recommendations;[3] finally, $\varepsilon_{i,t,y}$ is a standard error term. We use lagged ESG scores to rule out endogeneity concerns related to the joint determination of PDs and sustainability attributes. LSEG ESG composite scores are adopted in our baseline estimates, but we present some robustness tests using alternative ESG ratings. We use the same empirical specification for all four time horizons and we standardize all explanatory variables to ensure comparability across regressors; the inference is based on robust standard errors.

The first set of estimates is reported in Table 3, which shows how sustainability considerations actually influence firms' inherent credit risk, with a statistically significant effect

[3] Higher values of the analysts' recommendations signal positive valuation of the company (buy signal).

Table 3: Impact of ESG scores on corporate PDs - baseline estimates

VARIABLES	(1) PD 1	(2) PD 3	(3) PD 5	(4) PD 10
ESG score	-0.039***	-0.068***	-0.092***	-0.152***
	(0.003)	(0.004)	(0.004)	(0.003)
Leverage	0.175***	0.218***	0.213***	0.162***
	(0.006)	(0.006)	(0.006)	(0.005)
ICR	-0.024***	-0.054***	-0.073***	-0.075***
	(0.006)	(0.008)	(0.010)	(0.012)
Total assets	-0.046***	-0.069***	-0.081***	-0.094***
	(0.003)	(0.004)	(0.004)	(0.004)
Working capital	-0.054***	-0.069***	-0.071***	-0.066***
	(0.002)	(0.003)	(0.003)	(0.003)
PPE/assets	-0.053***	-0.052***	-0.046***	-0.036***
	(0.005)	(0.005)	(0.005)	(0.004)
Buy recomm.	-0.114***	-0.120***	-0.108***	-0.074***
	(0.005)	(0.005)	(0.005)	(0.004)
EPS (fwd)	-0.063***	-0.081***	-0.085***	-0.074***
	(0.003)	(0.003)	(0.003)	(0.003)
PE (fwd)	-0.008*	-0.012*	-0.012*	-0.010
	(0.005)	(0.006)	(0.007)	(0.007)
ROE (fwd)	-0.032***	-0.037***	-0.036***	-0.028***
	(0.009)	(0.011)	(0.011)	(0.009)
Constant	0.168***	0.369***	0.530***	0.728***
	(0.049)	(0.056)	(0.055)	(0.044)
Observations	58,386	58,386	58,386	58,386
R-squared	0.22	0.28	0.32	0.40
Time FE	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES
Country FE	YES	YES	YES	YES

The table reports parameter estimates and standard errors of the model presented in Equation 1. For each variable, the first row reports the estimated standardized coefficient on the PD at different maturities (1, 3, 5 and 10 years); the second row reports robust standard errors in parentheses. All models include time, industry and country fixed-effects (*FE*). *, **, and *** denote significance at, respectively, the 10%, 5% and 1% level. The variables are the LSEG ESG score, the *leverage* ratio equal to total debt over total assets, the interest coverage ratio *ICR*, firm size measured as *total assets*, working capital (current assets minus current liabilities), the amount of property, plant and equipment over total assets (*PPE/assets*), the LSEG analysts' buy recommendations for company stocks *Buy recomm.*, the IBES 1-year forward expected earning per share *EPS (fwd)*, the IBES 1-year forward price earnings ratio *PE (fwd)*, the IBES 1-year forward return on equity *ROE (fwd)*.

that is more pronounced for longer maturities. A one standard deviation increase in the ESG score is linked to a lower PD around 4 basis points at the 1-year horizon, while this

effect increases to approximately 15 basis points at the 10-year horizon. From an economic standpoint, this impact is quite significant, and corresponds to a reduction up to 15% in the average PD, depending on the specification. Not surprisingly, these results suggest that sustainability primarily affects corporate viability as a long-term risk factor, akin to company size, whereas factors such as high debt, profitability, or analyst recommendations place greater pressure on firm viability in the short and medium term.

As depicted in Figure 1, firms generally exhibit an upward-sloping term structure of default probabilities, indicating that longer horizons are typically associated with higher risk. To gauge how probabilities respond across different time horizons, we examine the influence of sustainability on the relative change in the default probability across maturities. To this end, Table 4 presents the impact of the ESG score on the slope of the term structure, defined as the difference in the level of PD over the 3-, 5-, and 10-year horizons compared to the 1-year horizon. The estimates reveal that ESG scores exert a negative effect on the slope of the probability of default. These findings, in conjunction with the baseline estimates reported in Table 3, suggest that higher sustainability scores tend to flatten the term structure of the default probability, primarily due to their impact on longer-term risks.

We next examine how the influence of sustainability criteria on corporate credit risk has evolved over time, acknowledging that the Covid-19 pandemic in 2020 undoubtedly marked a significant turning point in the relative importance of the ESG paradigm.. After a period of intense turbulence between February and March 2020, during which the focus of financial markets was particularly on corporate liquidity stress, sustainability subsequently emerged as a critical factor in bolstering business resilience and in fostering growth following the pandemic shock (a "green wake-up call"), see Albuquerque et al. (2020), Ferriani and Natoli (2021), Mohommad and Pugacheva (2022) among many oth-

Table 4: Impact of ESG scores on the slope of the PD term structure

VARIABLES	(1) PD3 - PD1	(2) PD5 - PD1	(3) PD10 - PD1
ESG score	-0.029***	-0.054***	-0.114***
	(0.001)	(0.002)	(0.002)
Leverage	0.043***	0.038***	-0.014***
	(0.002)	(0.002)	(0.003)
ICR	-0.030***	-0.049***	-0.051***
	(0.004)	(0.006)	(0.010)
Total assets	-0.023***	-0.035***	-0.049***
	(0.001)	(0.002)	(0.002)
Working capital	-0.015***	-0.018***	-0.012***
	(0.001)	(0.001)	(0.002)
PPE/assets	0.001	0.007***	0.017***
	(0.002)	(0.002)	(0.003)
Buy recomm.	-0.006***	0.006***	0.040***
	(0.001)	(0.002)	(0.003)
EPS (fwd)	-0.019***	-0.022***	-0.011***
	(0.001)	(0.001)	(0.001)
PE (fwd)	-0.003*	-0.004	-0.002
	(0.002)	(0.003)	(0.004)
ROE (fwd)	-0.004**	-0.004*	0.004**
	(0.002)	(0.002)	(0.002)
Constant	0.202***	0.362***	0.560***
	(0.014)	(0.018)	(0.023)
Observations	58,386	58,386	58,386
R-squared	0.29	0.31	0.35
Time FE	YES	YES	YES
Industry FE	YES	YES	YES
Country FE	YES	YES	YES

The table reports parameter estimates and standard errors of the model presented in Equation 1, but where we substitute the dependent variable with the difference between the probability of default in 3, 5 and 10 years and the probability of default in 1 year (PD3-PD1, PD5-PD1, PD10-PD1). For each variable, the first row reports the estimated standardized coefficient on the PD terms structure; the second row reports robust standard errors in parentheses. All models include time, industry and country fixed-effects (*FE*). *, **, and *** denote significance at, respectively, the 10%, 5% and 1% level. See Table 3 for details on the list of model variables.

ers. To capture this effect, we enhance the baseline model with a dummy variable (set to 0 before 2020 and to 1 after 2020) interacted with the ESG score ($ESGscore \times Post2020$). The results are displayed in Table 5. The interaction term with the ESG score is consistently negative and statistically significant, confirming that sustainability risks have be-

Table 5: Impact of ESG scores: pre vs post Covid-19 period

VARIABLES	(1) PD 1	(2) PD 3	(3) PD 5	(4) PD 10
ESG score	-0.020***	-0.044***	-0.068***	-0.130***
	(0.004)	(0.004)	(0.004)	(0.004)
ESG × Post 2020	-0.067***	-0.085***	-0.088***	-0.081***
	(0.007)	(0.008)	(0.008)	(0.007)
Leverage	0.176***	0.219***	0.215***	0.163***
	(0.006)	(0.006)	(0.006)	(0.005)
ICR	-0.021***	-0.050***	-0.068***	-0.071***
	(0.006)	(0.008)	(0.010)	(0.013)
Total assets	-0.045***	-0.068***	-0.080***	-0.093***
	(0.003)	(0.004)	(0.004)	(0.004)
Working capital	-0.053***	-0.068***	-0.071***	-0.065***
	(0.002)	(0.003)	(0.003)	(0.003)
PPE/assets	-0.054***	-0.053***	-0.047***	-0.036***
	(0.005)	(0.005)	(0.005)	(0.004)
Buy recomm.	-0.114***	-0.119***	-0.107***	-0.074***
	(0.005)	(0.005)	(0.005)	(0.004)
EPS (fwd)	-0.063***	-0.082***	-0.085***	-0.074***
	(0.003)	(0.003)	(0.003)	(0.003)
PE (fwd)	-0.008*	-0.012*	-0.012*	-0.010
	(0.005)	(0.006)	(0.007)	(0.007)
ROE (fwd)	-0.032***	-0.037***	-0.036***	-0.028***
	(0.009)	(0.011)	(0.011)	(0.009)
Constant	0.180***	0.385***	0.546***	0.743***
	(0.049)	(0.056)	(0.055)	(0.044)
Observations	58,386	58,386	58,386	58,386
R-squared	0.22	0.28	0.32	0.40
Time FE	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES
Country FE	YES	YES	YES	YES

The table reports parameter estimates and standard errors of the model presented in Equation 1, with the inclusion of a dummy variable (Post2000) equal to one for observations post 2020 (Covid-19 period). For each variable, the first row reports the estimated standardized coefficient on the PD at different maturities (1, 3, 5 and 10 years); the second row reports robust standard errors in parentheses. All models include time, industry and country fixed-effects (*FE*). *, **, and *** denote significance at, respectively, the 10%, 5% and 1% level. See Table 3 for details on the list of model variables.

come more relevant since 2020. This observation will also be confirmed by the subsequent dynamic analysis that we present in Section 3.2.

Lastly, we analyse whether sustainability profiles not only influence the term structure

of corporate credit risk , but also the volatility of firms' probability of default. To this end, we consider a version of Equation 1 where the dependent variable is now the annual volatility of corporate PD for the four different maturities considered in our analysis.[4] The estimates are reported in Table 6, showing that firms with higher ESG scores are also less exposed to credit risk volatility. The effect is economically significant and increasing with maturity, similar to the baseline estimates. A one standard deviation increase in the ESG score generates a reduction in the volatility of PDs between 0.8 and 1.15, corresponding to a decrease of up to 12% in the average PD volatility for the 10-year horizon.

Additional results and robustness exercises. We conduct further empirical exercises to validate and extend our findings.

First, we address the potential concern that the estimates presented in Table 3 are driven by the inclusion of certain industry sectors, such as energy and utilities, which are traditionally viewed as underperforming from an ESG perspective. In this regard, it is important to note that our estimates incorporate industry fixed-effects and that LSEG ESG scores are industry-adjusted, thereby suggesting that within-sector heterogeneity should primarily explain our results. This being said, Table A.1 in the Appendix replicates the analysis excluding companies in the energy and utility sectors and displays estimates that are qualitatively comparable to the baseline case.[5]

Second, we estimate the baseline model outlined in Equation 1 using three alternative ESG scores provided by Robeco, Bloomberg and Sustainalytics.[6] Using alternative methodologies to assess the impact of sustainability on corporate PD is critical to ensure that our

[4]Volatility is computed using the annualized standard deviation of daily probability of defaults. Data is multiplied by 100.

[5]The results are comparable even if we exclude only energy or utilities at a time or if we exclude from the sample not only energy and utilities but also 'sin' sectors such as tobacco, gambling or defense, see Table A.2, Table A.3 and Table A.4 in the Appendix, respectively.

[6]Sustainalytics scores are defined in terms of ESG risks, so we multiply Sustainalytics scores by -1 to have an interpretation consistent with other rating providers.

Table 6: Impact of ESG scores on PD volatility

VARIABLES	(1) PD 1	(2) PD 3	(3) PD 5	(4) PD 10
ESG score	-0.804***	-1.095***	-1.204***	-1.135***
	(0.129)	(0.114)	(0.099)	(0.069)
Leverage	3.831***	3.072***	2.481***	1.562***
	(0.207)	(0.180)	(0.155)	(0.106)
ICR	-1.612***	-2.042***	-2.038***	-1.395***
	(0.251)	(0.263)	(0.262)	(0.226)
Total assets	-1.132***	-1.216***	-1.206***	-0.902***
	(0.125)	(0.097)	(0.082)	(0.054)
Working capital	-1.299***	-1.170***	-1.027***	-0.656***
	(0.089)	(0.074)	(0.063)	(0.042)
Buy recomm.	-1.979***	-1.429***	-1.047***	-0.573***
	(0.186)	(0.158)	(0.135)	(0.091)
EPS (fwd)	-1.965***	-1.863***	-1.674***	-1.124***
	(0.098)	(0.087)	(0.077)	(0.052)
PE (fwd)	-0.198*	-0.247*	-0.247*	-0.183*
	(0.113)	(0.132)	(0.134)	(0.105)
ROE (fwd)	-0.724***	-0.617***	-0.554***	-0.400***
	(0.221)	(0.203)	(0.188)	(0.138)
Constant	3.096**	4.183***	4.581***	4.480***
	(1.498)	(1.300)	(1.116)	(0.764)
Observations	57,451	57,451	57,451	57,451
R-squared	0.14	0.16	0.17	0.19
Time FE	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES
Country FE	YES	YES	YES	YES

The table reports parameter estimates and standard errors of the model presented in Equation 1 where the dependent variable is the volatility of corporate PD computed using the annualised standard deviation of daily probability of defaults multiplied by 100. For each variable, the first row reports the estimated standardized coefficient on the PD at different maturities (1, 3, 5 and 10 years); the second row reports robust standard errors in parentheses. All models include time, industry and country fixed-effects (*FE*). *, **, and *** denote significance at, respectively, the 10%, 5% and 1% level. See Table 3 for details on the list of model variables.

findings are not driven by the selection of a specific ESG rating supplier, given the literature's emphasis on disagreement between ESG scores (e.g. Billio et al., 2021, Berg et al., 2022). Unfortunately, while LSEG offers sufficient historical depth for our analysis, scores from other providers are only available for the most recent years. Nonetheless, the results in Table 7 show that using alternative ESG scores has a qualitatively similar impact

Table 7: Impact of ESG scores on corporate PDs - alternative ESG scores

VARIABLES	(1) PD 1	(2) PD 3	(3) PD 5	(4) PD 10
Robeco ESG	-0.078***	-0.109***	-0.122***	-0.141***
	(0.005)	(0.005)	(0.005)	(0.004)
Observations	30,890	30,890	30,890	30,890
R-squared	0.20	0.26	0.31	0.41
Bloomberg ESG	-0.036*	-0.057***	-0.075***	-0.114***
	(0.005)	(0.006)	(0.006)	(0.005)
Observations	42,249	42,249	42,249	42,249
R-squared	0.21	0.27	0.31	0.40
Sustainalytics ESG	-0.116***	-0.191***	-0.222***	-0.241***
	(0.011)	(0.012)	(0.011)	(0.009)
Observations	21,161	21,161	21,161	21,161
R-squared	0.26	0.33	0.37	0.44
Controls	YES	YES	YES	YES
Time FE	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES
Country FE	YES	YES	YES	YES

The table reports parameter estimates and standard errors of the model presented in Equation 1. For each variable, the first row reports the estimated standardized coefficient on the PD at different maturities (1, 3, 5 and 10 years); the second row reports robust standard errors in parentheses. All models include time, industry and country fixed-effects (*FE*). *, **, and *** denote significance at, respectively, the 10%, 5% and 1% level. LSEG ESG scores are now substituted with ESG scores from Robeco, Bloomberg, Sustainalytics; see Table 3 for details on the list of model variables.

on corporate PDs to that reported in our baseline estimates. The main difference is in the magnitude, which generally appears higher than LSEG estimates. Plausibly, this discrepancy could be attributed to the growing influence of sustainability on firm's intrinsic credit risk in the latter part of the sample, when scores from all rating agencies are available (see also the subsection on dynamic estimates for further discussion).

Third, we estimate the baseline model outlined in Equation 1 using monthly ESG scores obtained through cubic spline interpolation of yearly ESG scores provided by LSEG. This approach allows us to align the higher frequency of PDs with the lower frequency of

yearly sustainability assessments. The results, provided in Table A.5 in the Appendix, closely resemble our baseline estimates both qualitatively and quantitatively.[7]

Fourth, we analyze the impact of the three dimensions of sustainability separately using LSEG scores for the individual Environmental, Social, and Governance risk profiles. The results, displayed in Tables A.6, A.7, and A.8 in the Appendix, are consistent with the baseline estimates, although the governance score has little impact on corporate PDs compared to the environmental and social scores.

Finally, we investigate whether the impact of the ESG score on corporate PDs is affected by the growing attention towards sustainability topics. An increase in investors' interest in the ESG paradigm may signal a shift in sustainability concerns and a change in the premium requested by investors to compensate for sustainability risks. This shift in investors' preferences likely has asset pricing implications, channelled via changes in asset risk premia (see Section 5), whereas its impact on objective risk measures, such as corporate PDs, could be less apparent. However, a significant impact on corporate PDs could also occur when increased attention towards ESG topics is accompanied by a higher likelihood of stricter sustainability regulation (mainly environmental and social), litigation risks, and reduced financing sources for firms' sustainable initiatives, with direct implications for firms' viability and the risk of assets becoming stranded. We use earnings call transcripts from NL analytics to measure the importance of ESG considerations for professionals and corporate executives (see Hassan et al., 2019 for a similar approach). Results on the interaction between the ESG score and firms' exposure to ESG topics reveal that during periods of increasing relevance of ESG considerations, there is also an amplifying impact of the sustainability score on firms' inherent credit risk (Table A.9).[8]

[7] Results are robust also to the alternative exercise of estimating the impact of yearly ESG scores on the annual rather than the monthly average PD.

[8] As a further robustness test, we replicate the analysis using the Lewbel (2012) approach to control for potential endogeneity and results are qualitatively similar. Moreover, we consider an empirical specifica-

3.2 Dynamic estimates.

In this subsection, we analyse the dynamic response of the PDs to corporate sustainability ratings. To this purpose, we move from the time-average estimation described in Section 3.1 to a dynamic cross-sectional specification and estimate for each month the following equation:

$$PD_{i,t,y} = \alpha_0 + S_i + C_i + T_{t,y} + \beta ESG_{i,y-1} \times T_{t,y} + \gamma_0 Z_{i,y-1} + \gamma_1 X_{i,t-1,y} + \varepsilon_{i,t,y} \qquad (2)$$

where the interaction of the ESG score with the monthly fixed effects ($\beta ESG_{i,y-1} \times T_{t,y}$) captures the evolution of β over time. The results are displayed in Figure 4. Overall, we find that better ESG scores are negatively reflected into corporate PDs, with a point-in-time estimate of the impact which is larger for longer tenors, consistent with the static estimates reported earlier. The magnitude of the effect in absolute terms has also increased over time, with a noticeable trend beginning with the 2015 Paris Agreement , an event that marked a critical juncture in how heightened exposure to sustainability risks, such as climate regulatory risks, may have impacted corporate viability. Interestingly, the Covid-19 shock in 2020 had a positive upside impact on β, particularly for medium to long-term maturities. Although seemingly surprising, this result can be explained by market concerns during the most acute phase of the pandemic period, when investors were primarily focused on corporate liquidity and viability (e.g. FSB, 2020 and Acharya and Steffen, 2020) and firms' exposure to risk factors beyond pure balance-sheet fundamentals was perceived as potentially detrimental to profitability. However, the increase in β observed in 2020 was short-lived and did not halt the major downward trend that

tion that explicitly controls for a measure of corporate credit risk (Moody's credit rating); the results are also qualitatively similar and confirm our baseline evidence that sustainability risks mainly affect long-term viability. However, these latter results are based on a significantly smaller number of observations due to data limitations. Both sets of estimates are available upon request.

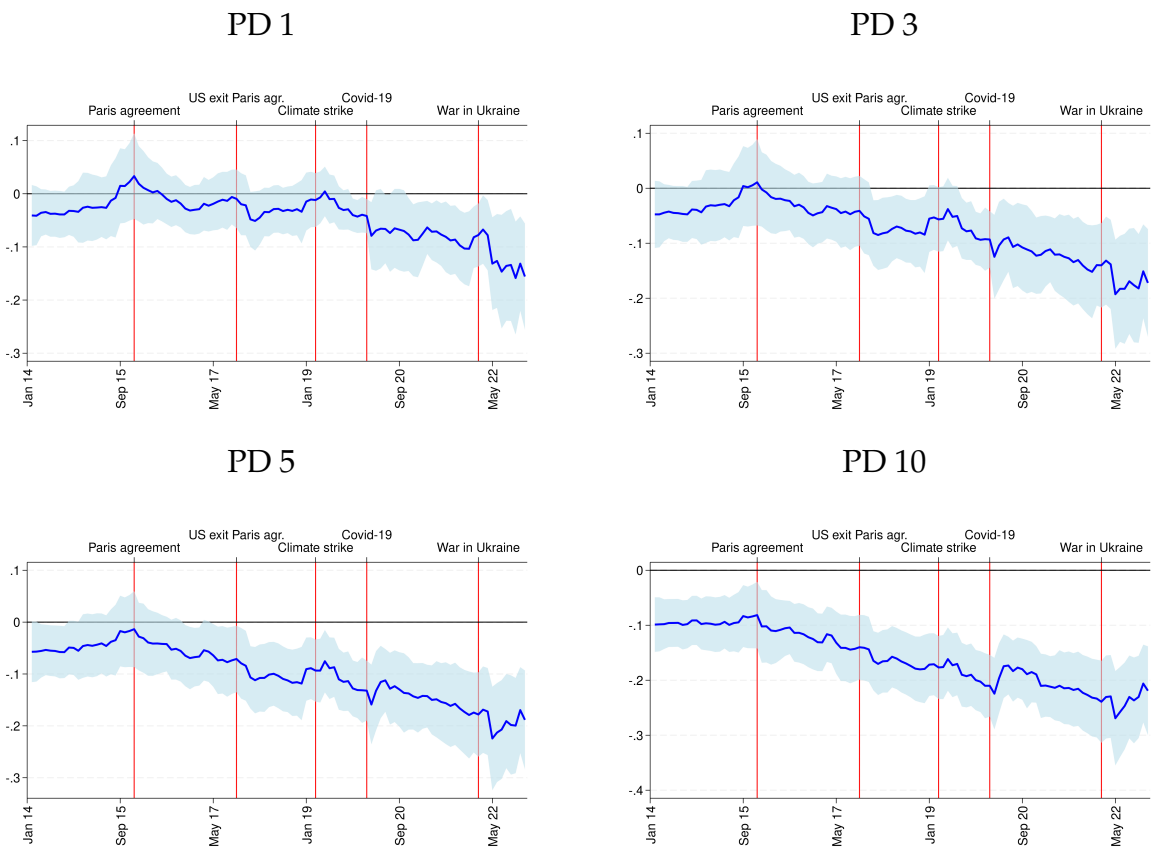

FIGURE 4: *The figure reports for each month estimates of $\beta ESG_{i,y-1} \times T_{t,y}$ of Equation 2. The shaded area is the 95% confidence interval.*

had begun after the 2015 Paris Agreement, quickly reversing after a couple of months. This resumption of the downward trend in the second half of 2020 aligns with the evidence that the valuation of ESG's impact on credit risk tends to vary over time (e.g. Barth et al., 2022, Kölbel et al., 2024, Eskildsen et al., 2024). Lastly, a strong negative reaction of PDs to sustainability scores was observed after the war in Ukraine, particularly for short-term horizons. A possible explanation for this result lies in firms' sustainability exposure, especially regarding environmental factors and reliance on green energy sources. This likely acted as a mitigating factor during the European energy crisis, arguably due to stronger expected policy responses supporting the green transition or reduced competitive disadvantages compared to regions with more affordable energy sources (Deng

et al., 2022, Ferriani and Gazzani, 2023b).

4 Estimating the ESG risk premium

The use of physical corporate PDs allows us to remove the risk premia component and analyze the impact of ESG scores on corporate inherent credit risk. However, when turning to the market, the price of traded financial assets embodies two distinct risk components and it reflects how risk factors are priced-in from the perspective of a risk neutral investor. The first component informs us about how sustainability risks, such as adverse shifts in environmental and social regulation, affect corporate profitability and viability. Conversely, the second factor reflects shifts in investors' preferences toward the ESG paradigm, which can be driven, for instance, by non-pecuniary motivations and increased awareness about ESG risks. This second component captures changes in the compensation required by investors to be exposed to ESG-related risks. We aim to estimate the dynamics of the ESG risk premium over time. Our empirical strategy, inspired by Berndt et al. (2005), first aims to estimate the risk premium as the residual and unexplained component of market-priced credit risk, once the objective risk-adverse component has been wiped out. Then, we analyze how this residual evolves in relation to corporate ESG scores. We use the 5-year fair value average monthly CDS spreads as it is traditionally considered the most liquid CDS contract and this helps to minimize the impact of liquidity issues in the estimate of the ESG premium.[9] In practice, the spread is first regressed

[9]Data on CDS spreads are obtained from Moody's and corresponds to the Fair Value CDS spread at 5 years. Results are qualitatively comparable using CDS spreads from CMA, although based on a significantly smaller number of observations.

on monthly 5Y PD (both expressed in log terms) using the following specification:

$$Spread_{i,t,y} = \alpha_0 + S_i + C_i + T_{t,y} + \sum_{j=0}^{1} \beta_j PD_{i,t-j,y} + \varepsilon_{i,t,y} \tag{3}$$

where S_i, C_i, and $T_{t,y}$ are respectively sector, country, and time (monthly) fixed effects. Then the residual of this regression, which is purged out of the intrinsic credit risk captured by firms' PDs, serves as our measure of risk premium. We then study its dynamic interlink with ESG attributes as follows:

$$RP_{i,t,y} = \alpha_0 + \beta ESG_{i,y-1} \times T_{t,y} + \varepsilon_{i,t,y} \tag{4}$$

where RP is the residual of the first step regression proxying for firms' risk premium, and ESG are the monthly interpolated scores interacted with monthly fixed effects. Figure 5 displays the dynamics of the β coefficient from Equation 4, representing the evolution of investors' sensitivity to ESG concerns. Compared to the time-varying estimates displayed in Figure 4, we do not find evidence of a clear-cut negative trend. However, on average, we find that corporate ESG scores are negatively related to the risk premium, indicating that investors demand compensation for firms with higher sustainability risks. Moreover, the estimate of the ESG premium is also quite volatile, and its magnitude is increasing in absolute value after periods of major shocks to ESG concerns such as the Paris Agreement, the Covid-19 recovery and the subsequent "green wake-up call", or the war in Ukraine, when greener firms less reliant on fossil fuels were less exposed to the energy shock. Conversely, the ESG premium decreases in absolute magnitude during period of major financial distress (e.g. the Covid-19 financial turmoil in February-March 2020) when investors' focus was on liquidity and short-term viability rather than sustainability or when less climate-friendly political administrations take office (Anderson and Robin-

son, 2024, Blomqvist and Stradi, 2024). These results confirm that changes in sustainability risks alter the price of corporate financial assets through two channels, which may, in principle, operate simultaneously: on one side, through a direct impact on firms' costs related to factors such as adverse environmental regulatory shocks or increased compliance to improve social performance, and second, through the greater compensation required by investors to take on sustainability risks during periods of heightened ESG hazards or increased disutility from holding non-sustainable assets.

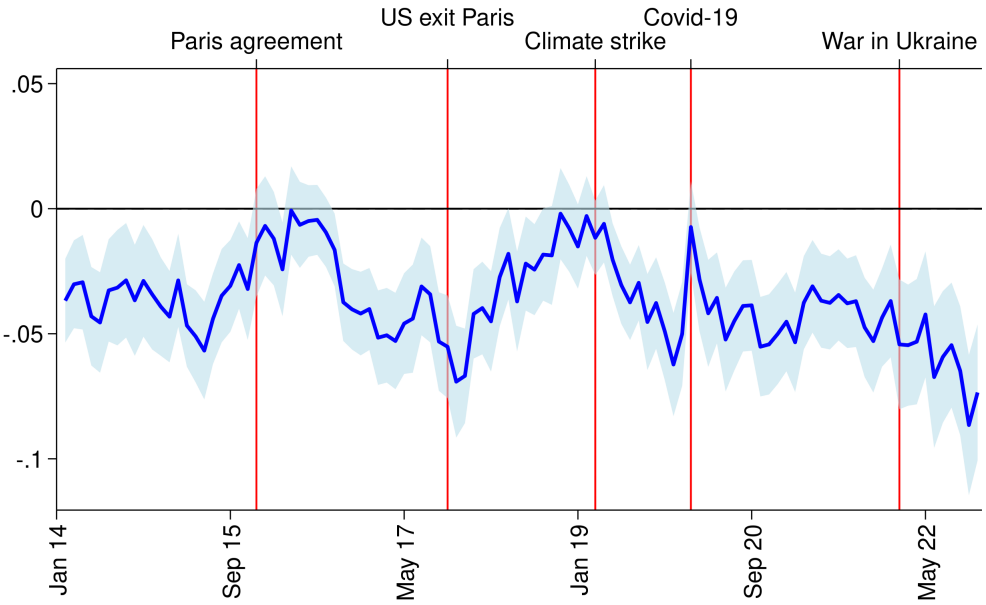

FIGURE 5: *The figure reports for each month estimates of* $\beta ESG_{i,y-1} \times T_{t,y}$ *of Equation 4, i.e. the time-varying average sensitivity of corporate risk premia to ESG scores. The shaded area is the 95% confidence interval.*

5 Conclusions

We examine the impact of ESG risks on the term structure of PDs of European non-financial corporations during the period 2014-2022. We document robust evidence of

a negative correlation between firms' sustainability profiles and their creditworthiness, with a more pronounced effect observed as the time horizon of default probability increases. The relationship between ESG risks and PDs displays significant time variation, particularly intensifying during periods marked by mounting ESG concerns, such as those following the Paris Agreement and the Covid-19 pandemic. Importantly, we present a simple strategy to disentangle the "*risk channel*" from the "*preference channel*", which are the two channels through which ESG risks can affect firms' viability and corporate asset prices. Our findings show that sustainability risks impactboth firms' inherent credit risk and investor compensation , emphasizing the importance of capturing a broader set of risk factors in addition to the conventional financial risk factors. In this way, our study delivers valuable insights into firms' default mechanisms and asset pricing considerations, facilitating more informed decisions by firms and investors and contributing to the promotion of sustainable and responsible investing practices.

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Appendix

Table A.1: Impact of ESG scores on PDs of firms ex energy and utilities sectors

VARIABLES	(1) PD 1	(2) PD 3	(3) PD 5	(4) PD 10
ESG score	-0.028***	-0.050***	-0.070***	-0.125***
	(0.003)	(0.004)	(0.004)	(0.003)
Leverage	0.130***	0.172***	0.174***	0.131***
	(0.005)	(0.006)	(0.006)	(0.005)
ICR	-0.024***	-0.049***	-0.066***	-0.072***
	(0.005)	(0.008)	(0.010)	(0.012)
Total assets	-0.018***	-0.030***	-0.041***	-0.062***
	(0.002)	(0.003)	(0.003)	(0.004)
Working capital	-0.036***	-0.049***	-0.053***	-0.050***
	(0.002)	(0.002)	(0.002)	(0.002)
PPE/assets	-0.001	0.008	0.009*	0.003
	(0.004)	(0.005)	(0.005)	(0.004)
Buy recomm.	-0.090***	-0.100***	-0.092***	-0.064***
	(0.005)	(0.005)	(0.005)	(0.004)
EPS (fwd)	-0.053***	-0.069***	-0.072***	-0.065***
	(0.002)	(0.003)	(0.003)	(0.002)
PE (fwd)	-0.008**	-0.010**	-0.011*	-0.008
	(0.004)	(0.005)	(0.006)	(0.006)
ROE (fwd)	-0.023***	-0.027***	-0.027***	-0.021***
	(0.007)	(0.008)	(0.009)	(0.008)
Constant	0.393***	0.671***	0.845***	0.999***
	(0.057)	(0.065)	(0.062)	(0.048)
Observations	51,644	51,644	51,644	51,644
R-squared	0.16	0.22	0.27	0.38
Time FE	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES
Country FE	YES	YES	YES	YES

The table reports parameter estimates and standard errors of the model presented in Equation 1 for companies not belonging to the energy and utilities sectors. For each variable, the first row reports the estimated standardized coefficient on the PD at different maturities (1, 3, 5 and 10 years); the second row reports robust standard errors in parentheses. All models include time, industry and country fixed-effects (*FE*). *, **, and *** denote significance at, respectively, the 10%, 5% and 1% level. See Table 3 for details on the list of model variables.

Table A.2: Impact of ESG scores on corporate PDs - excluding energy firms

VARIABLES	(1) PD 1	(2) PD 3	(3) PD 5	(4) PD 10
ESG score	-0.032***	-0.055***	-0.075***	-0.130***
	(0.003)	(0.003)	(0.003)	(0.003)
Leverage	0.120***	0.162***	0.166***	0.127***
	(0.005)	(0.006)	(0.005)	(0.004)
ICR	-0.028***	-0.054***	-0.071***	-0.075***
	(0.005)	(0.008)	(0.010)	(0.012)
Total assets	-0.008***	-0.020***	-0.031***	-0.051***
	(0.002)	(0.003)	(0.003)	(0.003)
Working capital	-0.030***	-0.039***	-0.041***	-0.038***
	(0.002)	(0.002)	(0.002)	(0.002)
PPE/assets	-0.008**	0.002	0.005	0.006
	(0.004)	(0.005)	(0.004)	(0.004)
Buy recomm.	-0.088***	-0.098***	-0.091***	-0.064***
	(0.004)	(0.005)	(0.005)	(0.004)
EPS (fwd)	-0.055***	-0.071***	-0.074***	-0.067***
	(0.002)	(0.003)	(0.003)	(0.002)
PE (fwd)	-0.007**	-0.010**	-0.010*	-0.008
	(0.004)	(0.005)	(0.006)	(0.006)
ROE (fwd)	-0.022***	-0.026***	-0.025***	-0.019***
	(0.006)	(0.008)	(0.008)	(0.007)
Constant	0.341***	0.612***	0.790***	0.973***
	(0.050)	(0.057)	(0.055)	(0.042)
Observations	54,625	54,625	54,625	54,625
R-squared	0.15	0.22	0.27	0.39
Time FE	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES
Country FE	YES	YES	YES	YES

The table reports parameter estimates and standard errors of the model presented in Equation 1 excluding energy firms. For each variable, the first row reports the estimated standardized coefficient on the PD at different maturities (1, 3, 5 and 10 years); the second row reports robust standard errors in parentheses. All models include time, industry and country fixed-effects (*FE*). *, **, and *** denote significance at, respectively, the 10%, 5% and 1% level. See Table 3 for details on the list of model variables.

Table A.3: Impact of ESG scores on corporate PDs - excluding utilities

VARIABLES	(1) PD 1	(2) PD 3	(3) PD 5	(4) PD 10
ESG score	-0.036***	-0.065***	-0.089***	-0.150***
	(0.004)	(0.004)	(0.004)	(0.003)
Leverage	0.188***	0.232***	0.225***	0.168***
	(0.006)	(0.007)	(0.006)	(0.005)
ICR	-0.019***	-0.048***	-0.068***	-0.072***
	(0.006)	(0.008)	(0.010)	(0.012)
Total assets	-0.061***	-0.086***	-0.098***	-0.110***
	(0.004)	(0.004)	(0.005)	(0.004)
Working capital	-0.059***	-0.078***	-0.082***	-0.076***
	(0.003)	(0.003)	(0.003)	(0.003)
PPE/assets	-0.049***	-0.050***	-0.047***	-0.041***
	(0.005)	(0.006)	(0.006)	(0.005)
Buy recomm.	-0.116***	-0.122***	-0.110***	-0.075***
	(0.005)	(0.005)	(0.005)	(0.004)
EPS (fwd)	-0.061***	-0.079***	-0.082***	-0.071***
	(0.003)	(0.003)	(0.003)	(0.003)
PE (fwd)	-0.008*	-0.012*	-0.012*	-0.010
	(0.005)	(0.006)	(0.007)	(0.007)
ROE (fwd)	-0.032***	-0.037***	-0.037***	-0.030***
	(0.009)	(0.011)	(0.012)	(0.010)
Constant	0.195***	0.397***	0.552***	0.727***
	(0.055)	(0.063)	(0.061)	(0.049)
Observations	55,405	55,405	55,405	55,405
R-squared	0.22	0.28	0.32	0.40
Time FE	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES
Country FE	YES	YES	YES	YES

The table reports parameter estimates and standard errors of the model presented in Equation 1 excluding utilities. For each variable, the first row reports the estimated standardized coefficient on the PD at different maturities (1, 3, 5 and 10 years); the second row reports robust standard errors in parentheses. All models include time, industry and country fixed-effects (*FE*). *, **, and *** denote significance at, respectively, the 10%, 5% and 1% level. See Table 3 for details on the list of model variables.

Table A.4: Impact of ESG scores on corporate PDs - no energy, utilities and sin sectors

VARIABLES	(1) PD 1	(2) PD 3	(3) PD 5	(4) PD 10
ESG score	-0.034***	-0.057***	-0.078***	-0.135***
	(0.003)	(0.004)	(0.004)	(0.003)
Leverage	0.131***	0.177***	0.180***	0.138***
	(0.005)	(0.006)	(0.006)	(0.005)
ICR	-0.027***	-0.056***	-0.075***	-0.085***
	(0.006)	(0.008)	(0.011)	(0.014)
Total assets	-0.011***	-0.025***	-0.036***	-0.054***
	(0.003)	(0.003)	(0.003)	(0.003)
Working capital	-0.030***	-0.039***	-0.040***	-0.039***
	(0.002)	(0.002)	(0.002)	(0.002)
PPE/assets	-0.022***	-0.012**	-0.006	0.001
	(0.004)	(0.005)	(0.005)	(0.004)
Buy recomm.	-0.092***	-0.103***	-0.096***	-0.070***
	(0.005)	(0.005)	(0.005)	(0.004)
EPS (fwd)	-0.059***	-0.078***	-0.083***	-0.076***
	(0.003)	(0.003)	(0.003)	(0.003)
PE (fwd)	-0.007*	-0.010*	-0.010*	-0.008
	(0.004)	(0.005)	(0.005)	(0.006)
ROE (fwd)	-0.024***	-0.028***	-0.027***	-0.020***
	(0.007)	(0.009)	(0.009)	(0.008)
Constant	0.424***	0.763***	0.985***	1.208***
	(0.051)	(0.058)	(0.055)	(0.043)
Observations	51,792	51,792	51,792	51,792
R-squared	0.16	0.22	0.27	0.39
Time FE	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES
Country FE	YES	YES	YES	YES

The table reports parameter estimates and standard errors of the model presented in Equation 1 excluding energy, utilities and sin sectors(defined as tobacco, gambling and defense). For each variable, the first row reports the estimated standardized coefficient on the PD at different maturities (1, 3, 5 and 10 years); the second row reports robust standard errors in parentheses. All models include time, industry and country fixed-effects (*FE*). *, **, and *** denote significance at, respectively, the 10%, 5% and 1% level. See Table 3 for details on the list of model variables.

Table A.5: Impact of ESG scores on corporate PDs - monthly interpolated

VARIABLES	(1) PD 1	(2) PD 3	(3) PD 5	(4) PD 10
ESG interp.	-0.042***	-0.071***	-0.095***	-0.154***
	(0.003)	(0.004)	(0.004)	(0.003)
Leverage	0.171***	0.214***	0.211***	0.161***
	(0.006)	(0.006)	(0.006)	(0.005)
ICR	-0.019***	-0.048***	-0.066***	-0.068***
	(0.006)	(0.008)	(0.010)	(0.012)
Total assets	-0.048***	-0.070***	-0.081***	-0.094***
	(0.003)	(0.004)	(0.004)	(0.004)
Working capital	-0.049***	-0.064***	-0.067***	-0.063***
	(0.002)	(0.003)	(0.003)	(0.003)
PPE/assets	-0.040***	-0.040***	-0.036***	-0.029***
	(0.005)	(0.005)	(0.005)	(0.004)
Buy recomm.	-0.101***	-0.105***	-0.094***	-0.063***
	(0.005)	(0.005)	(0.005)	(0.004)
EPS (fwd)	-0.056***	-0.074***	-0.077***	-0.068***
	(0.003)	(0.003)	(0.003)	(0.003)
PE (fwd)	-0.007*	-0.010*	-0.011*	-0.009
	(0.004)	(0.006)	(0.006)	(0.006)
ROE (fwd)	-0.031***	-0.036***	-0.035***	-0.027***
	(0.009)	(0.011)	(0.011)	(0.009)
Constant	0.109**	0.302***	0.466***	0.679***
	(0.048)	(0.056)	(0.054)	(0.042)
Observations	55,906	55,906	55,906	55,906
R-squared	0.22	0.28	0.32	0.41
Time FE	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES
Country FE	YES	YES	YES	YES

The table reports parameter estimates and standard errors of the model presented in Equation 1 with monthly interpolated ESG scores data. For each variable, the first row reports the estimated standardized coefficient on the PD at different maturities (1, 3, 5 and 10 years); the second row reports robust standard errors in parentheses. All models include time, industry and country fixed-effects (*FE*). *, **, and *** denote significance at, respectively, the 10%, 5% and 1% level. The ESG interpolated score in the table is the monthly ESG score obtained by a cubic spline interpolation of yearly ESG scores. See Table 3 for details on the list of model variables.

Table A.6: Impact of the environmental (E) score on corporate PDs

VARIABLES	(1) PD 1	(2) PD 3	(3) PD 5	(4) PD 10
Env. score	-0.027***	-0.052***	-0.076***	-0.135***
	(0.004)	(0.004)	(0.004)	(0.003)
Leverage	0.175***	0.218***	0.214***	0.165***
	(0.006)	(0.007)	(0.006)	(0.005)
ICR	-0.023***	-0.044***	-0.052***	-0.022**
	(0.007)	(0.009)	(0.010)	(0.011)
Total assets	-0.050***	-0.075***	-0.087***	-0.102***
	(0.003)	(0.004)	(0.004)	(0.004)
Working capital	-0.053***	-0.068***	-0.070***	-0.064***
	(0.002)	(0.003)	(0.003)	(0.003)
PPE/assets	-0.050***	-0.047***	-0.040***	-0.026***
	(0.005)	(0.005)	(0.005)	(0.004)
Buy recomm.	-0.114***	-0.120***	-0.109***	-0.076***
	(0.005)	(0.005)	(0.005)	(0.004)
EPS (fwd)	-0.062***	-0.080***	-0.082***	-0.070***
	(0.003)	(0.003)	(0.003)	(0.003)
PE (fwd)	-0.008*	-0.012*	-0.012*	-0.009
	(0.005)	(0.006)	(0.007)	(0.006)
ROE (fwd)	-0.030***	-0.034***	-0.033***	-0.025***
	(0.009)	(0.010)	(0.010)	(0.009)
Constant	0.195***	0.416***	0.594***	0.834***
	(0.049)	(0.057)	(0.055)	(0.044)
Observations	57,962	57,962	57,962	57,962
R-squared	0.22	0.28	0.32	0.40
Time FE	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES
Country FE	YES	YES	YES	YES

The table reports parameter estimates and standard errors of the model presented in Equation 1, using the E (environmental) score instead of the composite ESG score. For each variable, the first row reports the estimated standardized coefficient on the PD at different maturities (1, 3, 5 and 10 years); the second row reports robust standard errors in parentheses. All models include time, industry and country fixed-effects (FE). *, **, and *** denote significance at, respectively, the 10%, 5% and 1% level. See Table 3 for details on the list of model variables.

Table A.7: Impact of the social (*S*) score on corporate PDs

VARIABLES	(1) PD 1	(2) PD 3	(3) PD 5	(4) PD 10
Soc. score	-0.050***	-0.083***	-0.107***	-0.159***
	(0.004)	(0.004)	(0.004)	(0.003)
Leverage	0.175***	0.217***	0.212***	0.159***
	(0.006)	(0.006)	(0.006)	(0.005)
ICR	-0.025***	-0.055***	-0.074***	-0.075***
	(0.006)	(0.008)	(0.010)	(0.013)
Total assets	-0.044***	-0.067***	-0.080***	-0.098***
	(0.003)	(0.004)	(0.004)	(0.004)
Working capital	-0.054***	-0.069***	-0.071***	-0.066***
	(0.002)	(0.003)	(0.003)	(0.003)
PPE/assets	-0.052***	-0.050***	-0.044***	-0.032***
	(0.005)	(0.005)	(0.005)	(0.004)
Buy recomm.	-0.115***	-0.121***	-0.108***	-0.074***
	(0.005)	(0.005)	(0.005)	(0.004)
EPS (fwd)	-0.063***	-0.082***	-0.085***	-0.074***
	(0.003)	(0.003)	(0.003)	(0.003)
PE (fwd)	-0.008*	-0.012*	-0.012*	-0.010
	(0.005)	(0.006)	(0.007)	(0.007)
ROE (fwd)	-0.033***	-0.038***	-0.037***	-0.030***
	(0.009)	(0.011)	(0.011)	(0.010)
Constant	0.153***	0.347***	0.504***	0.699***
	(0.049)	(0.057)	(0.055)	(0.044)
Observations	58,386	58,386	58,386	58,386
R-squared	0.22	0.28	0.32	0.41
Time FE	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES
Country FE	YES	YES	YES	YES

The table reports parameter estimates and standard errors of the model presented in Equation 1, using the *S* (social) score instead of the composite ESG score. For each variable, the first row reports the estimated standardized coefficient on the PD at different maturities (1, 3, 5 and 10 years); the second row reports robust standard errors in parentheses. All models include time, industry and country fixed-effects (*FE*). *, **, and *** denote significance at, respectively, the 10%, 5% and 1% level. See Table 3 for details on the list of model variables.

Table A.8: Impact of the governance (*G*) score on corporate PDs

VARIABLES	(1) PD 1	(2) PD 3	(3) PD 5	(4) PD 10
Gov. score	-0.003	-0.010***	-0.017***	-0.039***
	(0.003)	(0.003)	(0.003)	(0.003)
Leverage	0.174***	0.215***	0.210***	0.157***
	(0.006)	(0.006)	(0.006)	(0.005)
ICR	-0.018***	-0.044***	-0.060***	-0.056***
	(0.006)	(0.008)	(0.010)	(0.013)
Total assets	-0.057***	-0.088***	-0.107***	-0.135***
	(0.003)	(0.004)	(0.004)	(0.004)
Working capital	-0.054***	-0.070***	-0.072***	-0.067***
	(0.002)	(0.003)	(0.003)	(0.003)
PPE/assets	-0.054***	-0.054***	-0.049***	-0.041***
	(0.005)	(0.005)	(0.005)	(0.005)
Buy recomm.	-0.112***	-0.117***	-0.104***	-0.067***
	(0.005)	(0.005)	(0.005)	(0.004)
EPS (fwd)	-0.063***	-0.082***	-0.085***	-0.075***
	(0.003)	(0.004)	(0.004)	(0.003)
PE (fwd)	-0.008*	-0.011*	-0.012*	-0.009
	(0.004)	(0.006)	(0.007)	(0.006)
ROE (fwd)	-0.033***	-0.037***	-0.037***	-0.029***
	(0.009)	(0.011)	(0.011)	(0.010)
Constant	0.189***	0.404***	0.575***	0.792***
	(0.050)	(0.057)	(0.056)	(0.045)
Observations	58,386	58,386	58,386	58,386
R-squared	0.22	0.28	0.31	0.38
Time FE	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES
Country FE	YES	YES	YES	YES

The table reports parameter estimates and standard errors of the model presented in Equation 1, using the *G* (governance) score instead of the composite ESG score. For each variable, the first row reports the estimated standardized coefficient on the PD at different maturities (1, 3, 5 and 10 years); the second row reports robust standard errors in parentheses. All models include time, industry and country fixed-effects (*FE*). *, **, and *** denote significance at, respectively, the 10%, 5% and 1% level. See Table 3 for details on the list of model variables.

Table A.9: Impact of the ESG scores on corporate PDs - topic relevance

VARIABLES	(1) PD 1	(2) PD 3	(3) PD 5	(4) PD 10
ESG score	-0.031***	-0.070***	-0.101***	-0.172***
	(0.005)	(0.005)	(0.005)	(0.005)
ESG score X ESG expos.	-0.028***	-0.028***	-0.025***	-0.019***
	(0.004)	(0.005)	(0.005)	(0.004)
Leverage	0.183***	0.229***	0.225***	0.172***
	(0.008)	(0.008)	(0.008)	(0.006)
ICR	-0.051***	-0.092***	-0.110***	-0.098***
	(0.010)	(0.014)	(0.017)	(0.018)
Total assets	-0.044***	-0.073***	-0.087***	-0.098***
	(0.004)	(0.005)	(0.005)	(0.005)
Working capital	-0.047***	-0.063***	-0.065***	-0.062***
	(0.003)	(0.004)	(0.004)	(0.004)
PPE/assets	-0.060***	-0.065***	-0.060***	-0.047***
	(0.007)	(0.008)	(0.007)	(0.006)
Buy recomm.	-0.083***	-0.087***	-0.075***	-0.044***
	(0.006)	(0.006)	(0.006)	(0.005)
EPS (fwd)	-0.068***	-0.088***	-0.091***	-0.079***
	(0.004)	(0.005)	(0.005)	(0.004)
PE (fwd)	-0.007*	-0.010*	-0.010*	-0.008
	(0.004)	(0.005)	(0.006)	(0.006)
ROE (fwd)	-0.092***	-0.110***	-0.111***	-0.090***
	(0.019)	(0.022)	(0.021)	(0.016)
Constant	0.484***	0.760***	0.942***	1.142***
	(0.060)	(0.070)	(0.067)	(0.050)
Observations	34,758	34,758	34,758	34,758
R-squared	0.18	0.26	0.30	0.40
Time FE	NO	NO	NO	NO
Industry FE	YES	YES	YES	YES
Country FE	YES	YES	YES	YES

The table reports parameter estimates and standard errors of the model presented in Equation 1 augmented with the interaction between the *ESG* score and a variable counting the frequency of ESG-related themes in firms' earning calls. For each variable, the first row reports the estimated standardized coefficient on the PD at different maturities (1, 3, 5 and 10 years); the second row reports robust standard errors in parentheses. All models include time, industry and country fixed-effects (*FE*). *, **, and *** denote significance at, respectively, the 10%, 5% and 1% level. See Table 3 for details on the list of model variables.