From ESG disclosure to credit risk: evidence from European firms

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Abstract

Purpose – This study aims to examine the impact of environmental, social and governance (ESG) disclosure on credit risk at the firm level, focusing on companies listed in the Euro Stoxx 50 index. Specifically, the study evaluates whether transparent and standardized sustainability reporting improves financial stability, as measured by Altman's Z-Score.

Design/methodology/approach – A two-way fixed effect panel regression model was applied to annual data from 2005 to 2024. ESG disclosure indicators were analysed alongside financial variables. One-and two-year lagged models were used to assess long-term effects. Hausman and F-tests confirm the robustness and suitability of the model.

Findings – The results reveal a statistically significant lagged relationship between ESG disclosure and credit risk. Several ESG indicators are linked to improved creditworthiness, as evidenced by higher Altman's Z-scores. The effects are strongest with a two-year lag, suggesting that ESG reporting builds financial resilience over time. Since the Paris Agreement, the importance of ESG disclosures has increased, underscoring their growing role in credit evaluations.

Research limitations/implications – One limitation of the study is that ESG disclosure data on the Bloomberg Terminal is only available annually, resulting in a short time series and few observations per company. Additionally, the lack of a long time series for sustainability-related indicators complicates the study, especially when considering the delayed impact of reporting on credit risk. The study is also limited by its failure to consider crisis periods, such as the 2008–2009 global financial crisis and the 2020–2021 pandemic, which may have affected the importance of credit risk assessment and ESG disclosure.

Originality/value – This study presents the direct, long-term impact of ESG disclosure on credit risk. By focusing on large European firms and using fixed effects modelling, the study emphasizes the vital role of standardized ESG reporting in enhancing transparency, investor confidence and the quality of risk assessments in financial markets.

Keywords ESG disclosure, ESG reporting, Credit risk, Altman's Z-Score, Fixed effects model, GRI, TCFD, SASB, Sustainable finance, PANEL regression, Euro Stoxx 50

Paper type Research paper

1. Introduction

Integrating environmental, social and governance (ESG) factors into corporate credit risk assessments reflects a significant shift in financial theory and practice. However, it also poses new challenges regarding implementation and standardization. Traditional credit risk assessment models have primarily relied on quantitative metrics, such as financial indicators and the credit history of borrowers. However, these models do not account for all possible risks, including non-financial risks related to environmental responsibility, governance weaknesses and social issues (Wong and Zhang, 2024; Yue *et al.*, 2024). Additionally, a growing body of academic research recognizes that non-financial risks, particularly those related to ESG factors, can significantly impact a company's creditworthiness, leading to a more conservative assessment (Jiang *et al.*, 2023; Qian *et al.*, 2023; Tang *et al.*, 2024; Jin and Wang, 2025).

Considering that credit markets price information, ESG performance indicators are not the only important factors; disclosure and the quality of disclosed information are important as well. The reviewed studies showed that markets react not only to ESG performance information but also to the credibility, specificity, readability, tone and third-party validation of ESG disclosures [see Table 1]. Therefore, any disclosure that distinguishes reliable

Table 1. The impact of ESG disclosure attributes on credit risk

ESG disclosure attribute	Researchers	Year	Research results
Specificity of disclosure	Sangiorgi and Schopohl	2021	A survey of EU asset managers showed that 79% would not make a purchase if the Use of Proceeds disclosure was unclear. Weak post-issuance reporting triggers selling and engagement
Tone of ESG communications	Naumer and Yurtoglu	2022	For large EU/US firms, a positive tone in ESG news is associated with a 4% lower CDS, while a negative tone is associated with a 6% higher CDS
	Sharma and Sharma	2025	Using more positive or "greener" language in the prospectus tightens the issue spreads
Third-party validation and credibility	Xu *et al.*	2022	Greenwashing risk increases credit spreads, but third-party certification mitigates the penalty
	Allman and Lock	2024	External reviews lower yields when the information environment and legal origin support them. Reputable reviewers amplify the greenium
	Intonti, De Leonardis and Bussoli	2025	ICMA SBP compliance and SPOs are associated with lower social premiums (narrower asset-swap spreads)
Readability of prospectuses and reports	Sharma and Sharma	2025	The readability of a prospectus is inversely related to credit spreads at issuance. Using greener language and a positive tone can also reduce spreads
	Shimamura, Tanaka and Managi	2025	Report readability that is more context-dependent correlates with higher ESG scores and lower rater disagreement

Source(s): Created by authors

information from unreliable information should, in principle, influence credit risk ratios (and the standardization of ESG disclosure contributes to this distinction).

After reviewing the existing empirical studies, three observations emerged that prompted this study. First, credit markets react to ESG-related information. Positive ESG news or sentiment is associated with lower credit default swap (CDS) spreads, as seen with large-cap companies in East Asia, Europe and the USA. Negative ESG sentiment or contradictions, on the other hand, increase spreads (Naumer and Yurtoglu, 2022; Tang *et al.*, 2024).

Second, bond and loan pricing sometimes rewards companies with stronger ESG signals; however, the premium depends on credibility, meaning greenwashing with weak verification can have the opposite effect, leading to higher CDS. Similarly, external reviews, certifications and clear, easy-to-read prospectuses are associated with lower CDS spreads (Xu *et al.*, 2022; Allman and Lock, 2024; Sharma and Sharma, 2025).

Third, the Paris Agreement has contributed to the consideration of ESG-related information. Since 2015, environmental information received more attention in assessments and models, with increasing tendency to include it (Bolognesi and Burchi, 2023). However, whether the importance of ESG disclosure in Europe, a region with stringent ESG disclosure and standardization regulations, has increased for credit investors since the Paris Agreement remains insufficiently researched.

It is important to note that the European region selected for the study is more informative and useful for decision-making because companies operating in this region have increasingly adopted financially material (Sustainability Accounting Standards Board [SASB]: This framework provides industry-specific, investor-focused metrics for financially material ESG topics) and climate-related financial (Task Force on Climate-Related Financial Disclosures (TCFD): This framework emphasizes the financial risks and governance of climate change). Under the principle of double materiality, these companies have also adopted wider stakeholder impact disclosures (Global Reporting Initiative [GRI]: This stakeholder-oriented framework captures the impact of organizations on the economy, environment and society). In other words, ESG reporting in Europe is becoming more standardized than in non-EU countries (Allman and Lock, 2024; Dou *et al.*, 2025; Huang *et al.*, 2025).

However, it is important to note that disclosure labels do not guarantee credibility on their own. For instance, Bingler *et al.* (2024) discovered that TCFD endorsement alone is linked to more "empty words" when not supported by concrete initiatives and quantifiable objectives.

In summary, the data from the reviewed studies are convincing yet fragmented. This conclusion was reached, given that the analysis did not cover the EU region and different credit risk metrics were used.For example, Jiang *et al.* (2023) and Qian *et al.* (2023) examined the Chinese bond and loan markets and found that ESG-oriented activities result in more favourable financing conditions, such as lower yield spreads, larger loans and reduced collateral requirements. Apergis *et al.* (2022) obtained similar results when analysing US primary bond issues, finding that higher ESG scores are associated with lower spreads. Other authors have also linked lower perceived default risk to ESG activities. This has been observed in Europe, the USA (Naumer and Yurtoglu, 2022) and East Asia (Tang *et al.*, 2024). Based on the reviewed studies, it can be concluded that most examined the impact of ESG performance rather than disclosure on credit risk. Only a few studies have directly examined the reliability of disclosure (e.g. green bond certification, greenwashing and pricing) (Xu *et al.*, 2022) or the readability of US green prospectuses compared to spreads (Sharma and Sharma, 2025).

However, even these studies do not cover the impact of ESG disclosure standardization on credit risk, and they often take place outside of Europe. As previously mentioned, this topic is particularly relevant in Europe, where standardization is among the most stringent.

This document addresses this shortcoming by examining whether and how ESG disclosure impacts the credit risk of European companies, whether this impact is lagged and whether the Paris Agreement coincided with structural changes in this area.

The article is divided into five sections. It begins with an overview of scientific research on how ESG disclosure shapes credit risk (Section 1), followed by a presentation of the research hypotheses (Section 2). Section 3 presents the sample and explains the main design choices. Section 4 describes the empirical model in detail. Section 5 presents the results. Finally, the study's results are interpreted, practical conclusions are presented, limitations are highlighted and directions for future research are outlined.

2. Literature review

Integrating ESG factors into corporate credit risk assessment signals a theoretical shift from shareholder to stakeholder theory. This shift recognizes that a company's long-term value hinges on more than just its shareholders; it also depends on all its stakeholders and the value it creates for them.

Standardized ESG disclosure demonstrates a company's commitment to meeting stakeholder expectations by providing reliable and comprehensive information, which prevents greenwashing. This increases stakeholder confidence in the company. Bolognesi and Burchi (2023) discussed the convergence around SASB and the TCFD, showing that markets reward transparent ESG disclosure. This is consistent with responsiveness to capital-market stakeholders. Cui *et al.* (2025) found that mandatory, standardized ESG reporting improves transparency and reduces earnings management, demonstrating responsiveness to regulators and a broader set of stakeholders. Huang *et al.* (2025) demonstrated that higher-quality material disclosures are associated with higher valuations, reflecting responsiveness to investors and policy objectives.

Consequently, the trust that stakeholders have in the company translates into financial benefits for the borrower. For instance, Qian *et al.* (2023) discovered that superior ESG performance, particularly in social and governance areas, was linked to larger loans, reduced collateral requirements and lower interest rates. This finding was also confirmed by Jiang *et al.* (2023). Stronger ESG engagement is associated with lower bond yield spreads, with S and G influencing this relationship through the information asymmetry channel. Following the introduction of China's green finance policy, Lin and Li (2025) discovered that companies with high ESG scores experienced reduced debt costs. In line with these findings, Nguyen *et al.* (2023) discovered that firms with more extensive and higher-quality climate-related reporting incurred lower costs of equity capital, indicating that investors reward credible carbon disclosure.

However, from a shareholder theory perspective, disclosure that increases reporting costs but does not improve risk management may not reduce credit risk. Jiang *et al.* (2023) discovered that S and G engagement lowers bond yield spreads, whereas E engagement is linked to higher spreads, which is interpreted as investor caution regarding potential greenwashing. Qian *et al.* (2023) echoed these results, finding that, in bank lending, S and G lead to larger loans with less collateral and lower rates. However, the E pillar is insignificant. It does not reduce loan rates. These findings provide a solid theoretical basis for testing the hypothesis described in the next section (*H1*).

In the context of legitimacy theory, ESG disclosure helps companies maintain legitimacy in the eyes of creditors, employees, the public and regulatory authorities. It is also consistent with stakeholder theory. Stronger stakeholder relationships and monitoring reduce risks (e.g. operational, financial and legal) and potential financial costs (e.g. fines and reduced demand).

As a result, the likelihood of default decreases and financial performance improves (companies that meet expectations are more financially stable). However, negative ESG events in the supply chain can hurt performance and raise downside risk. For instance, Wang et al. (2025) discovered that poor ESG ratings of partners negatively impact firms' results. In summary, studies have found smaller spreads, better coverage of financial obligations and a shorter distance to default in companies with stronger and more transparent ESG practices. Xue et al. (2024) and Liu et al. (2025) stated in their studies that ESG disclosure builds stakeholder trust and legitimacy by reducing information asymmetry. This is consistent with recognizing stakeholders as a risk mitigation tool (D'Apolito et al., 2024; Li and Gu, 2025, Shang et al., 2025).

Turning to signalling theory, high-quality ESG disclosure, especially when it is comparable, complete, or assured, reduces the information asymmetry between companies and creditors. Data from bond and loan markets in various regions indicates that companies that reliably disclose ESG information or are otherwise well-rated on ESG receive better financing conditions, including lower yield spreads, lower collateral requirements and higher loan amounts. Studies reviewed interpret this as an information environment channel (Apergis et al., 2022; Qian et al., 2023; Alves and Meneses, 2024). Investors also conclude that credit risk is lower when confirmation is strong, such as when it is confirmed by external opinions or reviews, or when disclosure is clear and transparent. Investors then price it accordingly (Intonti et al., 2025; Allman and Lock, 2024; Sharma and Sharma, 2025).

According to institutional theory, which suggests that companies' growing disclosure of ESG-related information is related not only to the desire to create long-term value – greater accountability is associated with greater responsibility and reliability, but only if the disclosed information is accurate and comprehensive – but also to a response to the growing demand for such information from society and the regulatory environment. Thus, public expectations and regulatory pressure contribute to and shape corporate accountability behaviour (Hassanein et al., 2024; Nasreen et al., 2022). For example, Intonti et al. (2025) found that for social bonds, ICMA certification and second-party opinions (SPOs) are associated with tighter spreads and more specific use-of-proceeds disclosure strengthens this association, meaning credibility and specificity are priced. Similarly, Xu et al. (2022) found that green default risk increases credit spreads in the Chinese green bond market. However, third-party certification reduces these spreads, indicating that assurance mitigates information asymmetry and borrowing costs.

In summary, ESG disclosure primarily reduces corporate credit risk through stakeholder trust and information asymmetry channels. This is especially true when the disclosed information is relevant, comparable and externally verified.

3. Theoretical framework and hypothesis development

According to stakeholder and signalling theories, better framework-aligned disclosure should lower perceived credit risk today by reducing information frictions and operational

Table 2. Hypothesis *H1* of the study

H1 ESG disclosure-related indicators do not have a statistically significant impact on a company's credit risk
Hypothesis *H1* is supported if none of the ESG disclosure-related indicators is statistically significant for the company's credit risk (*p*-value should be > 0.05)
Source(s): Created by authors

uncertainty. However, conflicting results could support hypothesis *H1* [see Table 2], especially when information lacks credibility or the market suspects greenwashing.

Studies in Europe and other developed markets suggest that companies with better ESG performance tend to have lower borrowing costs and higher ratings (Hazaea *et al.*, 2025). This effect is related to governance quality, information disclosure and the clarity and reliability of ESG information (Hazaea *et al.*, 2025; Allman and Lock, 2024; Anselmi and Petrella, 2025). Real-time reactions to the tone of ESG news could also contribute to an immediate increase in the pricing of ESG disclosure in credit risk (Allman and Lock, 2024; Anselmi and Petrella, 2025). Therefore, rejecting *H1* would be associated with the dominance of stakeholders and signalling channels (Naumer and Yurtoglu, 2022; Tang *et al.*, 2024).

According to stakeholder theory, the impact of ESG risks on financial performance may only become apparent over time. For example, Angelidis *et al.* (2024) showed that better ESG indicators are associated with lower economic activity in the short term and higher activity in the long term. The researchers interpreted this long-term positive impact as consistent with the creation of stakeholder value that materializes over time. Qureshi *et al.* (2025) found that ESG plays a lagging role in predicting long-term economic activity in developed and emerging markets. Li and Gu (2025) confirmed this lagged effect when they analysed Chinese companies. They found that ESG reduces the risk of default with significant lag structures (e.g. some effects appear with a second lag).

At the same time, there is also a direct market channel. This means that credit markets price ESG signals simultaneously. For instance, CDS spreads fluctuate based on the tone and volume of ESG-related news and public ESG evaluations. The clarity and readability of green bond prospectuses, as well as the "green" content, are reflected in primary issuance spreads (Naumer and Yurtoglu, 2022; Tang *et al.*, 2024; Sharma and Sharma, 2025). Consistent with this distinction, credit ratings based on analysts' assessments adjust more slowly than market measures. Therefore, rejecting *H2* [see Table 3] for contemporaneous ratings aligns with the slow nature of ratings while suggesting that current disclosure aids in predicting future credit risk.

The regulatory environment related to sustainability has changed significantly since 2015. Spurred by the Paris Agreement, the ECB and other regulators now require the integration of climate risk in credit assessments, capital adequacy, stress tests, etc. (Bingler *et al.*, 2024; Yue *et al.*, 2024; Huang *et al.*, 2025). Pressure from other stakeholders, such as institutional investors who want to ensure that investments go toward financing environmentally friendly projects, has also contributed to the growing need for comprehensive and accurate disclosure of sustainability-related information and consideration of such data. Consequently, in the post-Paris Agreement era, ESG disclosures should be more relevant to credit. Rejecting hypothesis *H3* [see Table 4] would signal a regime shift in which disclosure becomes more useful to creditors. This is consistent with stakeholder and institutional theory.

Table 3. Hypothesis *H2* of the study

H2 ESG disclosure-related indicators do not have a statistically significant lagged effect on the company's credit risk
Hypothesis *H2* is supported if none of the ESG disclosure-related indicators has a statistically significant lag effect on the company's credit risk (p-value should be > 0.05)

Source(s): Created by authors

Table 4. Hypothesis *H3* of the study

H3 ESG disclosure indicators for company credit risk have not become statistically significant since the Paris agreement

Hypothesis *H3* is supported if none of the following indicators (which could signal increased accountability or pressure on ESG reporting) – ESGD, GRIE, GRIS, GRIG, GRI, SASB, TCFD, PostMore, PostLess, PostMixed – become more statistically significant since 2016

Source(s): Created by authors

This study will assess the impact of increased ESG reporting on credit risk. Specifically, we will determine how ESG disclosure affects credit risk immediately, over time and under different policy regimes, such as the period following the Paris Agreement. The three hypotheses described above will enable us to test this impact.

4. Methodology

4.1 Data, samples and variables

This study focuses on companies included in the euro Stoxx 50 stock index, which represents 50 of the largest and most liquid companies in the eurozone. The initial sample consists of annual firm-level data from 2000 to 2024, providing a comprehensive panel data set that captures changes in ESG disclosure practices and credit risk over time. However, after data cleaning, this study uses a panel data set with 548 firm-year observations covering the period from 2005 to 2024. The choice of annual frequency data is based on the fact that ESG indicators published on Bloomberg Terminal tend to be annual.

The data analysed can be divided into three parts: ESG, financial and credit risk indicators. [For more detailed information on the indicators used in the study, see Appendix I, "Indicators used in the model."] All variables were extracted from the Bloomberg Terminal. ESG-disclosure variables were drawn either directly from Bloomberg (e.g. the ESG Disclosure Score) or computed by the authors from Bloomberg-indexed corporate filings and reports. Specifically, we used Bloomberg's document retrieval to count the number of company documents per year that reference the GRI topic standards, TCFD and SASB.

The dependent variables in the model are related to credit risk: Altman's Z-Score, 1-year Distance-to-Default (1yrDD), 1-year Probability of Default (1yrPD), CDS spread. We aggregated CDS spreads and PD to annual averages, aligning them with the annual ESG reporting frequency, to ensure the measures reflect the firm's overall yearly credit risk rather than a single point in time.

The independent variables are related to ESG and the financial position of the company. These indicators are selected after a correlation analysis, which shows that the highest correlation between independent indicators is |0.72| (the study assumes that if the correlation between variables is less than 0.8, it means that such variables can be included in the model). [The correlation results can be found in Appendix 3, titled "Correlation matrix"] the variance inflation factor (VIF) is also used to select indicators. The highest indicator is 2.93 (all are below 5.00). Therefore, all indicators are included in the modelling. [the VIF results can be found in Appendix I, entitled "Indicators used in the model."]

Companies are also classified into three groups according to their sector affiliation: companies in the more sustainable sector, companies in the mixed sector and companies in the less sustainable sector [see Table 5]. Al-Qudah and Houcine (2023) also highlighted in their study that the scope of sustainability reporting is impacted by a company's sector of activity.

Table 5. Indicators used in the model

Category	Sectors that fall into the category
More sustainable	Communication services
	Information technology
Mixed	Consumer discretionary
	Consumer staples
	Health care
	Utilities
Less sustainable	Energy
	Industrials
	Materials

Source(s): Created by authors

Sectors such as communication services and information technology are considered more sustainable due to their relatively low environmental footprint and strong governance structures. These industries are characterized by limited direct emissions, low resource intensity and generally higher digital integration, which is consistent with improved ESG transparency and innovation-driven sustainability.

The mixed category includes sectors such as consumer discretionary, consumer staples, health care and utilities. The health-care and consumer sectors can vary widely in supply chain management and labour practices. The utilities sector, while traditionally linked to carbon emissions, has seen increased variance due to the rise of renewable energy investments.

Industries such as energy, materials and industrials are considered less sustainable due to their high environmental impacts, including greenhouse gas emissions, resource extraction and waste generation. These sectors are often subject to stricter regulatory oversight due to their direct environmental impact and are generally slower to adopt ESG-focused business models.

To evaluate the relationship between corporate sustainability and credit risk, we conducted a descriptive analysis of four key credit risk indicators across three sector classifications: less sustainable, mixed and more sustainable [see Table 6].

1yrDD serves as a market-based measure of credit risk, where higher values indicate lower risk. Firms in the more sustainable sector exhibited the highest average 1yrDD (mean = 10.68, SD = 4.59). This suggests that firms with stronger sustainability profiles are perceived as more solvent by financial markets. Similarly, 1yrPD, which represents the estimated probability of default within the next year, was lowest among more sustainable firms (mean = 0.0004, SD = 0.0010).

Table 6. Statistical summary of credit risk indicators

Category	Count	Mean				Standard deviation			
		1yrDD	1yrPD	CDS	AltmanZ	1yrDD	1yrPD	CDS	AltmanZ
Less sustainable	187	8.45	0.0009	76.38	2.68	3.45	0.0026	55.09	1.17
Mixed	290	9.08	0.0014	83.71	4.35	4.50	0.0050	70.74	3.87
More sustainable	71	10.68	0.0004	62.40	4.62	4.59	0.0010	44.99	3.02

Source(s): Created by authors

The analysis of CDS Spreads, another market-based risk indicator, further supports this trend. Firms in the more sustainable category had the lowest average CDS spread (mean = 62.40), while mixed and less sustainable firms exhibited progressively higher spreads (mean = 83.71 and mean = 76.38, respectively). Lower CDS spreads indicate lower perceived credit risk by the market.

Finally, the Altman's Z-Score, a widely used measure of financial health where higher scores denote lower bankruptcy risk, was again highest for more sustainable firms (mean = 4.62, SD = 3.02), followed by mixed (mean = 4.35, SD = 3.87) and lowest for less sustainable firms (mean = 2.68, SD = 1.17).

After all, these findings provide preliminary evidence supporting a negative relationship between company sustainability and credit risk. Firms classified as more sustainable consistently exhibit more favourable credit risk profiles across all indicators. This suggests that ESG disclosure and sustainability practices may be associated with enhanced financial stability and lower perceived risk by capital markets.

4.2 Research model

This study identifies Altman's Z-Score as the most appropriate and theoretically consistent metric for subsequent empirical analysis. Of the credit risk indicators, Altman's Z-Score exhibited the greatest explanatory power (F = 19.35, $p < 0.001$) [see Table 7].

This finding was further supported by Tukey HSD tests, which confirmed that Altman's Z-Score differs significantly across all sector categories, particularly between less sustainable firms and both mixed and more sustainable firms [see Table 8]. In contrast, differences in 1yrPD and CDS were not statistically significant, and differences in 1yrDD were less pronounced. These results support selecting Altman's Z-Score as the most reliable credit risk indicator for subsequent analysis.

Beyond its statistical significance, its interpretability and long-standing use in bankruptcy prediction models make it a robust and credible proxy for credit risk. In addition, Altman's Z-score is less sensitive to short-term market volatility and external shocks, making it a more stable and reliable measure for longitudinal analysis. This credit risk indicator is also appropriate because sustainability refers to a long-term time horizon.

Table 7. Summary of credit risk indicators and significance

Indicator	Type of indicator	Description	F-statistic	Statistical significance (*p*-value)
AltmanZ	Accounting-based	Measures financial health using profitability, leverage, liquidity and efficiency	19.35	<0.001
1yrDD	Market-based	Distance from insolvency threshold based on asset volatility and market value	7.35	<0.001
1yrPD	Market-based	Model-estimated probability of default over the next year	2.21	0.1104
CDS	Market-based	Reflects market-perceived credit risk through cost of insuring debt	3.43	0.0329

Source(s): Created by authors

Table 8. Tukey HSD test results for differences in credit risk indicators across sectors

Group1	Group2	AltmanZ	1yrDD	1yrPD	CDS
			p-adj		
Less sustainable	Mixed	0.0000	0.2423	0.4050	0.4277
Less sustainable	More sustainable	0.0000	0.0004	0.5799	0.2484
Mixed	More sustainable	0.7913	0.011	0.1239	0.0288

Source(s): Created by authors

The Hausman test was used to determine which model to use, fixed effects (FE) or random effects (RE). The test compared FE and RE estimates to check whether the regressors were correlated with unobserved firm-specific effects. The results strongly favoured the FE model. We obtained a test statistic of $\chi^2 = 158.17$ with the appropriate degrees of freedom and a p-value close to zero ($p < 2.2 \times 10^{-16}$). This extremely significant result led us to reject the null hypothesis that the RE estimator is consistent.

To validate the inclusion of FE in the panel regression framework, we conducted an F-test for the joint significance of both entity (company) and time (year) FE. The results indicated that the two-way FE specification is statistically significant (F = 1.9255, df1 = 18, df2 = 470, p-value = 0.01258). This rejects the null hypothesis that all FE are equal to zero, implying that both firm-specific and time-specific effects explain a significant portion of the variance in credit risk (Altman's Z-Score). After all, the two-way FE model is the best specification for analysing the impact of ESG disclosure on firm-level credit risk.

To reduce the number of statistically insignificant independent variables in the model and make it less complex, the stepwise procedure was applied in the study. It should be noted that the stepwise procedure has significant limitations. While it can simplify the model by reducing the number of dependent variables, it may also exclude theoretically significant variables that are statistically insignificant. This can lead to biased coefficient estimates and reduce the model's generalizability. This was one of the reasons we decided not to use the model in our study: theoretically important dependent variables were excluded.

The basic FE model achieves a lower residual sum of squares (RSS = 415.04) than the stepwise model (RSS = 420.29), indicating a better fit to the observed data [see Table 9]. Similarly, the basic FE model explains a slightly larger proportion of the variance in the dependent variable, as reflected by its R-Squared value of 0.3018 (vs 0.2929 for the stepwise model). However, the adjusted R-squared value is higher in the stepwise model. The stepwise model yields a higher F-statistic (15.2658 on 13 and 479 df) than the basic FE model (9.2339), and this reflects the reduced model's greater efficiency in explaining variation per df rather than an improvement in overall fit.

In addition, two separate models are developed in which the basic FE model's ESG indicators are lagged by one or two years because sustainability is linked to financial stability, value creation and risk management over the long term. The two-year lag model achieved the highest overall R-squared value (0.3111) and the lowest residual sum of squares value (274.35), indicating that it best explains the variance in credit risk outcomes. It is important to note that the R-squared value increased from 0.3018 in the baseline FE model to 0.3111 in the two-year lag model. This confirms that ESG disclosure has a lagged effect on credit risk. However, its adjusted R-squared value (0.1769) is slightly lower than that of the stepwise model and the Basic FE model. As the theory states, this model shows that sustainability affects finances (in this study, credit risk) over the long term. Considering this, the two-year lagged FE model was selected as the final specification for further analysis.

Table 9. Comparison of models

Indicator	Basic FE model	Model by stepwise procedure	Model with one-year lag	Model with two-year lag
		Model		
Total sum of squares	594.43	594.43	482.97	398.24
Residual sum of squares	415.04	420.29	343.62	274.35
R-Squared	0.3018	0.2929	0.2885	0.3111
Adj. R-Squared	0.1874	0.1926	0.1600	0.1769
F-statistic	9.2339 on 22 and 470 DF	15.2658 on 13 and 479 DF	7.64979 on 22 and 415 DF	7.7999 on 22 and 380 DF
p-value	< 2.22e-16	< 2.22e-16	< 2.22e-16	< 2.22e-16

Source(s): Created by authors

It is important to note that multicollinearity did not affect the regression estimates in this study. As shown in Appendix I (the results of the VIF can be found in this appendix) and Appendix 3 (the results of the correlation can be found in this appendix), the correlations between all pairs of independent variables were below the usual threshold of 0.8 and the VIF values were below 5. These results suggest that multicollinearity is not an issue, thus ensuring the reliability of the presented coefficients [the coefficients can be found in Appendix 2, which is titled "Coefficients and significance of independent indicators"].

Also, we examined the distribution properties of all continuous variables using asymmetry, excess and normality tests [the results obtained can be seen in Appendix 4, which is titled "The results of the tests for asymmetry, excess and normality of the variables"]. The results showed that some variables, such as Altman's Z-score, exhibited moderate to high asymmetry, heavy tails and kurtosis; most variables, however, were closer to normal distributions. To maintain the economic interpretation of the original units of financial and credit risk indicators, no logarithmic transformations or standardization were applied in the study. Instead, we estimated all regressions using robust, clustered standard errors to mitigate potential errors because of non-normality and heteroscedasticity.

As can be seen in Appendix 2, "Coefficients and Significance of Independent Indicators," greater ESG reporting is associated with a better Altman's Z score. This indicates that increased transparency reduces information asymmetry, strengthening investor confidence and reducing the cost of capital and credit risk. Companies that integrate environmental standards (GRI standards, which are closely related to stakeholder theory because of their dual significance) into their reporting signal regulatory compliance, values and responsibility, leading to greater financial resilience. Conversely, opposite results were obtained for companies that integrate social GRI standards into their reporting. This could be interpreted as meaning that social responsibility disclosure is more prevalent in sectors facing greater labour or operational risks, meaning investors expect greater potential liabilities from companies operating in such sectors.

Following the signing of the Paris Agreement, companies operating in sustainable sectors obtained better financing costs due to lower credit risk. Conversely, companies in mixed sectors experienced fewer financial benefits from sustainability practices. Finally, the positive GRI factor coefficient confirms that standardized ESG reporting improved credit

ratings after the Paris Agreement was signed by reducing uncertainty and information asymmetry and increasing comparability between companies.

5. Results analysis and discussion

5.1 Results analysis

According to the results of the two-year lagged FE model, the six independent variables related to ESG disclosure are statistically significant [see Table 10 and Appendix 2, which is titled "Coefficients and significance of independent indicators"]. Therefore, *H1* is rejected.

H2 is also rejected [see Table 11 and Appendix 2, which is titled "Coefficients and significance of independent indicators"]. After applying a two-year lag, five ESG indicators related to ESG reporting became statistically significant. Meanwhile, two indicators remained statistically significant after two years, though their significance decreased with the application of a lag. These results confirm the theory that ESG indicators and their disclosure impact finances in the long term.

H3 is rejected because ESGD became statistically significant [see Table 12]. This suggests that regulatory and societal pressures increased the importance of ESG disclosure in credit risk assessments.

Table 10. Results of *H1* testing

Variable	Model with two-year lagged sustainability data	
	Estimate	*p*-value
ESGD	2.6270e-02	0.0152191*
GRIE	2.3052e-01	0.0007767***
GRIS	−1.7079e-01	0.0264827*
PostMore	1.6599e-01	0.0318757*
PostMixed	−7.8965e-02	0.0642997
GRI	7.7073e-02	0.0494653*

Note(s): ***$p < 0.001$; **$p < 0.01$; *$p < 0.05$; $p < 0.1$
Source(s): Created by authors

Table 11. Results of *H2* testing

Variable	Basic FE model		Model with one-year lagged sustainability data		Model with two-year lagged sustainability data	
	Estimate	*p*-value	Estimate	*p*-value	Estimate	*p*-value
ESGD	3.9327e-02	0.000160***	3.6223e-02	0.001043**	2.6270e-02	0.0152191*
BoardMeetings	−4.2280e-02	0.014476*	−3.6985e-02	0.045621*	−2.7711e-02	0.1003272
GRIE	−6.2242e-03	0.906232	6.8871e-02	0.232558	2.3052e-01	0.0007767***
GRIS	−6.9192e-03	0.914141	−6.8043e-02	0.332279	−1.7079e-01	0.0264827*
PostMore	1.9252e-02	0.797550	5.3280e-02	0.494759	1.6599e-01	0.0318757*
PostMixed	−2.7852e-02	0.497384	−4.7318e-02	0.266734	−7.8965e-02	0.0642997
GRI	−1.6716e-02	0.555554	2.6416e-02	0.447930	7.7073e-02	0.0494653 *

Note(s): ***$p < 0.001$; **$p < 0.01$; *$p < 0.05$; $p < 0.1$
Source(s): Created by authors

Table 12. Results of *H3* testing

Variable	Prior to the Paris Agreement (up to 2015)		Post-Paris Agreement (from 2016)	
	Estimate	*p*-value	Estimate	*p*-value
ESGD	9.0080e-03	0.4771675	1.0654e-01	0.0175524*

Note(s): ***$p < 0.001$; **$p < 0.01$; *$p < 0.05$; $p < 0.1$
Source(s): Created by authors

5.2 Discussion

The results of the study show that broader ESG disclosure (ESGD) and references to GRI environmental standards (GRIE) are associated with higher Altman Z-scores. However, GRI references to social performance (GRIS) have a negative impact on credit risk; that is, greater disclosure increases credit risk. These results align with stakeholder theory and institutional theory. Standardized and comprehensive ESG disclosure can strengthen stakeholder confidence in the company, reduce information asymmetry and contribute to better financial resilience over time through governance and risk management procedures that meet the highest quality standards.

The results are also consistent with signalling theory and reveal a channel of information asymmetry. For instance, positive GRI and GRIE ratios indicate that the disclosure is aligned with the standardized framework, which reduces verification costs for creditors. Thus, standardized ESG disclosure that complies with the framework reduce information asymmetry and improve financing conditions.

The impact delays used in the study align with the logic of stakeholders and institutions who argue that governance quality, risk process management and stakeholder relations gradually accumulate value. Thus, the benefits of disclosure should manifest with a delay, as observed when comparing the baseline model with the two-year delay model.

The positive PostMore coefficient, which represents more sustainable sectors, is consistent with the idea that industries that are more sustainable and environmentally friendly are more likely to earn public trust because it signals strong governance. Conversely, the weak negative PostMixed effect and negative GRIS coefficient likely reflect the prevalence of intensive social disclosure in sectors with higher risks of operations and work, as well as a higher likelihood of unforeseen adverse events. This could be consistent with legitimacy theory, whereby disclosure is used to maintain social legitimacy in higher-risk environments.

Furthermore, testing hypothesis *H3* revealed a change in the significance of the impact of ESG disclosure. Following the Paris Agreement, the ESGD variable became statistically more significant. This finding aligns with institutional theory, which posits that tighter compliance requirements and increasing regulatory expectations increase the importance and valuation of sustainability information.

Finally, the negative GRIS coefficient and the fact that not all ESG aspects reduce risk equally allow for critical thinking from a shareholder theory perspective. This means that when disclosure increases costs without corresponding improvements in risk management, or when the market suspects that sustainability claims are not realistic, credit spreads do not necessarily decrease.

In summary, the evidence aligns with the article's theoretical framework: stakeholder, institutional and signalling (information asymmetry) channels collectively account for the positive correlation between standardized ESG disclosure and reduced credit risk over time.

Meanwhile, legitimacy dynamics and shareholder theory caveats account for the observed variability in impact across ESG pillars and sectors.

6. Conclusion, further research and limitations of research

6.1 Conclusion

From a practical perspective, the study's findings suggest that credit rating agencies should incorporate standardized ESG disclosure indicators into their credit risk assessment models and pay attention to GRI sustainability standards. This is because the delayed impact of ESG disclosures is statistically significant in predicting a company's future financial position. A study conducted by Kumar *et al.* (2021) confirmed that standardized ESG disclosure (GRI standards) improves the quality of information disclosure and increases financial credibility in capital markets, including credit risk assessments. The results of a study conducted by Nasreen *et al.* (2022) confirmed that GRI standards have been properly applied as an ESG disclosure indicator and that this indicator is widely used in scientific research.

Lenders should also consider a company's ESG disclosures when assessing creditworthiness, as incorporating them into risk models reduces default risk, improves loan portfolio quality and enhances sustainability performance.

Company managers should recognize the benefits of transparent, comprehensive and standardized ESG reporting. Such reporting reduces information asymmetry, which leads to better access to financing sources and improved financing conditions. These improvements lead to long-term financial stability and enhanced creditworthiness. The results of this empirical study confirm this: a one-point increase in the ESG disclosure score is associated with a 0.026 increase in Altman's Z-score. Therefore, companies should view ESG disclosure as a strategic tool rather than a means of complying with regulatory requirements.

Furthermore, the results of the study suggest that regulatory authorities and policymakers are justified in increasing requirements for standardized disclosure of sustainability-related information - this is especially evident in the European Union. This can reduce information asymmetry in financial markets. The results further confirm the necessity of mandatory, verifiable disclosure of sustainability-related information to combat greenwashing.

This study also has pedagogical value. In financial risk analysis courses, it shows how ESG indicators can supplement traditional models, such as Altman's Z-score. In corporate governance courses, it emphasizes the importance of transparency and disclosure standards. In ESG investing, it makes the case for incorporating sustainability factors into credit assessments.

It is also important to mention that ESG reporting supports the UN Sustainable Development Goals by promoting sustainable economic growth, stronger institutions, climate resilience and responsible production.

Economic growth. According to stakeholder theory, standardized ESG disclosure reduces information asymmetry and builds trust. This lowers credit risk, leading to cheaper and more stable financing for sustainable activities.

Strong institutions. According to institutional theory, high governance standards that align with public expectations and norms lead to comprehensive, detailed and unbiased accountability. This, in turn, determines stakeholder trust and improves financing conditions. Stakeholder theory supports this idea, adding that high governance standards also improve a company's long-term performance.

Climate action. According to legitimacy theory, sustainable business models, shaped by regulation and public pressure, increase resilience to climate risks and strengthen financial stability.

Responsible production. According to legitimacy theory, rising demand and regulations are driving ESG disclosure (this is in line with market expectations), which improves creditworthiness and steers markets and society toward sustainability.

In summary, ESG disclosure improves reputation, meets public expectations and complies with legal requirements. According to theories, it also contributes to improved creditworthiness and long-term financial stability. Looking ahead, growing regulatory and stakeholder pressure will lead to more standardized disclosure of sustainability-related data. This is important to avoid greenwashing practices. The importance of sustainability-related information for credit risk assessment underscores the need for improved research on incorporating it into credit risk assessment and its practical application.

6.2 Further research and limitations of research

Future research could involve conducting a similar study with small and medium-sized companies. Another option would be to conduct a similar study in emerging markets, which have less stringent ESG disclosure requirements. Further research could also examine lagged ESG impacts or adapt models to study time-varying impacts, especially during economic or regulatory shocks, such as the pandemic or the implementation of sustainability initiatives. Additionally, a qualitative study could analyse ESG reports using text analysis, sentiment analysis, or greenwashing detection methods. Future studies may also seek to replicate this study by addressing certain limitations, which are listed below.

One limitation of the study is that ESG disclosure data on the Bloomberg Terminal is only available on an annual basis. This results in a short time series and a small number of observations per company. The lack of a long time series for sustainability-related indicators also complicates the study, particularly in relation to the delayed impact of reporting on credit risk. The study is also limited by its failure to consider crisis periods such as the global financial crisis of 2008–2009 and the pandemic of 2020–2021, which may have impacted the importance of credit risk assessment and ESG disclosure. Future research could re-evaluate the model by excluding these periods. Furthermore, future research could focus on identifying a reliable metric to evaluate the average ESG disclosure score within the sector.

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Appendix 1

Table A1. Indicators used in the model

Type of indicator	Abbreviation of indicator	Name of indicator	Source	Aim of the indicator in the model	VIF
Credit risk indicators	AltmanZ	Altman Z-score	Bloomberg terminal	The purpose of this indicator is to measure credit risk	–
	1yrPD	1-year probability of default	Bloomberg terminal		
	1yrDD	1-year distance to default	Bloomberg terminal		
	CDS	CDS spread	Bloomberg terminal		
Financial indicators	EBIT	EBIT	Bloomberg terminal	The purpose of this indicator is to reflect the impact of financial indicators on credit risk	2.56
	FinLev	Financial leverage	Bloomberg terminal		1.49
	IntCov	Interest coverage ratio	Bloomberg terminal		1.23
	NDSE	Net debt to shareholders equity	Bloomberg terminal		1.46
	NDCF	Net debt to cash flow	Bloomberg terminal		1.35
	OperMargin	Operating margin	Bloomberg terminal		2.58
	ProfitMargin	Profit margin	Bloomberg terminal		2.77
	ROE	ROE	Bloomberg terminal		1.90
	Asset	Total asset	Bloomberg terminal		2.91
ESG indicators	AuditMeetings	Number of audit committee meetings per year	Bloomberg terminal	A higher number of meetings is assumed to be associated with higher governance standards, which implies better transparency	2.51
	BoardMeetings	Number of board meetings per year	Bloomberg terminal		1.43
	ESGD	ESG disclosure score	Bloomberg terminal	Higher ESG disclosure score is associated with better transparency	2.47
	GRIE	Number of documents per year mentioning GRI environmental standards (301, 302, 303, 304, 305, 306, 307)	Bloomberg terminal (the calculation was done by authors)	The purpose of this indicator is to assess whether the company is committed to ESG reporting and meeting the highest reporting standards	2.24
	GRIG	Number of documents per year mentioning GRI governance standards (201, 203, 205, 207, 419)	Bloomberg terminal (the calculation was done by authors)		2.32

(continued)

Table A1. Continued

Type of indicator	Abbreviation of indicator	Name of indicator	Source	Aim of the indicator in the model	VIF
	GRIS	Number of documents per year mentioning GRI social standards (401, 402, 403, 404, 405, 406, 413, 414)	Bloomberg terminal (the calculation was done by authors)		2.93
	Women	Percentage of women on the board	Bloomberg terminal	A higher percentage of women in an organization is associated with greater equality. This, in turn, is linked to higher standards of governance, leading to a better transparency	2.22
	GRI	Change in the number of documents per year that mention GRI	Bloomberg terminal (the calculation was done by authors)	The indicator is calculated from 2016, the year of the Paris Agreement. The purpose of this indicator is to measure changes in accountability since the signing of the Paris Agreement, which is a significant event for sustainability.	1.21
	SASB	Change in the number of documents per year that mention SASB	Bloomberg terminal (the calculation was done by authors)		1.32
	TCFD	Change in the number of documents per year that mention TCFD	Bloomberg terminal (the calculation was done by authors)		1.34
	PostMore	Annual change in ESG disclosure score for companies in the more sustainable sector	Bloomberg terminal (the calculation was done by authors)		1.04
	PostMixed	Annual change in ESG disclosure score for companies in the mixed sector	Bloomberg terminal (the calculation was done by authors)		1.72
	PostLess	Annual change in ESG disclosure score for companies in the less sustainable sector	Bloomberg terminal (the calculation was done by authors)		1.10

Source(s): Created by authors

Appendix 2

Table A2. Coefficients and significance of independent indicators

Variable	Basic FE model		Model by stepwise procedure		Model with one-year lagged sustainability data		Model with two-year lagged sustainability data	
	Estimate	p-value	Estimate	p-value	Estimate	p-value	Estimate	p-value
NDSE	-2.9251e-03	0.021745*	-2.7559e-03	0.0220335*	-2.2564e-03	0.170712	-2.0924e-03	0.1293371
ROE	7.8481e-03	0.293415	–	–	1.6377e-02	0.066549	1.7184e-02	0.0482203*
EBIT	-2.7850e-06	0.888389	-1.3928e-06	0.9424841	-8.6164e-06	0.664522	-7.6417e-06	0.6891794
OperMargin	9.4853e-02	1.034e-07***	9.4833e-02	7.249e-08***	9.3231e-02	4.62e-07***	9.1576e-02	1.178e-06***
ProfitMargin	-1.2052e-02	0.518261	2.2586e-03	0.8691845	-2.2741e-02	0.280437	-1.6539e-02	0.4417937
NDCF	-7.7949e-04	0.929563	–	–	-1.4129e-02	0.627162	-8.5498e-05	0.9919641
ESGD	3.9327e-02	0.00016***	3.7550e-02	0.0002070***	3.6223e-02	0.001043**	2.6270e-02	0.0152191*
AuditMeetings	-4.6046e-02	0.139007	–	–	-3.3198e-02	0.319538	-3.8619e-02	0.2444553
Women	9.9169e-04	0.878875	3.6935e-04	0.9532523	-1.8724e-03	0.782847	-2.9406e-03	0.6625843
BoardMeetings	-4.2280e-02	0.01447*	-4.7300e-02	0.0039247**	-3.6985e-02	0.045621*	-2.7711e-02	0.1003272
Asset	-4.6608e-06	0.00345**	-4.6605e-06	0.0027752**	-4.3108e-06	0.009950***	-3.0771e-06	0.0720360
FinLev	-8.2658e-02	0.00642**	-8.4481e-02	0.0045597**	-6.5709e-02	0.040429*	-5.3382e-02	0.0941734
IntCov	7.9230e-04	0.00199**	8.4990e-04	0.0007547***	6.9483e-04	0.007556**	4.3325e-04	0.0923048
GRIE	-6.2242e-03	0.906232	5.8048e-03	0.9094333	6.8871e-02	0.232558	2.3052e-01	0.0007767***
GRIS	-6.9192e-03	0.914141	-1.0652e-02	0.8540460	-6.8043e-02	0.332279	-1.7079e-01	0.0264827
GRIG	8.1169e-03	0.902922	–	–	2.1688e-03	0.978858	4.4852e-02	0.6641988
PostLess	-4.9371e-02	0.411306	–	–	-2.7688e-02	0.655870	4.3607e-02	0.5176805
PostMore	1.9252e-02	0.797550	–	–	5.3280e-02	0.494759	1.6599e-01	0.0318757*
PostMixed	-2.7852e-02	0.497384	-2.3191e-02	0.5653941	-4.7318e-02	0.266734	-7.8965e-02	0.0642997
GRI	-1.6716e-02	0.555554	–	–	2.6416e-02	0.447930	7.7073e-02	0.0494653*
SASB	2.0125e-02	0.464763	–	–	3.1915e-03	0.922609	-3.9985e-02	0.7240758
TCFD	1.2647e-02	0.489712	–	–	3.4028e-02	0.247116	-5.3417e-02	0.1793669

Note(s): ****$p < 0.001$; ***$p < 0.01$; **$p < 0.05$; *$p < 0.1$
Source(s): Created by authors

Appendix 3

Table A3. Correlation matrix

Indicator	NDSE	ROE	EBIT	OperMargin	ProfitMargin	NDCF	ESGD	AuditMeetings	Women	BoardMeetings	Asset	FinLev
NDSE	1	-0.09	0.05	-0.03	-0.14	0.45	-0.05	0.11	-0.05	0.05	0.06	0.13
ROE	-0.09	1	0.11	0.46	0.53	-0.07	-0.16	-0.13	-0.01	-0.25	-0.23	0.01
EBIT	0.05	0.11	1	0.21	0.05	-0.05	0.26	0.17	0.04	0.08	0.62	0
OperMargin	-0.03	0.46	0.21	1	0.53	0.02	-0.02	0	0.05	-0.14	-0.25	-0.3
ProfitMargin	-0.14	0.53	0.05	0.53	1	0.07	-0.04	-0.08	0.07	-0.14	-0.22	-0.25
NDCF	0.45	-0.07	-0.05	0.02	0.07	1	0.01	0.06	-0.02	-0.04	-0.07	-0.02
ESGD	-0.05	-0.16	0.26	-0.02	-0.04	0.01	1	0.35	0.56	0.25	0.29	-0.13
AuditMeetings	0.11	-0.13	0.17	0	-0.08	0.06	0.35	1	0.07	0.44	0.23	0.06
Women	-0.05	-0.01	0.04	0.05	0.07	-0.02	0.56	0.07	1	0.07	0.05	-0.12
BoardMeetings	0.05	-0.25	0.08	-0.14	-0.14	-0.04	0.25	0.44	0.07	1	0.24	0.07
Asset	0.06	-0.23	0.62	-0.25	-0.22	-0.07	0.29	0.23	0.05	0.24	1	0.32
FinLev	0.13	0.01	0	-0.3	-0.25	-0.02	-0.13	0.06	-0.12	0.07	0.32	1
IntCov	-0.22	0.18	-0.08	0.3	0.19	-0.08	-0.11	-0.09	0.01	-0.09	-0.15	-0.13
GRIE	-0.05	-0.01	0.1	0	0.01	0.03	0.36	0.19	0.29	0.25	0.14	0.08
GRIS	0.01	0.04	0.05	0.04	0.01	0.03	0.42	0.14	0.37	0.14	0.07	0.02
GRIG	0.04	0.04	0.07	0.03	0.02	0.06	0.37	0.1	0.36	0.08	0.06	0.03
Paris	-0.01	-0.01	0.17	0.04	0.07	0.01	0.64	0.11	0.7	0.14	0.21	-0.02
PostLess	-0.03	-0.1	0.09	-0.09	-0.07	0.02	0.21	0.01	0.13	0.02	0.1	0.02
PostMore	-0.01	0.05	0	0.05	0.06	-0.01	0.04	0	0.09	-0.01	-0.01	-0.01
PostMixed	-0.02	-0.07	0	0.14	-0.39	-0.08	0.17	-0.01	0.13	0.02	0.07	-0.01
GRI	0.02	0	0.11	0.05	-0.07	-0.01	0.14	0.12	0.12	-0.04	0.1	0.03
SASB	0.08	0	0.09	0.01	0.02	0.03	0.1	0	0.14	0.02	0.12	0.05
TCFD	0.04	0.01	0.08	0.03	0.01	0	0.09	0.02	0.13	0.03	0.1	0.04

Source(s): Created by authors

Table A3. Continued

Indicator	IntCov	GRIE	GRIS	GRIG	Paris	PostLess	PostMore	PostMixed	GRI	SASB	TCFD
NDSE	-0.22	-0.05	0.01	0.04	-0.01	-0.03	-0.01	-0.02	0.02	0.08	0.04
ROE	0.18	-0.01	0.04	0.04	-0.01	-0.1	0.05	-0.07	0	0	0.01
EBIT	-0.08	0.1	0.05	0.07	0.17	0.09	0	0	0.11	0.09	0.08
OperMargin	0.3	0	0.04	0.03	0.04	-0.09	0.05	0.14	0.05	0.01	0.03
ProfitMargin	0.19	0.01	0.01	0.02	0.07	-0.07	0.06	-0.39	-0.07	0.02	0.01
NDCF	-0.08	0.03	0.03	0.06	0.01	0.02	-0.01	-0.08	-0.01	0.03	0
ESGD	-0.11	0.36	0.42	0.37	0.64	0.21	0.04	0.17	0.14	0.1	0.09
AuditMeetings	-0.09	0.19	0.14	0.1	0.11	0.01	0	-0.01	0.12	0	0.02
Women	0.01	0.29	0.37	0.36	0.7	0.13	0.09	0.13	0.12	0.14	0.13
BoardMeetings	-0.09	0.25	0.14	0.08	0.14	0.02	-0.01	0.02	-0.04	0.02	0.03
Asset	-0.15	0.14	0.07	0.06	0.21	0.1	-0.01	0.07	0.1	0.12	0.1
FinLev	-0.13	0.08	0.02	0.03	-0.02	0.02	-0.01	0.07	0.03	0.05	0.04
IntCov	1	-0.05	-0.05	-0.05	-0.08	-0.04	-0.01	-0.01	-0.02	-0.02	-0.02
GRIE	-0.05	1	0.7	0.59	0.42	0.03	0.02	0.06	0.07	0.2	0.16
GRIS	-0.05	0.7	1	0.72	0.48	0.04	0.09	0.11	0.13	0.19	0.18
GRIG	-0.05	0.59	0.72	1	0.46	0.01	0.02	0.09	0.17	0.21	0.2
Paris	-0.08	0.42	0.48	0.46	1	0.21	0.11	0.14	0.19	0.16	0.16
PostLess	-0.04	0.03	0.04	0.01	0.21	1	-0.02	0.01	0.05	0.01	0.01
PostMore	-0.01	0.02	0.09	0.02	0.11	-0.02	1	-0.01	-0.04	0.05	-0.03
PostMixed	0	0.06	0.11	0.09	0.14	0.01	-0.01	1	0.06	-0.02	0
GRI	-0.02	0.07	0.13	0.17	0.19	0.05	-0.04	0.06	1	0.23	0.31
SASB	-0.02	0.2	0.19	0.21	0.16	0.01	0.05	-0.02	0.23	1	0.44
TCFD	-0.02	0.16	0.18	0.2	0.16	0.01	-0.03	0	0.31	0.44	1

(*continued*)

Appendix 4

Table A4. The results of the tests for asymmetry, excess and normality of the variables

Variable	Skewness	Kurtosis	W-statistic	p-value
NDSE	0.44	1.18	0.975	3.55e-05
ROE	1.05	5.18	0.916	4.60e-12
EBIT	2.42	7.94	0.769	2.02e-20
OperMargin	1.39	3.63	0.911	1.98e-12
ProfitMargin	1.17	2.81	0.922	1.54e-11
NDCF	9.09	170.04	0.218	9.32e-34
ESGD	−0.18	0.28	0.993	1.94e-01
AuditMeetings	1.88	4.72	0.815	2.30e-18
Women	0.28	−0.62	0.965	1.07e-06
BoardMeetings	2.38	9.22	0.795	2.71e-19
Asset	1.73	3.56	0.814	2.01e-18
FinLev	5.33	28.9	0.306	2.69e-32
IntCov	7.24	58.22	0.214	8.04e-34
GRIE	17.46	305.0	0.032	1.88e-36
GRIS	12.29	149.97	0.053	3.69e-36
GRIG	12.29	149.97	0.053	3.69e-36
1yrDD	0.6	0.09	0.971	9.15e-06
1yrPD	6.69	52.23	0.291	1.53e-32
CDS	2.08	5.38	0.799	3.83e-19
AltmanZ	2.45	8.26	0.778	4.93e-20
Paris	0.0	0.0	1.0	1.00e + 00
PostLess	0.0	0.0	1.0	1.00e + 00
PostMore	0.0	0.0	1.0	1.00e + 00
PostMixed	0.0	0.0	1.0	1.00e + 00
GRI	−12.99	172.97	0.053	3.66e-36
SASB	−15.44	249.34	0.046	2.98e-36
TCFD	−16.99	292.9	0.039	2.34e-36

Source(s): Created by authors

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