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Banking Supervision Policy Working Paper Series
In the context of the SSM-EUI partnership on SSM Banking Supervision Learning Services

WORKING PAPER

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Abstract

This paper investigates the impact of the firms' environmental performance on their credit rating. To this end, we conduct a transatlantic study covering companies in the United States (US) and in the European Union (EU). Our study reveals that firms' environmental improvements positively contribute to their credit ratings. However, this effect varies between the US and the EU. If US and European firms enhance their environmental performance by the same scale, the former's creditworthiness benefits more than the latter's. Additionally, we show that improvements in environmental performance affect credit ratings linearly in the US but nonlinearly in the EU. These findings shed light on the implications of the firms' environmental performance and provide critical insights into the impact of corporate sustainability indicators on credit ratings.

Keywords

Credit Ratings, Climate Risk, Environmental Performance, Transatlantic Study

Environmental Performance and Credit Ratings: A Transatlantic Study

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JEL Classification: G15; G24; G32; Q51

[†]The views expressed in this paper are those of the authors and do not necessarily reflect the views of the Federal Financial Supervisory Authority (BaFin) or its staff.

1. Introduction

In this study, we investigate whether high environmental performances contribute to improvements in the US and European firms' credit ratings and how the influence of corporate environmental indicators differs between firms in the two regions. This question is of particular significance given the increasing attention to companies' environmental performance over time (Bauer & Hann, 2010; Christensen, Hail, & Leuz, 2021; Dyck, Lins, Roth, & Wagner, 2019; Klassen & McLaughlin, 1996; Trinh, Cao, Li, & Elnahass, 2023), and uncovers the environmental determinants of credit ratings in two of world's largest economies. The implications are substantial: even minor improvements in credit ratings can result in reduced debt costs, fewer debt issues, and increased capital investment (Baghai, Servaes, & Tamayo, 2014; T.T. Tang, 2009).

This paper provides an important update on this research question, since the leading credit rating agencies (CRAs) have incorporated climate-related and environmental risk measures into their assessments of debt issuers' creditworthiness (Fitch, 2019; Moody's, 2023; Standard & Poor's, 2023). This is due to the growing importance of the firms' environmental and social activities, which impact both their financial and non-financial attributes, such as management strength and long-term sustainability (Attig, El Ghoul, Guedhami, & Suh, 2013). Given the differing perceptions and regulatory requirements of ESG/CSR between the US and EU, we further posit that the influence of environmental performance on credit ratings differs across these two regions.[1]

To empirically examine the effects of firms' environmental indicators on their credit ratings, we use the environmental pillar of the ESG ratings provided by Thomson Reuters ASSET4 ESG database as a measure of the company's environmental performance. Our rating sample includes long-term foreign currency issuer ratings issued by S&P, Moody's, and Fitch. We employ two methodologies to transform credit rating into scores: (1) we combine credit ratings, watches and outlooks together into numerical values ranging from 0 to 58 for the OLS model, and (2) we only consider credit rating signals and transform rating notches into ordinal numbers from 1 to 20 for the ordinal logit model.

Our findings suggest that rating agencies tend to grant firms with higher environmental scores better credit ratings. Moreover, we find that the impact of environmental performances on firms' ratings differs between the US and EU. This can be partially explained by the differences in the level of environmental performance in the two regions, in line with Cai, Pan, and Statman (2016) and Liang and Renneboog (2017).The EU's more strict ESG/CSR regulations result in better environmental performance of their firms (Christensen et al., 2021), whereas environmental or social performance disclosure is optional in the US. Thus, credit rating agencies are likely to evaluate the implications of an increase in environmental performance differently across these two regions. For instance, US firms that improve their environmental scores can be perceived as more proactive due to their country's less stringent environmental policy (Chava, 2014), and such voluntary improvements may be rewarded. In contrast, the EU has the norm of a high-level environmental consciousness, and thus an additional improvement in EU firms' environmental performance may have smaller benefits on their credit ratings, especially considering strict penalties for non-compliance (Paris Agreement, 2015).

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[1] We follow Gillan, Koch, and Starks (2021) to treat the terms ESG and CSR as if they are interchangeable and use the terminology ESG/CSR.

Our first contribution is to investigate how improvements in firms' environmental performance affect their credit ratings. Previous studies have examined the factors that influence credit rating in several areas. A few of these focus on CSR and corporate social performance (CSP) in the US (Attig et al., 2013; Ge & Liu, 2015; Oikonomou, Brooks, & Pavelin, 2014) and in the EU (Menz, 2010; Stellner, Klein, & Zwergel, 2015). Some studies document the correlation between firms' credit ratings and environmental performance in the US (Bauer & Hann, 2010; Safiullah, Kabir, & Miah, 2021; Seltzer, Starks, & Zhu, 2022). We extend this line of research by investigating the relation between firm-level environmental scores and credit ratings with a more comprehensive credit rating measure and a more recent dataset in both US and EU.

Our second contribution is to provide insights on the regional differences between the US and the EU regarding the impact of firms' environmental performance on credit ratings. Cai et al. (2016), Liang and Renneboog (2017), and Christensen et al. (2021) find that the ESG/CSR level is generally higher in the EU than in the US. Inspired by this line of research, our findings enrich the existing literature by suggesting that regional environmental norms also affect the influence of firms' environmental performance on their credit ratings.

The remainder of this paper is organised as follows. Section 2 presents the hypothesis development. Section 3 elaborates on the construction of numerical credit ratings and the baseline model. Section 4 outlines the data and provides summary statistics. Section 5 presents the empirical results, including a brief description of the endogeneity and robustness tests we conducted. Due to space limitations, we do not illustrate the results of these additional tests but can provide them upon request. Section 6 concludes the paper and discusses implications.

2. Hypothesis development

International treaties and guidelines on climate change have significantly increased the importance of climate and environmental factors in the practice of risk assessment and management. The United Nations Framework Convention on Climate Change (UNFCCC) was a pioneering treaty that set the goal of "stabilising greenhouse gas concentrations in the atmosphere". In 1997, the Kyoto Protocol set out a roadmap for implementing the UNFCCC's measures. The Paris Agreement on climate change, which was signed in 2015 and replaced the Kyoto Protocol, marked a historic commitment to transition to a more sustainable global economy. Following the Paris Agreement, a number of countries have published their national climate action plans, including proposals for new regulations for both financial and non-financial firms. In this context, the Big Three CRAs have incorporated climate and environ- mental factors into their credit risk assessments of debt issuers (Fitch, 2019; Moody's, 2023; Standard & Poor's, 2023).

A firm's credit ratings can be indirectly affected by its ESG factors, through the effects of corporate financial performance (CFP) and cost of debt. A number of previous studies find a positive correlation between firms' ESG dimensions and CFP (Clarkson, Li, Richardson, & Vasvari, 2011; Gompers, Ishii, & Metrick, 2003; Kang, Germann, & Grewal, 2016; Klassen & McLaughlin, 1996; Konar & Cohen, 2001; Liesen, Figge, Hoepner, & Patten, 2017; Oikonomou, Platanakis, & Sutcliffe, 2018; Russo & Fouts, 1997; Siddique, Akhtaruzzaman, Rashid, & Hammami, 2021). Although the leading CRAs have not disclosed their rating methodology in detail, they confirm that good CFP has a positive impact on their credit rating assessment (see e.g. Fitch, 2023; Standard & Poor's, 2019). In this sense, a company's ESG achievements can help to reduce its credit risk. Moreover, empirical evidence shows that companies with good ESG performance have a lower cost of debt (Apergis, Poufinas, & Antonopoulos, 2022; Chava, 2014; Eliwa, Aboud, & Saleh, 2021; Goss & Roberts, 2011; Javadi & Masum, 2021). Since a firm's cost of debt is negatively correlated with its credit risk (Kisgen, 2006), an improvement of the firm's ESG performance can have a positive impact on its external credit ratings.

Firms' environmental performance is also a crucial criterion for their interactions with stakeholders. In view of stakeholder theory (Freeman, 1984), firms that demonstrate high social responsibility are more likely to establish good relationships with various stakeholders, including employees, consumers, suppliers, investors and regulators (Fombrun & Shanley, 1990; Waddock & Graves, 1997). Successful relationship management can help increase a firm's intangible value and market reputation, such as higher customer loyalty, better ability to attract and retain high quality employees (Greening & Turban, 2000; Turban & Greening, 1997), and more external financial resources (Chava, 2014; Dyck et al., 2019; Fernando, Sharfman, & Uysal, 2017; D.Y. Tang & Zhang, 2020). These enhancements can further improve the company's credit risk profile.

In line with these theoretical and empirical arguments, we posit that the rating agencies treat improvements in the firms' environmental performance as a positive determinant of credit ratings. Hence, we propose the following hypothesis:

> **H1.** In both the US and the EU, an enhancement in a firm's environmental performance contributes to an improvement in its credit rating.

Although we expect that the positive impact of a firm's environmental improvement on its creditworthiness exists in both regions, the magnitude of this effect may differ between the US and European firms. Cai et al. (2016) use a sample of firms from 36 countries to investigate country-level differences in ESG ratings. Their results confirm that country factors are more influential for ESG ratings than firm characteristics and other economic factors. Moreover, most of the EU countries in their study present greater ESG ratings than the US. Liang and Renneboog (2017) use an extended sample of companies from 114 countries and come to a comparable conclusion: The legal origin of the country is the strongest explanatory factor for firms' ESG ratings. As a result, the US, as a common law country, has a lower average ESG performance than European countries, which are mostly civil law jurisdictions.

Differences in regulatory requirements and political ambitions between the EU and the US may further exacerbate the differential impact of corporate environmental performance on credit ratings. The EU Non-Financial Reporting Directive (NFRD), adopted in 2014, requires companies in scope to publish a non-financial report on their ESG performance. The NFRD contributes to the assessment of the non-financial performance of large companies as measured in ESG dimensions. In contrast, US firms publish CSR-related information either on a voluntary basis or when disclosure is material to investors under existing securities law, as in Christensen et al. (2021). In 2018, the EU published its Action Plan on Sustainable Finance, which aims to guide more investment in projects and companies that take ESG considerations into account. A year later, the European Commission presented the European Green Deal, with the political ambition to become the world's first climate neutral continent by 2050. As a crucial component of the Green Deal, European Climate Law set a legally binding target to reduce greenhouse gas emissions by 55% by 2030 compared to 1990. Unlike the EU, the US has not passed any major climate change legislation in the past decade. In addition, political uncertainty in the US, with the withdrawal from the Paris Agreement under the Trump administration being the most prominent example, may negatively affect the average level of US firms' environmental performance.

The ambitious political goals and strict regulations accelerate the adoption of a more sustainable business model in the EU, which can lead to good environmental performance becoming the new normal for European companies. As a result, further improvements in European firms' environmental indicators may not lead to substantial increases in credit ratings. By contrast, since the average level of ESG ratings is low in the US, firms demonstrating superior environmental performance are likely to be rewarded by rating agencies as recognition of their proactive environmental efforts. These considerations lead to our second hypothesis:

> **H2.** The improvement in a firm's credit rating brought forward by enhancements in its environmental performance is more pronounced in the US than in the EU.

3. Data

In this section, we illustrate the data sample and summary statistics. Our sample consists of firm-level environmental performance (measured by environmental scores from the Thomson Reuters ASSET4 ESG database) and long-term foreign-currency credit ratings issued by the three leading credit rating agencies (CRAs), namely Standard & Poor's, Moody's, and Fitch.

3.1. Sample construction

The credit rating sample is extracted from Bloomberg and contains three types of rating signals for all non-financial firms in the US and the EU: long-term foreign currency issuer ratings, credit watches and outlooks. The rating signals are issued by one of the three leading CRAs in the period from January 2003 to December 2022. According to Alsakka and Ap Gwilym (2013) and Alsakka, ap Gwilym, and Vu (2014), issuer ratings are transformed into numerical values according to a 20-point scale. Based on the numerical rating scale, upgrades (downgrades) are identified if the numerical current rating is higher (lower) than the previous one. Next, we consider credit watches and outlooks as additional rating signals. Positive (negative) watch signals, which by definition consist of placements on a rating agency's positive (negative) watch list, are either solo or combined signals. The former are identified as 'stand-alone' watch list placements, while the latter are watch signals accompanied by the same agency's rating changes. Positive (negative) outlook signals are additions to positive (negative) outlook lists for the countries with stable outlooks or no outlook announcement in advance. Similarly, outlook signals can also be solo or combined with rating changes.

In order to differentiate between solo and combined rating signals in a precise way, it is necessary to introduce a more powerful rating scale which fully takes the differences between solo and combined rating signals into consideration. For this purpose, the initial transformation based on a 20-point scale is extended to a 58-point system in line with Ferreira and Gama (2007) and Alsakka and Ap Gwilym (2013). The new rating scale is named as comprehensive credit rating (CCR) scale by prior literature. The CCR incorporates ratings, watch and out- look signals simultaneously in a new scale as follows: AAA/Aaa = 58, AA+/Aa1 = 55, AA/Aa2 = 52, ..., CCC-/Caa3 = 4, CC/Ca, SD-D/C = 1. In addition, “+2” (“-2”) is adjusted for positive (negative) watch signal, while “+1” (“-1”) is adjusted for positive (negative) outlook signal and “0” for stable outlook and no watch/outlook assignments.

We source our data of firms’ environmental performance from the Thomson Reuters ASSET4 ESG database. This database gathers information from various sources such as annual reports, corporate sustainability reports, nongovernmental organizations, and news media, focusing on large, publicly traded companies across more than 45 countries on an annual basis. According to Thomson Reuters, the selection of data items aims at optimizing factors like company coverage, timeliness, data availability, quality, and perceived relevance for investors. To assess firms’ environmental commitment, ASSET4 issues scores to three key areas: Emission Reduction, Product Innovation, and Resource Reduction. These environmental scores range from 0 to 100, where higher scores indicate better environmental performance.

The original frequency of both firm-level fundamentals and environmental scores is yearly. As company credit ratings can be updated multiple times per year, in order to align the frequency of firm-level variables with that of rating signals, we set up a monthly panel to include the two data sources. As a result, our initial sample contains 523,522 firm-month level observations of 1734 firms. We eliminate 138,044 firm-month observations that are missing the environmental scores and 37,548 firm-month observations that are missing financial statement data from Compustat. Our final sample consists of 347,930 observations of 1486 firms.[2]

Table 1 presents the sample distribution by credit rating agency, industry, and year. S&P is the most widely used credit rating agency in both subsamples. From the point of view of industry representation, Consumer Discretionary and Industrials are most present in both US and EU samples. Overall, the number of observations has risen gradually over the sample period, with a slight decrease in the final year, likely due to incomplete data availability for that particular year.

3.2. Summary statistics

Table 2 (Panel A) presents the descriptive statistics for all variables employed in our empirical analyses. The mean *RATING*_20 score sits just under 11 (equivalent to a BBB– rating), with a standard deviation of around 3 and an interquartile range of 4.[3] Notably, the statistics for *RATING*_58 are roughly triple that of *RATING*_20. The average environmental score is around 45, with a standard deviation of about 29, which suggests a wide range of environmental performance across firms. On average, debt leverage is around 34% of the total assets of the firms, while the mean *ROA* is 4.23%. The mean *SIZE* is around 9, indicating that our sample firms are generally large. The mean of *BIG*4 is 0.9489, which demonstrates that the majority of firms in our sample are audited by one of the Big 4 audit firms.

[2] The final EU sample incorporates data from 20 EU countries, including the United Kingdom, France, Germany, Italy, Netherlands, Spain, Sweden, Finland, Luxembourg, Ireland, Portugal, Austria, Denmark, Belgium, Greece, Czech Republic, Hungary, Cyprus, Romania, and Slovenia.

[3] Although *RATING*_20 is a categorical variable, we keep it in Table 2 for statistical purposes.

Table 1 Sample description by Agency, Industry, and Year

Panel A: Composition by Agency			Panel B: Composition by Industry			Panel C: Composition by Year		
Observations			Observations			Observations		
Agency	EU	US	Industry	EU	US	Year	EU	US
Fitch	25,638	54,109	Real Estate	102	6140	2003	1954	2947
Moody's	30,973	77,273	Telecommunications	10,775	7459	2004	2327	3418
S&P	48,060	111,877	Technology	2259	21,352	2005	3060	4779
			Energy	4895	19,717	2006	3987	5573
			Health Care	6327	19,817	2007	4226	6036
			Basic Materials	9672	16,712	2008	4429	6763
			Consumer Staples	9804	19,935	2009	4609	8516
			Utilities	14,288	21,612	2010	4758	9288
			Industrials	24,897	54,504	2011	5010	9830
			Consumer Discretionary	22,483	57,946	2012	5163	10,396
						2013	5204	10,649
						2014	5516	11,350
						2015	5860	12,190
						2016	6034	15,947
						2017	6204	18,373
						2018	6670	20,033
						2019	7125	20,834
						2020	7425	22,023
						2021	7946	23,943
						2022	7164	20,371
Total	104,671	243,259		104,671	243,259		104,671	243,259
Firms	472	1014		472	1014		472	1014

Notes: This table presents the number of observations by agency, industry, and year in Panels A, B, and C, respectively. This sample covers the long-term issuer credit ratings from S&P, Moody's, and Fitch, 10 ICB industries, and the period ranging from January 2003 to December 2022.

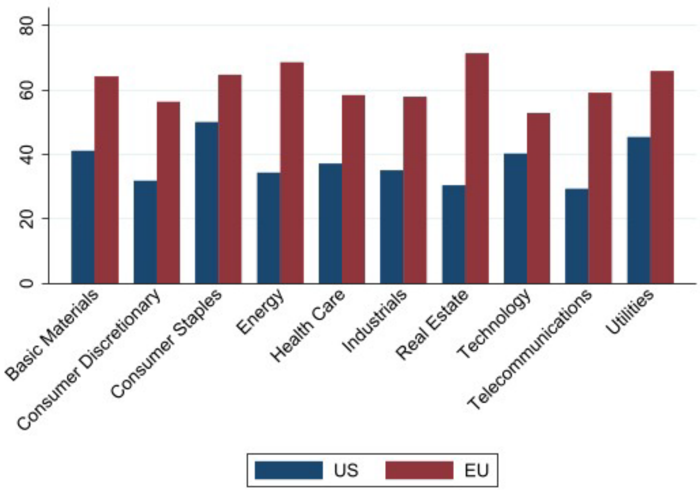
Panel B of Table 2 provides a comparative summary of the statistics between firms in the US and the EU. Credit ratings appear to be slightly higher for EU firms than for their US counterparts. EU firms also show higher environmental scores, capital intensity, profit margin, and larger firm size. By contrast, they present lower losses, lower leverage, and a smaller standard deviation of operational cash flow and ROA compared to US firms. These findings suggest that, on average, EU firms demonstrate stronger financial and environmental performance compared to US firms.

In Figure 1, we illustrate the average environmental scores by firms in different industries and years for the US and EU samples. Considerable variation can be observed in the environmental scores across different industries and years. Figure 1a displays the average environ- mental scores for various industries. It is to be noted that environmental scores are consistently higher for firms in the EU sample, and this trend persists even in industries known to have high emissions, such as Energy and Utilities. In the EU sample, these industries demonstrate relatively high environmental scores over 60. Figure 1b shows the fluctuations in the environmental score throughout the sample period, scores between US and EU firms persist on a year-to-year basis, as evidenced by the industry-level differences. EU firms consistently outperform their US counterparts in terms of environmental scores over the entire period. In summary, the differences in environmental scores displayed in Figure 1 suggest that EU firms tend to be more environmentally conscious compared to

US firms, which is observable across industries and over time. These findings emphasize the substantial role that geographical location spanning from 2003 to 2022. The disparities in environmental and industry characteristics may play in the environmental performance of firms.

The Pearson correlation matrix of the firm-level variables in the US and EU samples are reported in Table 3. The correlation coefficients between credit ratings and environmental scores are positive. The US sample correlation is around 0.37 while the EU sample presents a correlation of about 0.25. The results suggest that firms with higher environmental scores are likely to receive higher credit ratings and this positive relation might differ across the US and EU.

(a) Average environmental scores by industry



(b) Average environmental scores by year

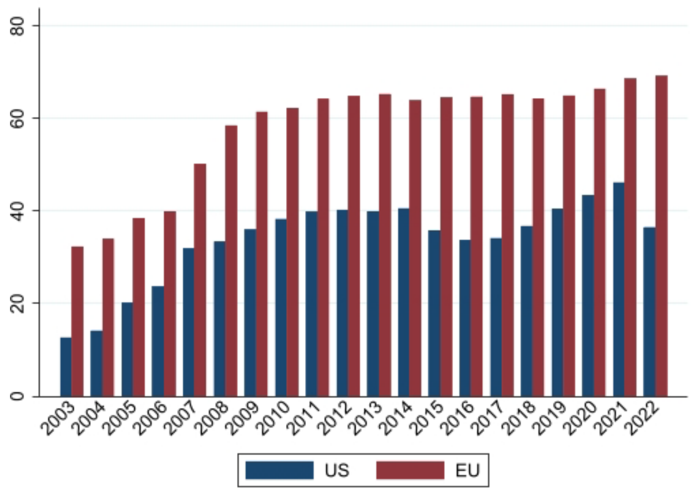


Fig. 1 This figure shows equal-weighted average environmental scores for US and EU firms. Figure (a) demonstrate the average environmental score of firms in each of the ICB industries, while figure (b) shows the average environmental scores of firms ranging from 2003 to 2022.

Table 2 Summary Statistics

Panel A: Full Sample statistics (N = 347,930)

Variables	Mean	S.D.	Min	Q1	Median	Q3	Max
RATING_58	30.1242	9.7803	0.0000	23.0000	31.0000	37.0000	58.0000
RATING_20	10.9990	3.1713	1.0000	9.0000	11.0000	13.0000	20.0000
ENV	45.8616	29.3326	0.0000	20.0000	48.8653	71.6250	99.1667
SIZE	9.2748	1.3743	4.3633	8.3168	9.1587	10.2401	14.1525
ROA	0.0423	0.0670	-0.2479	0.0173	0.0412	0.0740	0.2346
LOSS	0.0738	0.2615	0.0000	0.0000	0.0000	0.0000	1.0000
LEV	0.3404	0.1772	0.0021	0.2178	0.3215	0.4383	1.0013
INT_COV	13.8769	22.2931	-3.7178	4.7070	7.9797	13.9413	168.0000
CAP_INTEN	0.6003	0.4140	0.0045	0.2490	0.5383	0.8975	1.9075
BIG4	0.9489	0.2201	0.0000	1.0000	1.0000	1.0000	1.0000
CFO_STD	0.0296	0.0237	0.0033	0.0135	0.0225	0.0377	0.1357
ROA_STD	0.0373	0.0473	0.0019	0.0117	0.0223	0.0427	0.3302
MARGIN	0.2055	0.1455	-0.1643	0.1104	0.1762	0.2777	0.7180

Panel B: Descriptive statistics of firm variables in the two regions

Variables	US (N = 243,259)			EU (N = 104,671)		
	Mean	Median	S.D.	Mean	Median	S.D.
RATING_58	29.3796	31.0000	10.0124	31.8546	34.0000	8.9831
RATING_20	10.7536	11.0000	3.2426	11.5694	12.0000	2.9203
ENV	39.1938	38.8154	28.6842	61.3580	66.9823	24.5840
SIZE	9.1420	9.0339	1.3380	9.5836	9.5435	1.4076
ROA	0.0449	0.0446	0.0704	0.0364	0.0358	0.0579
LOSS	0.0771	0.0000	0.2667	0.0663	0.0000	0.2487
LEV	0.3516	0.3309	0.1835	0.3144	0.3009	0.1586
INT_COV	14.1841	7.8934	23.2267	13.1628	8.1413	19.9372
CAP_INTEN	0.5877	0.5090	0.4154	0.6294	0.5989	0.4093
BIG4	0.9688	1.0000	0.1739	0.9028	1.0000	0.2962
CFO_STD	0.0313	0.0241	0.0245	0.0258	0.0193	0.0213
ROA_STD	0.0399	0.0236	0.0504	0.0313	0.0197	0.0383
MARGIN	0.2030	0.1790	0.1402	0.2112	0.1710	0.1568

Notes: Panel A presents full sample descriptive statistics. Panel B presents the sample descriptive statistics for the two regions, the US and the EU.

The Pearson correlation coefficients demonstrate that there are no extreme correlations between our control variables. To further test for multicollinearity issues, we investigate the variance inflation factors (VIFs). The average of the VIFs in our model is (1.46) 1.45 for the US (EU) sample, and none of the variables have VIFs greater than the critical value of 2.5 (Johnston, Jones, & Manley, 2018).[4]

[4] Variables used in the multicollinearity test are RATING_58, ENV, and all firm-level control variables.

4. Methodology

In our empirical tests, we employ OLS (ordinal logit) model for the numerical 58-point (ordinal 20-point) scale of credit ratings, controlling for several firm characteristics. The benefit of using the ordinal logit model is that it does not assume that each rating notch represents the same increase in a firm's rating; higher numbers are considered better ratings, but the exact magnitude of the rating is irrelevant. As our numerical rating scaled from 0 to 58 is linear as opposed to the regular numerical rating scaled from 1-20, which doesn't require such as assumption, there are benefits of employing the OLS estimation because it is more straightforward and it allows the analysis of economic significance based and it is consistent with the use of additional tests (Baghai et al., 2014). To account for possible correlations in the error terms, we adjust standard errors via firm-level clustering. The fundamental empirical specification in the baseline regression is given by the following equation:

$$RATING_{i,t} = \alpha + \beta ENV_{i,t-12} + \gamma X_{i,t-12} + \Lambda + \epsilon_{i,t} \quad (1)$$

where $RATING_{i,t}$ constitutes the numerical conversion of the credit rating of firm *i* at year-month *t*, with a higher value signifying superior creditworthiness, denoted as *RATING*_58 or *RATING*_20. $ENV_{i,t-12}$, the key variable of interest, designates the environmental score from Thomson Reuters ASSET4 ESG database attributed to firm *i* at year-month $t - 12$. If credit rating agencies consider a firm's environmental performance as one of the credit risk factors, we would expect β to be positive. The control variables in vector $X_{i,t-12}$ are also lagged by a year (twelve months) and are common throughout the different specifications. Λ are year-month, country, and industry fixed effects.

To isolate the effects of key variable of interest (environmental score), we control for a set of variables commonly used in literature of firm credit ratings (Attig et al., 2013; Bhandari & Golden, 2021; Cornaggia, Krishnan, & Wang, 2017). These include: *SIZE*, the natural logarithm of total assets, expressed in millions of USD; *ROA*, the income before extraordinary items scaled by total assets; *LOSS*, an indicator variable set to 1 if income before extraordinary items is negative in the current and previous year, and 0 otherwise; *LEV*, total debt (long- term plus the portion of long-term debt in current liabilities) scaled by total assets; *INT_COV*, earnings before interest and taxes scaled by interest expense; *CAP_INTEN*, gross property, plant, and equipment scaled by total assets; *BIG4*, an indicator variable set to 1 if the auditor is a Big4 auditor, and 0 otherwise;[5] *CFO_STD*, the standard deviation of operating cash flows scaled by total assets for the previous 60 months; *ROA_STD*, the standard deviation of ROA for the previous 60 months; *MARGIN*, income before extraordinary items divided by sales. To mitigate the impact of outliers, we winsorize all continuous firm-level controls at the one and ninety-nine percentiles, except for *SIZE*, *LOSS*, and *BIG4*. Finally, we employ year-month, agency, industry, and country indicators to control for variations in ratings across different aspects.[6]

[5] The Big4 auditor are the four largest global accounting networks in the world: Deloitte, Ernst & Young (EY), KPMG, and PwC.
[6] The industry and country classification in this study is based on the Industry Classification Benchmark (ICB) and ISO country code, respectively.

Table 3 Correlation matrix

Variables		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
RATINTG_58	(1)	1	0.9628	0.2486	0.4691	0.2983	-0.296	-0.1925	0.1311	0.0157	-0.0453	-0.2862	-0.3277	0.1753
RATING_20	(2)	0.9514	1	0.2702	0.5151	0.3016	-0.3058	-0.1929	0.1325	0.0326	-0.0331	-0.2972	-0.3354	0.1781
ENV	(3)	0.3722	0.4045	1	0.4728	0.0128	-0.0519	-0.061	0.0261	0.0486	-0.0128	-0.2118	-0.2074	-0.025
SIZE	(4)	0.5013	0.5434	0.5291	1	-0.0207	-0.092	-0.1488	-0.0068	0.035	-0.0196	-0.3041	-0.2546	0.0206
ROA	(5)	0.3771	0.3808	0.1354	0.0817	1	-0.4433	-0.1525	0.3703	-0.0647	0.0401	0.0154	-0.1554	0.2629
LOSS	(6)	-0.2957	-0.3141	-0.1003	-0.1346	-0.4875	1	0.1201	-0.1247	0.0282	0.0044	0.1353	0.2354	-0.1581
LEV	(7)	-0.3205	-0.333	-0.0856	-0.125	-0.192	0.1651	1	-0.3783	0.1713	0.0304	0.017	0.0761	0.4529
INT_COV	(8)	0.2117	0.2015	0.06	0.0276	0.3607	-0.1373	-0.4379	1	-0.05	-0.0309	0.0896	-0.0158	0.0433
CAP_INTEN	(9)	-0.0511	-0.0426	0.069	0.0237	-0.163	0.0718	0.1086	-0.1027	1	0.0716	-0.0618	-0.0572	0.2609
BIG4	(10)	0.2074	0.2056	0.1525	0.2175	0.1079	-0.0978	-0.0962	0.0437	-0.0569	1	0.0128	0.0304	-0.0018
CEO_STD	(11)	-0.2232	-0.2475	-0.1538	-0.2609	-0.0413	0.159	0.026	0.0568	-0.0007	-0.0545	1	0.4731	-0.0664
ROA_STD	(12)	-0.2999	-0.329	-0.0963	-0.2034	-0.2619	0.2728	0.0959	-0.0413	0.1398	-0.1008	0.4676	1	-0.1096
MARGIN	(13)	0.1883	0.1944	0.0642	0.2286	0.3104	-0.1852	0.1205	0.0813	0.1918	-0.0281	-0.1476	-0.0864	1

Notes: This table presents the Pearson correlation matrix of the firm-level variables. The numbers below (above) the diagonal are the Pearson correlation coefficients for US (EU) sample. Correlations significant at the 10% level are highlighted in bold.

5. Empirical results

Table 4 reports the baseline regression results demonstrating the relation between environmental scores and credit ratings. In Column (1), the coefficient of *ENV* for the US firms is 0.0570, associated with a *t*-statistic of 6.50, signifying that the variable *ENV* is statistically significant at a 1% level. As for the EU sample (Column 2), the coefficient of *ENV* maintains its significance at 1% level, with a coefficient value of 0.0498. Columns (3) and (4) present results of the ordinal logit model, showing that the coefficients of *ENV* for both US and EU samples are notably positive and significant at 1% level, with a value of 0.0158 and 0.0117, respectively. These results suggest that the environmental score is a crucial determinant of credit ratings, for both US and EU firms. The economic impact of our empirical results is also significant. Under the OLS regression specification, one standard deviation increase in *ENV* is associated with a 1.6349 (0.0570 × 28.6842) increase in the 58 scaled credit ratings in the US, and a 1.2224 (0.0498 × 24.5840) increase for EU firms.

Results of the baseline regression by OLS and ordinal logit model confirmed our Hypothesis 1. Moreover, it should be noted that the difference in coefficients between the US and the EU indicates that this effect is more prominent for US firms. This finding aligns with our second hypothesis, which suggests that the credit rating benefits associated with improved environmental performance are indeed more pronounced in the US than in the EU.

The results on the control variables in the model are generally consistent with prior research (Ashbaugh-Skaife, Collins, & LaFond, 2006; Attig et al., 2013; Bhandari & Golden, 2021; Bonsall IV, Holzman, & Miller, 2017; Cornaggia et al., 2017; Hossain, Hossain, Jha, & Mougoué, 2023). Specifically, accounting variables that capture financial risk, such as *SIZE*, *ROA*, *INT_COV*, and *MARGIN* (*LEV*, *CFO_STD*, *LOSS* and *ROA_STD*), are significantly positively (negatively) associated with credit ratings, and their signs are consistent across all model specifications. *CAP_INTEN* is positively significant under the ordinal logit regression, which is in line with the literature, but for OLS regressions the coefficient is significantly negative for US companies and insignificant for EU firms. Finally, the corporate governance proxy, *BIG4*, reduces managerial opportunistic behaviour, which increases credit ratings for the US sample but decreases it for the EU sample. Panel B reports the probability of different ratings when the environmental score is at the 25th and 75th percentiles. Consistent with expectations, in both samples, the probability of higher ratings is higher when environmental score is high. However, when we compare the marginal effects on ratings between high scores and low scores, their difference is greater for the US than the EU sample for all rating grades, except for BBB- ratings. The greatest difference in the US sample is the probability of being rated A, with a value of 3.4693%, whilst in the EU sample the greatest difference is for the A- rating, 1.8536%. These results again prove Hypothesis 1.

Another way to investigate the difference between US and EU is by using a dummy variable (*HIGH_ENV*) which is equal to one if the firm's environmental score is above the median of the environmental score, and zero otherwise. We conduct OLS and ordinal logit regressions using HIGH ENV as an alternative measure for the environmental score to test whether the difference between the two markets is significant for firms with higher/lower environmental scores. The results are reported in Table 5. For the OLS regression specification, we find that the coefficient estimate

Table 4 Baseline results

Panel A: Main results

	(1)	(2)	(3)	(4)
	US	EU	US	EU
	OLS		Ordinal Logit	
Variables	Dependent Variable = RATING_58		Dependent Variable = RATING_20	
	0.0570***	0.0498***	0.0158***	0.0117***
ENV	(0.0088)	(0.0142)	(0.0021)	(0.0038)
	2.1373***	2.1609***	0.7089***	0.7722***
SIZE	(0.2409)	(0.2850)	(0.0662)	(0.0958)
	31.0905***	24.2721***	8.6754***	8.5351***
ROA	(2.7146)	(4.2376)	(0.7648)	(1.3279)
	-1.5701***	-2.8409***	-0.4406***	-0.7144***
LOSS	(0.4887)	(0.5210)	(0.1168)	(0.1668)
	-8.2153***	-8.9565***	-2.3536***	-2.7639***
LEV	(1.3907)	(2.0326)	(0.3434)	(0.6339)
	0.0178	0.0190	0.0060*	0.0101**
INT_COV	(0.0124)	(0.0117)	(0.0033)	(0.0039)
	-0.7527	0.0523	0.0240	0.0651
CAP_INTEN	(0.6258)	(0.8323)	(0.1690)	(0.2539)
	2.2613***	-0.6900	0.4230***	-0.1714
BIG4	(0.8419)	(0.6830)	(0.1627)	(0.2170)
	-11.7620	-40.4239***	-3.1004	-9.6492***
CFO_STD	(7.2890)	(10.7059)	(1.9111)	(3.3716)
	-16.3137***	-26.4226***	-5.5213***	-7.2303***
ROA_STD	(3.3958)	(6.7155)	(0.9794)	(2.2292)
	2.8696*	11.6559***	0.7609*	3.2536***
MARGIN	(1.7003)	(2.3208)	(0.4448)	(0.7268)
Time F.E.	YES	YES	YES	YES
Agency F.E.	YES	YES	YES	YES
Industry F.E.	YES	YES	YES	YES
Country F.E.	NO	YES	NO	YES
Firm clustered	YES	YES	YES	YES
Observations	243,259	104,671	243,259	104,671
Adj. R^2/Pseudo R^2	0.484	0.512	0.157	0.169

Panel B: Marginal effects of the ordinal logit model

Rating	US			EU		
	Probability at 75th pct.E-Score High E-Score [E-Score = 63.855]	Probability at 25th pct. E-Score Low E-Score [E-Score = 11.416]	High - Low	Probability at 75th pct.E-Score High E-Score [E-Score = 80.640]	Probability at 25th pct. E-Score Low E-Score [E-Score =45.834]	High - Low
AAA (=20)	0.3411%	0.1508%	0.1902%	No Obs.	No Obs.	
AA+ (=19)	0.2271%	0.1022%	0.1248%	0.0462%	0.0309%	0.0153%
AA (=18)	0.7559%	0.3492%	0.4066%	0.6588%	0.4523%	0.2065%
AA- (=17)	1.5697%	0.7607%	0.8090%	2.0761%	1.5004%	0.5758%
A+ (=16)	3.5453%	1.8537%	1.6915%	5.0371%	3.8238%	1.2133%
A (=15)	8.5612%	5.0919%	3.4693%	5.9753%	4.7572%	1.2181%
A- (=14)	7.4822%	5.0674%	2.4148%	12.1848%	10.3313%	1.8536%
BBB+ (=13)	13.0778%	10.0972%	2.9806%	17.9299%	16.5893%	1.3406%
BBB (=12)	16.7046%	15.1272%	1.5774%	19.2936%	19.5677%	-0.2741%
BBB- (=11)	11.9538%	12.4810%	-0.5273%	12.6802%	13.8488%	-1.1686%
BB+ (=10)	8.4827%	9.8087%	-1.3261%	6.5641%	7.5257%	-0.9616%
BB (=9)	8.3198%	10.4968%	-2.1769%	5.6672%	6.7200%	-1.0528%
BB- (=8)	7.2974%	10.0442%	-2.7468%	3.7675%	4.5869%	-0.8194%
B+ (=7)	4.7368%	7.0399%	-2.3031%	2.3647%	2.9279%	-0.5632%
B (=6)	3.6591%	5.8233%	-2.1642%	2.3069%	2.8915%	-0.5847%
B- (=5)	1.7291%	2.9220%	-1.1929%	1.7529%	2.2238%	-0.4710%
CCC+ (=4)	0.6181%	1.0806%	-0.4626%	0.8624%	1.1142%	-0.2518%
CCC (=3)	0.3418%	0.6069%	-0.2652%	0.2439%	0.3213%	-0.0774%
CCC- (=2)	0.0976%	0.1746%	-0.0770%	0.1154%	0.1535%	-0.0381%
C/CC/D (=1)	0.4991%	0.9215%	-0.4223%	0.4730%	0.6337%	-0.1608%

Notes: This sample contains firm-month observations from January 2003 to December 2022, using Eq.(1) regression models. Numerically transformed long-term issuer ratings by S&P, Moody's, and Fitch are used, with *RATING*_58 scaled from 0 to 58 and *RATING*_20 scaled from 1 to 20 (Section 3.1). The environmental score (*ENV*) is provided by Thomson Reuters ASSET4. All regressions include year- month, agency, and industry fixed effects; country fixed effects apply only to the EU sample. Reported significance is based on robust standard errors clustered at firm level. Significance at 10%, 5%, and 1% level is indicated by *, **, and ***, respectively. Panel A outlines the baseline model coefficients with OLS results in columns (1) and (2), and ordinal logit in (3) and (4). Panel B details the marginal effects from the ordinal logit regression reported in Panel B, displaying probabilities for various ratings at low (25th percentile) and high (75th percentile) environmental scores for companies in the US and EU samples. See Table A.1 in the appendix for more detailed variable definitions.

on *HIGH_ENV* is positive and statistically significant at 1% level, with a value of around 2.15 for the US and 1.22 for the EU sample. This means that the relation between credit ratings and environmental scores is stronger for the US sample than the EU sample, which is consistent with expectations. Also the coefficient estimate on *HIGH_ENV* for the US sample is significantly higher than the coefficient estimate from for EU sample (p-value < 0.05).[7] In terms of the ordinal logit model specification, the coefficient for the US sample (0.5647) is twice as large as the one of the EU sample (0.2897), and the difference is statistically significant.[8] This provides further evidence for our Hypothesis 2 that firms with high environmental scores are more likely to have a higher credit rating, and the effect is more pronounced for US firms as compared to firms in the EU.

Table 5 Effect of above median-level environmental scores on credit ratings

	(1)	(2)	(3)	(4)
	US	EU	US	EU
	OLS		Ordinal Logit	
Variables	Dependent Variable = RATING_58		Dependent Variable = RATING_20	
HIGH_ENV	2.1494***	1.2218***	0.5647***	0.2897**
	(0.3558)	(0.4330)	(0.0881)	(0.1331)
SIZE	2.4114***	2.3964***	0.7833***	0.8256***
	(0.2360)	(0.2643)	(0.0645)	(0.0889)
ROA	32.5187***	25.4248***	9.0690***	8.8153***
	(2.7179)	(4.2758)	(0.7682)	(1.3366)
LOSS	-1.5251***	-2.7656***	-0.4243***	-0.6902***
	(0.4887)	(0.5329)	(0.1179)	(0.1680)
LEV	-8.4331***	-8.8714***	-2.3918***	-2.7321***
	(1.3916)	(2.0549)	(0.3409)	(0.6311)
INT_COV	0.0181	0.0196*	0.0061*	0.0102***
	(0.0126)	(0.0115)	(0.0033)	(0.0039)
CAP_INTEN	-0.4982	0.1927	0.0991	0.1004
	(0.6328)	(0.8245)	(0.1702)	(0.2511)
BIG4	2.5243***	-0.6608	0.5071***	-0.1508
	(0.8569)	(0.6743)	(0.1602)	(0.2139)
CFO_STD	-11.9825	-41.8765***	-3.1690*	-9.9325***
	(7.2976)	(10.8517)	(1.8918)	(3.3507)
ROA_STD	-15.6522***	-26.6548***	-5.2592***	-7.2299***
	(3.3785)	(6.8675)	(0.9611)	(2.2680)
MARGIN	2.3261	11.2268***	0.5716	3.1392***
	(1.7055)	(2.3403)	(0.4428)	(0.7366)
Time F.E.	YES	YES	YES	YES
Agency F.E.	YES	YES	YES	YES
Industry F.E.	YES	YES	YES	YES
Country F.E.	NO	YES	NO	YES
Firm Clustered	YES	YES	YES	YES
Observations	243,259	104,671	243,259	104,671
Adj. R^2/Pseudo R^2	0.477	0.506	0.153	0.168

Notes: This table reports the results from regressions of credit ratings on high environmental score group. Columns (1) and (2) present results from the OLS specification, and columns (3) and (4) present those from the ordinal logit specification. We use the numerical transformation of domestic long-term issuer ratings by S&P, Moody's, and Fitch, increasing in credit quality. *RATING*_58 is the credit rating scaled from 0 to 58, while *RATING*_20 is scaled from 1 to 20, details in Section 3.1. *HIGH_ENV* equals one if the environmental score is above its median level, zero otherwise. All regressions include year-month, agency, and industry fixed effects, while country fixed effects are only employed in the EU sample. Reported significance is based on robust standard errors clustered at firm level. Significance at 10%, 5%, and 1% level is indicated by *, **, and ***, respectively.

[7] $(2.1494-1.2218)/\sqrt{0.3558^2+0.4330^2}$ = 1.6552 (p-value for the one tailed t-test = 0.049).

[8] $(0.5647-0.2897)/\sqrt{0.0881^2+0.1331^2}$ = 1.7229 (p-value for the one tailed t-test = 0.042).

A question that arises naturally is why the relation between credit ratings and environmental scores is stronger in the US than in the EU. First, we visually examine the link between credit ratings and environmental scores. We sort the credit ratings into four groups and compare them across the environmental score bins. Figure 2a depicts the average credit ratings by environmental score bins, for both markets. The figure clearly demonstrates that firms with lower environmental scores tend to have lower average credit ratings in both samples. However, when the environmental scores are below 50, EU firms, on average, have higher credit ratings than their US counterparts. In contrast, in the 50-100 range, US firms demonstrating superior environmental performance achieve better ratings than EU firms with similar environmental scores.

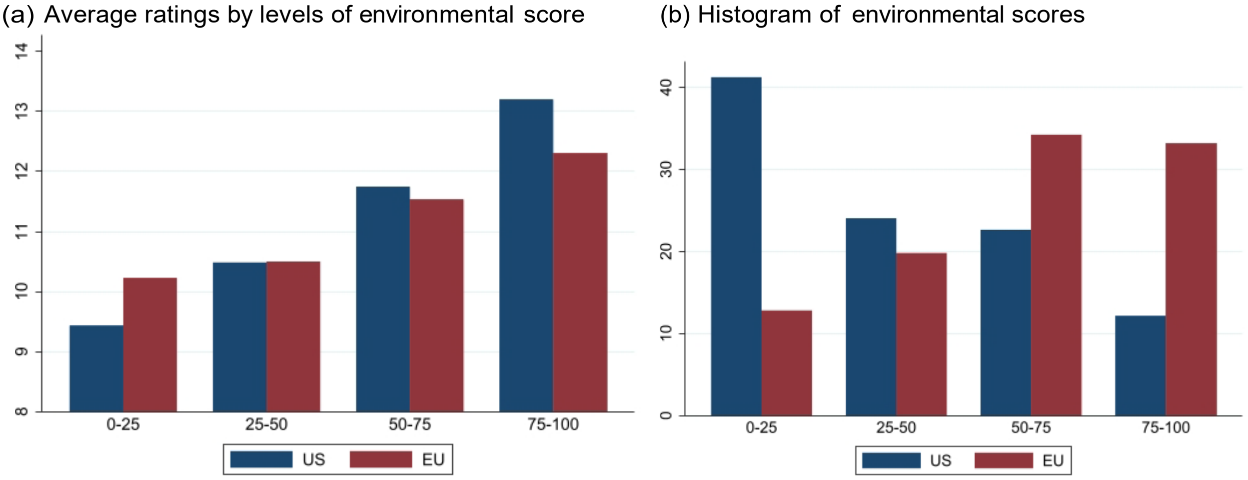


Fig. 2 This figure shows (a) equal-weighted average ratings for different categories of environmental scores and (b) the histogram of environmental scores, for US and EU samples.

Figure 2b displays the histogram of environmental scores among firms in each group. In the US, more than 40% of observations are concentrated at levels with environmental scores below 25, and the number of observations decreases as the environmental score level increases. In contrast, the EU sample has only about 33% of observations with environmental scores below 50, while the remaining observations are evenly distributed across the two highest levels. This distribution in the EU sample is the other way around, with most of the observations having higher environmental scores. Interestingly, in the 0-25 environmental score bin, approximately 40% of observations have an environmental score of 0 in the US, compared to 22% in the EU.

To further explore the observed patterns, we extend our baseline model to capture potential non-linear relation between environmental scores and credit ratings by adding a quadratic term for environmental scores, obtaining the following regression:

$$RATING_{i,t} = \alpha + \beta_1 ENV_{i,t-12} + \beta_2 ENV_{i,t-12}^2 + \gamma X_{i,t-12} + \Lambda + \epsilon_{i,t} \qquad (2)$$

where the dependent variable is the credit rating scaled from 0 to 58. *ENV* is the environmental score. We again include the same control variables and also control for fixed effects of agencies, industries, year-months, and countries (EU only). The results are reported in Table 6. In this setup we find that the relation between environmental performance and credit ratings is weakly significant in the US. However, for the EU sample, the coefficient of *ENV* is 0.1095 and statistically significant with a *p*-value below 0.01, which is twice as large as the coefficient of *ENV* from the baseline results (0.0498). The coefficient of ENV^2 is significantly negative at 10% level (−0.0006). This shows that there is a diminishing effect of the environmental score on credit ratings in the EU. In other words, the relation is strong and positive for low environmental scores, but it weakens for high values of the environmental score.

Table 6 Test for non-linear relation

	(1)	(2)
	US	EU
Variables	Dependent Variable = RATING_58	
ENV	0.0336†	0.1095***
	(0.0213)	(0.0388)
ENV^2	0.0003	-0.0006*
	(0.0003)	(0.0003)
SIZE	2.1297***	2.1939***
	(0.2406)	(0.2802)
ROA	31.0117***	24.3053***
	(2.7138)	(4.2397)
LOSS	-1.5826***	-2.8526***
	(0.4870)	(0.5189)
LEV	-8.3066***	-8.8792***
	(1.3966)	(2.0336)
INT_COV	0.0176	0.0187
	(0.0123)	(0.0116)
CAP_INTEN	-0.7414	0.0535
	(0.6250)	(0.8268)
BIG4	2.3424***	-0.6315
	(0.8370)	(0.6658)
CFO_STD	-12.2237*	-39.6285***
	(7.2357)	(10.6845)
ROA_STD	-16.2214***	-26.7302***
	(3.3983)	(6.6894)
MARGIN	2.8571*	11.5162***
	(1.6985)	(2.2872)
Time F.E.	YES	YES
Agency F.E.	YES	YES
Industry F.E.	YES	YES
Country F.E.	NO	YES
Firm Clustered	YES	YES
Observations	243,259	104,671
Adjusted R^2	0.484	0.513

Notes: this table reports the results from OLS regression of credit ratings on the environmental score and the square of environmental score. We use the numerical transformation of foreign long-term issuer ratings by S&P, Moody's, and Fitch, increasing in credit quality. *RATING_*58 is the credit rating scaled from 0 to 58, while *ENV* is the environmental score provided by Thomson Reuters ASSET4. All regressions include year-month, agency, and industry fixed effects, while country fixed effects are only employed in the EU sample. Reported significance is based on robust standard errors clustered at firm level. Significance at 10%, 5%, and 1% level is indicated by *, **, and ***, respectively. † indicates that, performing an one-sided significance test, the parameter estimate is significantly larger than zero at 10% significance level.

Fig. 3 presents the relation between the environmental score and the numerical transformation of credit ratings, ranging from 0 to 58, for both US and EU samples. In the US, the relation appears almost linear. In contrast, the EU depicts a decrease in marginal effects as *ENV* increases. Also, the relation between the two variables disappears for firms with an environmental score larger than about 80. The marginal impact on ratings spans from 0.1095 (evaluated at the minimum environmental score) to 0 (evaluated at 91.25) and it even becomes negative.

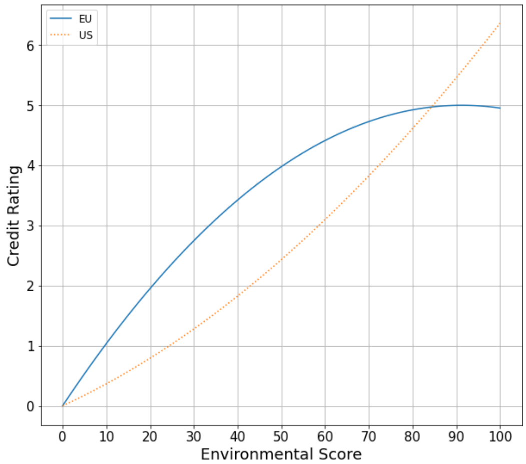


Fig. 3 Environmental performance versus credit ratings. The horizontal axis represents the environmental score. The vertical axis represents the predicted value of the numerical transform of credit rating scaled from 0 to 58. The solid blue (dotted orange) line shows the relation in the EU (US). The figure is based on the parameter estimates of Eq. (2) reported in Table 6. For simplicity, the control variables are held at zero.

Diverse regulatory environments and market perceptions in the EU and US may explain the detected discrepancies in the link between environmental scores and credit ratings. In the US, firms cluster at lower environmental scores, hence those achieving high environmental performance are often viewed as pioneering protectors of the environment, resulting in a more noticeable positive impact on their credit ratings. Conversely, in the EU, where environmental regulations are stricter and a larger proportion of firms attain high environmental scores, being environmentally conscious might be seen as a baseline expectation, rather than a distinguishing factor. This sheds light on the left-skewed distribution of environmental scores and diminishing marginal effect observed in the EU as environmental scores increase: firms are still rewarded for improved environmental performance, but the magnitude of the reward diminishes.

We implement instrumental variable estimation and propensity score matching method to address the potential endogeneity concern, and carry out several additional studies to prove the robustness of our results, including: (1) re-running regressions by distinguishing between investment-grade and speculative-grade ratings; (2) re-running regressions for individual rating agencies; (3) replacing foreign-currency issuer ratings with domestic-currency ratings; (4) employing alternative measures for the environmental performance; (5) industry-size matched sampling; (6) investigating the non-linear relation of social and governance performance on credit ratings. Results are available upon request.

6. Conclusion

Credit rating agencies play an essential role in the financial markets by issuing assessments of the companies' creditworthiness. In recent years, CRAs started to include environmental aspects into their rating assessments due to the increasing importance of firms' environmental performance. Inspired by the increasing global awareness of environmental sustainability, our study introduces a transatlantic perspective by investigating the impact of the firms' environmental performance on their credit ratings in the US and the EU. Considering differentiated regulatory requirements of ESG/CSR between the two economies, we further examine whether the influence of environmental performance on credit ratings differs across these two regions.

The baseline analysis explores the effect of environmental performance on credit ratings. Our analysis uses numerical ratings that account for the rating outlook and watch. Our findings suggest that an improvement in the firms' environmental scores contributes to higher credit ratings. However, we note a weaker relation in the EU compared to the US. We undertake additional investigation to corroborate our initial analysis. Our results indicate the main cause for this weaker effect: the effect of environmental performance on credit ratings is non-linear in the EU, resulting in a diminishing marginal effect of environmental score improvement on credit ratings. This is because firms in the EU are environmentally friendly. Hence, good environmental performance is viewed as the norm, rather than a stand-out performance. Thus, improvements in environmental scores are rewarded (in terms of credit rating improvements) less in the case of EU firms with good environmental performance.

Our empirical results have significant implications for corporate financial management. Besides the profitability-related factors that can improve the firms' credit ratings, we reveal an additional way in which firms can enhance their creditworthiness by improving their environmental performance. Therefore, firms can reduce financing costs via improvements in their environmental performance. Our results also suggest that this channel to reduce financing costs is more effective in the US than in the EU.

This study opens up avenues for further exploration. Some of the potential extensions of our research include: study of the relation between environmental scores and credit ratings across different industries; analysis of the dynamic of this relation across time, as well as assessment of the influence of social and governance indicators on credit ratings. We see these questions as opportunities to enrich the literature and broaden our understanding, and we leave these to be explored in future research.

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Appendix A

Table A.1 Variable definitions

Variable definitions			Data source
RATING_58	=	the long-term issuer credit ratings translated into numerically increasing credit quality as follows: CC/Ca, SD-D/C = 1, CCC-/Caa3 = 4, ..., AA/Aa2 = 52, AA+/Aa1 = 55, AAA/Aaa = 58. In addition, "+2" ("-2") is adjusted for positive (negative) watch signal, while "+1" ("-1") is adjusted for positive (negative) outlook signal and "0" for stable outlook and no watch/outlook assignments.	Bloomberg S&P, Moody's, and Fitch ratings database
RATING_20	=	the long-term issuer credit ratings translated into numerically increasing credit quality as follows: CC/Ca, SD-D/C = 1, CCC-/Caa3 = 2, ..., AA/Aa2 = 18, AA+/Aa1 = 19, AAA/Aaa = 20.	Bloomberg S&P, Moody's, and Fitch ratings database
ENV	=	the firm-level environmental score scaled from 0 to 100;	Thomson Reuters ASSET4
SIZE	=	the natural logarithm of the firm's total assets (AT);	Compustat Database
ROA	=	return on assets, calculated as income before extraordinary items (IB), divided by total assets (AT);	Compustat Database
LOSS	=	if net income before extraordinary items is negative, otherwise;	Compustat Database
LEV	=	total debt (DLC + DLTT) divided by total assets (AT);	Compustat Database
INT_COV	=	operating income before depreciation (OIBDP) divided by interest expense (XINT);	Compustat Database
CAP_INTEN	=	property, plant and equipment (PPEGT) scaled by total assets (AT);	Compustat Database
BIG4	=	if the auditor is a Big4 auditor, and 0 otherwise;	Compustat Database
CFO_STD	=	the standard deviation of cash flows from operation (CFO) scaled by total assets for the previous five years;	Compustat Database
ROA_STD	=	the standard deviation of ROA for the previous five years;	Compustat Database
MARGIN	=	the operating income before depreciation (OIBDP) divided by gross sales (SALE);	Compustat Database
HIGH_ENV	=	if the environmental score is above the median level of the environmental score, 0 otherwise;	Thomson Reuters ASSET4
ENV^2	=	square of environmental score;	Thomson Reuters ASSET4
IV_INDUS	=	the monthly average of the environmental score of firms in a given industry;	Thomson Reuters ASSET4
EMISSION	=	the natural logarithm of the total CO_2 emission (CO_2 emission scope 1 + CO_2 emission scope 2);	Thomson Reuters ASSET4
ENV_BLOOMBERG	=	the environmental score provided by Bloomberg ranging from 0 to 10;	Bloomberg
SOCIAL	=	the firm-level social score scaled from 0 to 100;	Thomson Reuters ASSET4
$SOCIAL^2$	=	the square of social score;	Thomson Reuters ASSET4
GOV	=	the firm-level governance score scaled from 0 to 100;	Thomson Reuters ASSET4
GOV^2	=	the square of governance score.	Thomson Reuters ASSET4

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