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## Article

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## Article

# The Relationship between Credit Rating and Environmental, Social, and Governance Score in Banking

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**Abstract:** The present paper investigates the relationship between stock prices, credit ratings, and ESG scores for banks internationally. First, it describes stock prices and ESG scores at an annual frequency, as well as stock price and credit risk at a daily frequency. The relationships between (a) stock price and credit rating returns with ESG score returns and (b) among ESG scores are examined by pairwise annual correlation, and daily correlations are examined between price and credit rating returns. Furthermore, Granger causality is used to examine the relationships between the following: (a) price and ESG score annual returns; (b) price and credit rating daily returns; and (c) total and pillar annual ESG scores. This study makes a significant contribution to the literature by providing a detailed temporal analysis using both annual and daily data frequencies, which is relatively rare in the field. There is evidence of statistically and empirically important relations in the form of pairwise correlations. The regressions reveal a low significance of few ESG score changes in explaining credit rating changes. A unique aspect of this paper is the comprehensive analysis of 16 granular ESG scores, including overall scores, pillar scores, and sub-scores, allowing for a multi-faceted understanding of how specific ESG factors impact financial metrics. We found evidence of the significance of COVID-19 in all research questions. Additionally, this paper highlights the impact of the COVID-19 pandemic on the relationships between ESG scores, credit ratings, and stock prices, offering timely insights into the heightened importance and volatility of ESG factors during crisis periods. Future research needs to shed more light on this relationship, however.

**Keywords:** banks; ESG; credit ratings; stock prices; inter-relation; COVID-19



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## 1. Introduction

Credit ratings estimate the creditworthiness of an entity and are provided by a few major agencies, such as Standard & Poor's, Fitch, and Moody's, all approved by the Securities and Exchange Commission (SEC). Credit ratings affect entities in numerous ways, including cost of capital and stock prices. These ratings offer a unique information set that is as critical for corporations as financial statements. Credit ratings concern the probability of either a default (default risk) or a credit event (credit risk), whereas financial statements refer to the economic condition and performance of an entity. In the banking sector, credit ratings are determined differently than in other sectors. Market anomalies and high information asymmetry significantly influence the effects of financial ratios on credit ratings in the banking sector (Shen et al. 2012). Additionally, the location of banks affects credit ratings through a monetary union effect (van Loon and Haan 2015).

The banking sector is influenced by both credit ratings and Environmental, Social, and Governance (ESG) scores (Jang et al. 2020). Credit ratings impact banks' capital structure, with banks close to a credit rating upgrade often having a higher capital-to-assets ratio. Furthermore, "too-big-to-fail" banks nearing an upgrade tend to have lower capital relative to assets, and credit ratings have a relatively minor economic effect on the speed at which

a bank's capital is adjusted (Wojewodzki et al. 2020). The credit ratings of banks are also affected by the solicitation status and financial profile of the banks (Poon et al. 2009). An important issue in bank credit ratings is whether there is enforcement action due to credit-rating changes from entities such as the Federal Deposit Insurance Corporation (FDIC), the Office of the Comptroller of the Currency (OCC), or the Federal Reserve Bank (FRB) in the USA, or other international or regional authorities (Apergis et al. 2012).

ESG factors are increasingly recognized as crucial for the banking sector. Europe has led in requiring ESG disclosures from banks since the Non-Financial Reporting Directive (2014/95/EU). ESG practices can enhance financial wealth and ensure financial stability for banking shareholders (Houston and Shan 2022). ESG factors should be integrated into the EU banking regulatory and supervisory framework (European Banking Authority 2023). ESGs affect main banking operations and nonperforming loans (Liu et al. 2023). It has been found that a bank's high performance in all three pillars of ESG evaluation reduces its ratio of nonperforming loans, and also that a bank's favorable ESG performance improves its loan quality and provides archival evidence of the importance of all three pillars of ESG. Other parameters are stock value (Azmi et al. 2021), stability (Chiaramonte et al. 2022), financial distress (Citterio and King 2022), and financial performance (Zhou et al. 2021). The ESG role in financial performance has been examined for different regions, including Europe (Batae et al. 2020), the Middle East, North Africa, and Turkey (MENT) (El Khoury et al. 2023). ESG features foster an investing culture focused on long-term growth in an entity's value and prioritize management targets for stakeholders and entity sustainability. Few studies have examined the relationship between ESGs and financial performance in the banking sector (Cornett et al. 2016; La Torre et al. 2021).

Despite the growing body of literature on ESG factors, credit ratings, and financial performance, there is limited research that comprehensively examines the relationships between these variables using both annual and daily data frequencies. Furthermore, the impact of specific ESG sub-scores on financial metrics has not been thoroughly explored. Additionally, while the COVID-19 pandemic has significantly influenced financial markets, its specific effects on the relationship between ESG scores, credit ratings, and stock prices in the banking sector require further investigation. Note that the first major wave of COVID-19 was from January to May 2020. Thus, the primary goal of this paper is to fill these research gaps by providing a detailed analysis of the relationships between stock prices, credit ratings, and ESG scores for banks internationally, using both annual and daily data frequencies. This study aims to offer a comprehensive understanding of how specific ESG factors impact financial metrics and to highlight the role of the COVID-19 pandemic in these relationships. This paper addresses questions such as the following:

What is the relationship between stock price returns and ESG score returns in the banking sector?

How do ESG score changes influence credit rating changes for banks?

What is the relationship between daily credit rating returns and daily stock price returns?

How has the COVID-19 pandemic affected the relationships between ESG scores, credit ratings, and stock prices?

This paper contributes to the literature in several ways. Firstly, it targets the banking sector internationally, providing insights into how ESG scores, credit ratings, and stock prices interact in different economic environments. Secondly, it examines the relationship between various ESG scores, offering a granular analysis that distinguishes between overall scores, pillar scores, and sub-scores. Thirdly, it investigates the effect of annual ESG score returns on credit rating changes and their relations, as well as the impact of daily credit rating returns on daily stock price returns. Finally, it highlights the significance of the COVID-19 pandemic in all research questions, providing timely insights into the heightened importance of ESG factors during crisis periods.

In addition to these noted contributions, this paper also considers the impact of fintech development on ESG performance, as discussed by Wang et al. (2022). The integration

of fintech in banking operations is shown to alleviate financing constraints and enhance ESG practices, particularly in emerging markets. This perspective provides a modern dimension to the analysis, emphasizing the role of digital technology in improving corporate sustainability. Galeone et al. (2024) further explore the relationship between fintech and sustainability, showing that social influence reinforced by ESG factors encourages technology adoption in the banking sector. The study by Dospinescu et al. (2021) highlights the importance of fintech in promoting ESG performance by reducing information asymmetry and transaction costs, thereby providing a comprehensive view of how technological advancements can bolster sustainable finance in the banking sector.

The rest of the paper is structured as follows: after this Introduction (part 1), Section 2 contains the literature review, Section 3 presents the tested hypotheses with a theoretical framework, Section 4 is the Methodology, Section 5 is the Discussion, and Section 6 provides concluding remarks.

## 2. Literature Review

The integration of Environmental, Social and Governance (ESG) factors into financial and credit risk assessments has gained increasing research attention in recent years. ESG considerations are becoming crucial for investors, credit rating agencies, and regulatory bodies as they strive to understand their impact on financial performance, credit risk, and overall market stability. This literature review synthesizes findings from up-to-date studies that examine the relationship between ESG factors and various aspects of financial risk, particularly credit ratings and default risk, across different markets and sectors. We have identified four main strands of literature on this topic (Table 1): the first strand deals with the relationship between ESGs and credit ratings, the second deals with ESGs and default risk, the third deals with ESGs and stock volatility, and the fourth deals with ESGs and the financial sector.

**Table 1.** Identified literature review groupings with a short summary of each reviewed paper.

ESGs and Credit Ratings	ESGs and Default Risk	ESGs and Stock Volatility	ESGs in the Financial Sector
Chodnicka-Jaworska (2021) investigates the impact of ESG measures on credit ratings for non-financial institutions. The study finds that ESG factors significantly influence credit ratings, particularly during periods of financial instability like the COVID-19 pandemic.	Michalski and Low (2024) use machine learning models to evaluate the predictive power of ESG variables on corporate credit ratings. Their results demonstrate that ESG factors, especially environmental and social responsibility variables, are significant predictors of corporate credit ratings, particularly post-financial crisis.	Singh and Jaiwani (2023) analyze the influence of ESG factors on share price volatility (SPV) in energy sector firms, considering the development phase of countries. They find that ESG factors reduce SPV in developing economies, while increasing SPV in developed economies, suggesting that the impact of ESG varies depending on the economic context.	Hau et al. (2013) examine the quality of bank ratings and identify determinants of rating quality. Their study reveals that larger banks receive more favorable ratings due to conflicts of interest, particularly those providing significant business to rating agencies. This bias highlights the need for enhanced transparency and improved public disclosure to ensure accurate and unbiased ratings.
Kiesel and Lücke (2022) analyze the incorporation of ESG factors into credit rating reports and their impact on financial markets. Their findings indicate that while governance issues are prominently considered, the overall integration of ESG factors remains limited.	Penikas (2022) explores the relationship between credit risk and climate risk, finding that this relationship varies significantly by industry and region. While certain sectors benefit from positive climate–credit risk correlations, the majority exhibit negative correlations, implying that green finance initiatives need to be carefully tailored to avoid financial instability.	Liu et al. (2022) identify the causal effect of ESG performance on stock idiosyncratic volatility in the Chinese market. They find that ESG performance significantly reduces stock idiosyncratic volatility by promoting high-quality information disclosure and enhancing transparency, thereby reducing firm-specific risk.	Grigorieva and Vukovic (2020) analyze the methodologies of credit rating assessments used by major rating agencies, with a focus on Fitch Ratings. They highlight the importance of qualitative measures such as risk appetite and economic and operational conditions in credit risk assessment.

Table 1. Cont.

ESGs and Credit Ratings	ESGs and Default Risk	ESGs and Stock Volatility	ESGs in the Financial Sector
<a href="#">Devalle et al. (2017)</a> examine the effect of ESG performance on the credit ratings of Italian and Spanish public firms. The study finds a positive association between ESG performance and higher credit ratings, with social and governance scores having a significant impact. This suggests that ESG factors enhance transparency and reduce information asymmetry, leading to better credit evaluations.	<a href="#">Liu et al. (2023)</a> investigate the volatility risk premium (VOLRP) in China and its relationship with ESG sentiment. They find a positive correlation between ESG sentiment and VOLRP, suggesting that investors perceive ESG investments as potentially risky in the short term. This contrasts with developed markets and indicates unique dynamics in emerging markets like China.	<a href="#">Burger et al. (2022)</a> examine the impact of ESG ratings on both the implied and historical volatility of companies' stock prices. They find that better ESG performance leads to lower stock price volatility, both historical and implied. The combined ESG rating has the strongest impact on reducing volatility compared to individual ratings from each agency.	<a href="#">Ruddy (2021)</a> compares Bank Financial Strength Ratings (BFSRs) with general credit ratings from different agencies. The study finds that BFSRs are more conservative and provide earlier indications of financial distress compared to general credit ratings, highlighting their importance for standalone creditworthiness assessment.
<a href="#">Pineau et al. (2022)</a> analyze the importance of ESG factors in sovereign credit ratings. They find that governance is the most crucial ESG factor for advanced economies, while non-ESG factors are more significant for emerging markets.	<a href="#">Arif et al. (2024)</a> examine the global association between ESG disclosures and future earnings risk, finding that higher ESG disclosures are linked to reduced earnings risk.		
	<a href="#">Li et al. (2022)</a> explore the relationship between ESG practices and default risk among Chinese listed firms. Their findings indicate that higher ESG ratings are associated with lower default risk, particularly over longer periods.		
	<a href="#">Brogi et al. (2022)</a> investigate the impact of ESG awareness on credit risk using a sample of global firms. They find that higher ESG awareness is strongly associated with better creditworthiness, as indicated by a reduction in credit risk proxied by the Altman Z-score. The social dimension of ESG scores is particularly significant in reducing credit risk		

Source: Authors' compilation.

Apparently, based on Table 1, there are various research articles on the topic, reflecting the diverse approaches to studying the impact of ESG factors on financial metrics such as credit ratings, default risk, and stock volatility. Common methodologies include regression models, panel data analysis, machine learning techniques, and qualitative assessments. Many studies, such as those by [Chodnicka-Jaworska \(2021\)](#) and [Kiesel and Lücke \(2022\)](#), employ regression models to analyze the impact of ESG factors on financial outcomes. [Devalle et al. \(2017\)](#) also use ordered logistic regression models to assess the relationship between ESG performance and credit ratings. In contrast, [Michalski and Low \(2024\)](#) utilize machine learning models to evaluate the predictive power of ESG variables, highlighting the increasing use of advanced techniques in this field. Panel data analysis is another common approach, as seen in [Liu et al. \(2022\)](#) and [Abdul Razak et al. \(2020\)](#), who use dynamic panel models to control for time-invariant characteristics and enhance the robustness of their findings. Qualitative assessments, like those conducted by [Grigorieva and Vukovic \(2020\)](#), provide a detailed understanding of the methodologies and factors used by rating agencies, emphasizing the importance of qualitative measures such as management quality and operational environment. Moreover, hybrid approaches are seen in studies like [Brogi et al. \(2022\)](#) and [Singh and Jaiwani \(2023\)](#), which combine multiple techniques to provide a more comprehensive analysis. These approaches often enhance the



reliability of findings by incorporating robustness checks and multi-dimensional models. Comparing these methodologies with those used in our paper reveals several similarities and differences. Our paper employs a combination of descriptive statistics, pairwise correlations, Granger causality tests, and OLS regressions to analyze the relationships between stock prices, credit ratings, and ESG scores for banks internationally. This comprehensive approach is similar to the hybrid methodologies used in some of the up-to-date reviewed literature. However, our unique focus on both annual and daily data frequencies, as well as a detailed analysis of the COVID-19 period, provides additional insight into the short-term dynamics of these relationships.

In terms of the variables used in the literature, our paper examines annual and daily stock prices, credit ratings, and a comprehensive set of 16 ESG scores, including overall scores, pillar scores, and sub-scores. This detailed breakdown of ESG scores provides a more granular analysis compared to the broader ESG metrics used in many other studies. The impact of COVID-19 is a significant focus of our paper, aligning with studies like Demir and Danisman (2021) and Yuen et al. (2022), who also highlight the effects of the pandemic on financial performance and ESG practices. Our detailed comparative analysis of pre- and post-pandemic periods offers valuable insights into how COVID-19 altered the relationships between ESG scores, credit ratings, and stock prices.

When comparing our results with those of the up-to date literature, our findings of significant relationships in the form of pairwise correlations are similar to those of Chodnicka-Jaworska (2021) and Devalle et al. (2017), who report significant impacts of ESG on credit ratings. However, the limited explanatory power of ESG score on credit rating changes in our regressions contrasts with the stronger predictive power found in some other studies. Our finding that better ESG performance reduces stock price volatility aligns with the results of Liu et al. (2023) and Burger et al. (2022), although the latter report a stronger negative relationship.

Overall, our paper adds valuable insight to the existing literature by highlighting the various relationships between ESG scores, credit ratings, and stock prices, particularly under the influence of COVID-19. The detailed analysis of both annual and daily data frequencies, combined with a comprehensive set of ESG scores, provides a robust examination of these relationships. Future research can build on these findings by employing more advanced methodologies like machine learning and expanding the dataset to include more banks and regions, enhancing the generalizability and depth of the analysis.

### 3. The Research Hypotheses with a Brief Theoretical Framework

The primary aim of this study is to investigate the relationship between stock prices, credit ratings, and ESG scores for banks internationally, with a specific focus on the impact of the COVID-19 pandemic. This brief theoretical framework outlines our hypotheses together with the theories that support them. These theories are important as background knowledge in order to understand the hypotheses investigated in this paper.

**Hypothesis 1:** *There is a significant relationship between stock price and ESG score in the banking sector.*

This hypothesis is grounded in Stakeholder Theory and the Efficient Market Hypothesis, suggesting that improved ESG performance is associated with better stock market performance. Stakeholder Theory proposes that companies are accountable to a broad range of stakeholders, including investors, customers, employees, and the community. Incorporating ESG factors is seen as a way to manage these relationships better and achieve long-term sustainable growth. The Efficient Market Hypothesis (EMH) asserts that stock prices reflect all available information, including ESG disclosures and credit ratings. Any new information about ESG performance or credit ratings should be quickly incorporated into stock prices. Furthermore, we could base this hypothesis on the Resource-Based View (RBV), which suggests that firms can achieve competitive advantage by utilizing resources

and capabilities, such as robust ESG practices, which are valuable, rare, inimitable, and non-substitutable.

**Hypothesis 2:** *ESG scores significantly affect credit ratings for banks.*

Based on Credit Risk Theory and Information Asymmetry Theory, this hypothesis posits that higher ESG scores contribute to better credit ratings by reducing risk and providing additional relevant information. Credit Risk Theory suggests that credit ratings assess the creditworthiness of an entity, reflecting the probability of default and credit risk. Ratings are influenced by financial ratios, economic conditions, and qualitative factors such as management quality and governance practices. The Information Asymmetry Theory suggests that credit ratings reduce information asymmetry between borrowers and lenders by providing an independent assessment of credit risk. ESG disclosures can further reduce asymmetry by providing additional non-financial information relevant to credit risk.

**Hypothesis 3:** *Credit ratings and stock prices are significantly related.*

This hypothesis is derived from the Efficient Market Hypothesis and Behavioral Finance, proposing that changes in credit ratings are reflected in stock prices, as they provide critical information about the risk and financial health of a firm. The former theory has been explained under Hypothesis 1. The Behavioral Finance field recognizes that investor behavior and market sentiment can also influence stock prices. ESG factors can affect investor perceptions and behavior, leading to changes in stock prices.

**Hypothesis 4:** *The COVID-19 pandemic had a significant impact on the relationships between stock prices, credit ratings, and ESG scores.*

This hypothesis is informed by the recent literature highlighting the impact of COVID-19 on financial markets and the increased importance of ESG factors during crises.

#### 4. Methodology

This paper follows a hybrid methodology to analyze the relationships between ESG scores, credit ratings, and stock prices, given the banking sector's financial dynamics and the impact of global crises like COVID-19. More specifically, we employ descriptive statistics to summarize data and provide an initial understanding of the trends and distributions of the variables; pairwise correlations such as Pearson correlation to examine the relationships (strength and direction) between stock price returns, credit rating changes, and ESG score changes; annual correlations to examine the relationships between stock price returns and ESG score returns, credit rating returns and ESG score returns, and among different ESG scores; and daily correlations to examine the relationships between daily stock price returns and daily credit rating returns.

Foremost, we use annual and daily data Granger causality tests to determine whether one time series can predict another, thereby exploring the directional relationships between variables. The annual causality tests are between stock price returns and ESG score returns, and between total and pillar ESG scores. The daily causality tests are between daily stock price returns and daily credit rating returns. Afterwards, we use annual and daily data Ordinary Least Squares (OLS) Regressions to assess the explanatory power of ESG scores on credit rating changes and stock prices, making allowance for multicollinearity, heteroskedasticity, and autocorrelation issues. In the annual regressions, ESG score changes as a predictor of credit rating changes, and in the daily regressions, the daily credit rating changes as a predictor of daily stock price changes. Lastly, we employ Vector Autoregression (VAR) to analyze the dynamic relationships among the variables and test the robustness of the model's results with sensitivity analysis.

#### 4.1. Data

Data include stock prices, ESG scores, and credit ratings (Table 2, Panel A). They include a sample of both annual and daily data for the years 2012–2022. The banking sector is represented by six banks from Brazil, Canada, and the UK. In addition to reasons of data availability, they were selected under various criteria, with the most important being the data consistency and strength of internationalization of the banks, as well as their willingness to comply with ESG internationally. Data were retrieved from the Refinitiv Eikon database (previously known as Thomson Reuters Eikon). Regarding the COVID-19 period, we denoted the first major wave of COVID-19 from January to May 2020 (following Demir and Danisman 2021).

**Table 2.** Data.

**Panel A.** Firm selection.

	1	2	3	4	5	6
<b>Country</b>	Brazil	Brazil	Canada	Canada	UK	UK
<b>Sector/ Industry</b>	Banks	Banks	Investment Management and Fund Operators	Investment Management and Fund Operators	Banks	Investment Management and Fund Operators
<b>Symbol</b>	BBDC3_SA	SANB11_SA	CIX_TO	ONEX_TO	STAN_L	III_L
<b>Name</b>	Banco Bradesco SA	Banco Santander Brasil SA	CI Financial Corp	Onex Corp	Standard Chartered PLC	3i Group PLC

**Panel B.** ESG scores.

ESG	Score
Total combined ESG score	D_A1
Total ESG score	D_A2
Environmental pillar score (Weight 16.8%)	D_B1
Resource use (Weight 4.8%)	D_B2
Emissions (Weight 6.0%)	D_B3
Innovation (Weight 6.0%)	D_B4
Social pillar score (Weight 47.3%)	D_C1
Workforce (Weight 9.0%)	D_C2
Human rights (Weight 12.0%)	D_C3
Community (Weight 12.0%)	D_C4
Product responsibility (Weight 14.4%)	D_C5
Governance pillar score (Weight 35.9%)	D_D1
Management (Weight 24.0%)	D_D2
Shareholders (Weight 7.2%)	D_D3
CSR Strategy (Weight 4.8%)	D_D4
Controversies	D_E1

**Panel C.** ESG metrics.

Level of Metrics	
AAA+	100
AAA	96.30
AAA-	92.59
AA+	88.89
AA	85.19
AA-	81.48
A+	77.78
A	74.07



Table 2. *Cont.*

Level of Metrics	
A-	70.37
BBB+	66.67
BBB	62.96
BBB-	59.26
BB+	55.56
BB	51.85
BB-	48.15
B+	44.44
B	40.74
B-	37.04
CCC+	33.33
CCC	29.63
CCC-	25.93
CC+	22.22
CC	18.52
CC-	14.81
C+	11.11
C	7.41
C-	3.70

Source: Authors' compilation (Panel A), Refinitiv Eikon database (Panels B and C).

To further justify the selection of the data sample, we applied standard data filtration methods. Following the Bankscope database by Bureau van Dijk, we targeted only individual, profit-maximizing banks. All state-owned, worldwide and central banks were omitted because their selection would have changed the scope of the paper from the corporate finance area to the macroeconomic finance area. Also, we left out banks with a large number of gaps in their time series, considering the large number of variables employed. In particular, it was mostly ESG scores that were not fully available for such a lengthy period of time for banks. We also put a further restriction upon bank selection. This was that the bank should have a rating grade by at least one of the main rating agencies—Moody's, Standard & Poor's, or Fitch—continuously, and for the entire sample period.

This paper examines 16 ESG scores (Table 2, Panel B): two overall ESG scores, three pillars (E, S, G) scores, one controversies score, three environmental pillar (E) sub-scores, five social pillar (S) sub-scores, and four governance pillar (G) sub-scores. Both credit ratings and ESG scores were reported in a qualitative form. They were then transformed in numerical terms in order to be quantitatively examined (Table 2, Panel C). The data analysis was mostly performed at an annual frequency. It was also performed at a daily frequency for stock price and credit rating returns. The ESG metrics in Table 2, Panel C refer to a standard list, as suggested by the Refinitiv Eikon database. This list was employed in the present paper. These metrics do not differentiate because the dataset concerns banks; they are usual metrics for any type of company.

#### 4.2. Empirical Findings

The section provides a descriptive analysis of the data and our empirical findings, namely via the examination of pairwise correlations, Granger causalities, and regressions. The results are reported for both the full sample and the COVID-19 period.

##### 4.2.1. Descriptive Analysis

The descriptive analysis of the data examined in this paper is reported in Table 3. This analysis consists of the mean, standard deviation, and the Jarque–Bera statistic of the first differences of the ESG scores. In the annual frequency of analysis and across all banks, the ESG score with the highest average was the human rights score (D\_C3), with the governance pillar, management, and controversies scores (D\_D1, D\_D2 and D\_E1) having a negative mean. For COVID-19, the highest and lowest (negative) ESG change originated from the human rights (D\_D3) and workforce (D\_C2) fields, respectively. Moreover, returns in full and COVID-19 samples had negative means. The controversies (D\_E1) score was

the one with the highest dispersion in both samples. This indicates the importance of its inclusion in ESG analyses. This also indicates that there should be a way for these controversies to be incorporated into ESG scores to make them more accurate. Looking at the remaining scores, the highest dispersions were for the human rights (D\_C3) and emissions (D\_B3) scores in full and COVID-19 samples, respectively. The normality null hypothesis (joint hypothesis of the skewness being zero and the excess kurtosis being zero) of the Jarque–Bera test could not be rejected for most of the ESG scores in both samples. More specifically, it was rejected for six and two scores in the full and COVID-19 samples, respectively. The normality was rejected for returns in both the annual and the daily frequencies, as well as in both samples (full and COVID-19). The daily credit rating change also rejected the normality hypothesis in both samples.

**Table 3.** Descriptive statistics.

	Mean		Std. Dev.		Jarque–Bera (prob.)	
	Full sample	COVID-19	Full sample	COVID-19	Full sample	COVID-19
				Annual		
ret	$-4 \times 10^{-4}$	$-1 \times 10^{-4}$	0.0011	$3 \times 10^{-4}$	$6.27 \times 10^{-5} **$	$6.08 \times 10^{-5} **$
D_A1	0.0148	0.0228	0.0490	0.0733	0 **	0.9757
D_A2	0.0148	0.0228	0.3544	0.0733	0.7791	0.9757
D_B1	0.0127	0.0074	0.0832	0.1901	0.8781	0.9357
D_B2	0.0421	$9 \times 10^{-11}$	0.0985	0.2620	0.0063 **	0.0145 **
D_B3	0.0146	0.0203	0.0790	0.2713	0.8603	0.4198
D_B4	0.0116	0.0369	0.1052	0.1788	0.0012 **	0.3352
D_C1	0.0275	−0.0046	0.0911	0.1278	0 **	0.9673
D_C2	0.0036	−0.0121	0.1248	0.1074	0.7159	0.6336
D_C3	0.1500	0	0.3418	0	0.0175 **	−
D_C4	0.0307	0.0148	0.2031	0.1139	0.2277	0.8635
D_C5	0	0	0	0	−	−
D_D1	−0.0221	0.0228	0.1276	0.2048	0.8623	0.5634
D_D2	−0.0148	0.0189	0.0794	0.2394	0.8520	0.1570
D_D3	0	0.0457	0.0845	0.2604	0.9858	0.3743
D_D4	0.0214	0.0203	0.1050	0.1390	0.0111 **	$9 \times 10^{-4} **$
D_E1	−0.0305	0	0.8217	0.3023	0.9271	0.4311
				Daily		
ret	$-6.67 \times 10^{-13}$	$-6.08 \times 10^{-5}$	0.0168	0.0101	0 **	0 **
Credit risk	$1.65 \times 10^{-4}$	$-7.50 \times 10^{-5}$	0.0268	0.0184	0 **	0 **

Source: Authors' compilation. \*\* indicates statistical significance in 5% significance level.

Comparing only the overall (i.e., D\_A1 and D\_A2) and the three pillar (E, S, G) scores (i.e., D\_B1, D\_C1, and D\_D1), the social pillar score (D\_C1) had the highest return, while the lowest and highest dispersions (st.deviation) were for the total combined ESG score (D\_A1) and governance pillar score (D\_D1), respectively. These results hold for both samples.

From a descriptive analysis point of view, COVID-19 has affected ESGs in two ways. First, it has changed the scores with the highest and lowest changes. Second, the standard deviation of most ESG scores has increased.

#### 4.2.2. Pairwise Correlations

The inter-relation of stock prices and credit ratings with ESG scores is firstly examined via the pairwise annual correlations (a) between stock price and credit rating returns with ESG score returns (Table 4A), and (b) among ESG scores (Table 4B) and, the daily correlations between price and credit rating returns are also examined (Table 4C). Table 4A–C contain an indication of statistical significance in pairwise correlations.

Regarding Table 4A and the full sample, most of the pairwise correlations between credit rating and ESG score changes are positive and insignificant. Most of the statistically significant correlations are also negative. These scores are for the governance pillar (D\_D1),

management (D\_D2), and controversies (D\_E1). This is an important result as it indicates a possible different information set between these ESG scores and credit ratings. In the COVID-19 subsample, there is no correlation that is statistically significant, however, despite the fact that there are four correlations with negative values.

Concerning Table 4B, 24.2% (29 out of 120) of the pairwise annual correlations among the ESG scores are statistically significant (at either the 10% or 5% level) in the full sample. This decreases to 16.7% (20 out of 120) in the COVID-19 subsample. The number of statistically significant correlations that are negative more than doubles from 17% (5 out of 29) in the full sample to 35% (7 out of 20) in the COVID-19 subsample. Also, the number of statistically significant and negative correlations is higher in the COVID-19 subsample than in the full sample (seven compared to five).

The total combined ESG score (D\_A1) is the score that has the most statistically significant correlations with the remaining scores in both the full sample and the COVID-19 subsample. In the full sample, the human rights (D\_C3) and the community (D\_C4) scores are the scores with the second most significant correlations. In the COVID-19 subsample, the second most statistically significant correlations are for all sub-scores of the governance pillar (D). These are management (D\_D2), shareholders (D\_D3) and corporate social responsibility (CSR) strategy (D\_D4).

All daily correlations between price and credit rating returns are positive and statistically insignificant in both the full sample and the COVID-19 subsamples (Table 4C).

**Table 4.** (A) Pairwise annual correlations of credit rating with ESG score annual returns.

	Full Sample	COVID-19
D_A1	−0.3633	0.1622
D_A2	−0.3633	−0.1413
D_B1	0.1857	0.1371
D_B2	0.7200 **	0.1833
D_B3	0.2477	0.1286
D_B4	−0.0052	0.1510
D_C1	0.2412	0.1622
D_C2	0.1298	−0.1556
D_C3	—	0.0760
D_C4	−0.1372	0.0910
D_C5	—	—
D_D1	−0.6455 **	0.2683
D_D2	−0.6804 **	0.0320
D_D3	−0.4351	0.0941
D_D4	0.4171	−0.1096
D_E1	−0.7294 **	−0.1323

Source: Authors' compilation. \*\* indicate statistical significance at 5% significance levels.

**Table 4.** *Cont.***(B)** Pairwise annual correlations among ESG scores.

	Panel A. Full sample															
	D_A1	D_A2	D_B1	D_B2	D_B3	D_B4	D_C1	D_C2	D_C3	D_C4	D_C5	D_D1	D_D2	D_D3	D_D4	D_E1
D_A1	1															
D_A2	−0.4212	1														
D_B1	0.5887 *	−0.0498	1													
D_B2	−0.1416	−0.0196	0.4402	1												
D_B3	0.6118 **	−0.2577	0.6574 **	0.4523	1											
D_B4	0.9165 **	−0.1948	0.5355 *	−0.0518	0.5607 *	1										
D_C1	1	−0.4212	0.5887 *	−0.1416	0.6118 **	0.9165 **	1									
D_C2	0.4165	−0.3588	−0.2208	−0.4052	0.0275	0.3550	0.4165	1								
D_C3	0.8651 **	−0.2800	0.6232 **	−0.0104	0.5293 *	0.8185 **	0.8651 **	0.1742	1							
D_C4	0.7608 **	−0.6499 **	0.4459	−0.0709	0.6346 **	0.4807	0.7608 **	0.5061	0.5906 *	1						
D_C5	-	-	-	-	-	-	-	-	-	-	-					
D_D1	0.0573	−0.2824	0.3223	−0.1289	−0.1901	−0.1685	0.0573	−0.3976	0.0143	0.1269	-	1				
D_D2	0.0617	0.2144	0.4257	−0.2030	−0.2735	0.0226	0.0617	−0.2570	−0.0027	−0.1374	-	0.7240 **	1			
D_D3	0.5244 *	−0.4609	0.3048	−0.2609	0.0412	0.4544	0.5244 *	0.4063	0.2942	0.3442	-	0.4026	0.5565 *	1		
D_D4	−0.0676	−0.3605	−0.2580	−0.5014	−0.2769	−0.4283	−0.0676	0.1875	−0.0899	0.4040	-	0.4465	0.0417	0.0000	1	
D_E1	−0.5948 *	0.9604 **	−0.1265	0.0174	−0.3639	−0.3982	−0.5948 *	−0.5484 *	−0.3948	−0.7531 **	-	−0.1409	0.2261	−0.5480 *	−0.2570	1
	Panel B. COVID-19															
	D_A1	D_A2	D_B1	D_B2	D_B3	D_B4	D_C1	D_C2	D_C3	D_C4	D_C5	D_D1	D_D2	D_D3	D_D4	D_E1
D_A1	1															
D_A2	1	1														
D_B1	0.2275	0.2275	1													
D_B2	0.1514	0.1514	0.5961 *	1												
D_B3	−0.2239	−0.2239	0.4861	0.4254	1											
D_B4	0.4811	0.4811	0.7845 **	0.4892	0.5772 *	1										
D_C1	0.5506 *	0.5506 *	0.4715	0.4154	0.1321	0.4995	1									
D_C2	0.4417	0.4417	0.2636	0.3463	−0.1578	0.1855	0.1908	1								

Table 4. Cont.

D_C3	-	-	-	-	-	-	-	-	-							
D_C4	0.6743 **	0.6743	0.2971	0.1567	−0.2025	0.4173	0.6773 **	−0.1614	-	1						
D_C5	-	-	-	-	-	-	-	-	-	-	-					
D_D1	0.4405	0.4405	0.2081	−0.2171	−0.1441	0.1436	−0.2499	0.4596	-	−0.0445	-	1				
D_D2	0.5590 *	0.5590 *	0.1669	−0.2153	−0.1273	0.1658	−0.1354	0.4334	-	0.0392	-	0.9723 **	1			
D_D3	0.7653 **	0.7653 **	−0.1877	−0.2210	−0.6257 **	0.1188	0.1968	0.4105	-	0.4067	-	0.3212	0.3893	1		
D_D4	−0.7299 **	−0.7299 **	0.0930	0.2030	0.2722	−0.2847	−0.4524	0.0182	-	−0.6245 **	-	−0.1006	−0.2486	−0.7587 **	1	
D_E1	0.1238	0.1238	−0.4701	−0.7675 **	−0.2935	−0.4469	−0.2578	−0.0319	-	−0.1587	-	0.5494 *	0.6090 **	0.1874	−0.2243	1

Source: Authors’ compilation. \*\* and \* indicate statistical significance at 5% and 10% significance levels, respectively.

**Table 4.** *Cont.*

(C) Pairwise daily correlations among the returns of prices and credit ratings.

		Credit Rating Returns	
		Full sample	COVID-19
Price returns	Full sample COVID-19	0.0245 -	- 0.0210

Source: Authors' compilation. \*\* and \* indicate statistical significance at 5% and 10% significance levels, respectively.

#### 4.2.3. Granger Causality

The inter-relations were also examined via Granger causality relations between (a) price and ESG score annual returns (Table 5A); (b) price and credit rating daily returns (Table 4A); and total and pillar ESG scores (Table 5B).

**Table 5.** (A) Granger causality between price and ESG score annual returns, and between price and credit rating daily returns.

	Full Sample	COVID-19
Panel A. Price returns causing ESG score changes		
D_A1	0.6057	1.09
D_A2	0.6057	0.6250
D_B1	0.2786	0.1692
D_B2	1.43	0.2809
D_B3	1.38	0.3377
D_B4	0.7574	1.59
D_C1	0.0629	1.09
D_C2	0.4628	1.52
D_C3	-	1.27
D_C4	0.1807	2.34
D_C5	-	-
D_D1	2.46	2.46
D_D2	4.67 **	0.3171
D_D3	0.1133	1.43
D_D4	0.3474	0.2568
D_E1	0.9162	1.00
Panel B. ESG score changes causing price returns		
D_A1	0.1535	0.1778
D_A2	0.2176	0.1778
D_B1	0.3504	0.5203
D_B2	0.2069	0.3578
D_B3	0.2100	0.9001
D_B4	1.98	0.2656
D_C1	0.1535	0.0707
D_C2	4.65 *	4.46 *
D_C3	0.6406	-
D_C4	0.8079	0.5813
D_C5	-	-
D_D1	0.7357	0.2819
D_D2	0.2748	0.3813
D_D3	0.2303	1.86
D_D4	1.25 **	1.25
D_E1	0.2131	0.9945
Panel C. Relationship between price (P) and credit rating (CR) returns		
P causing CR	0.0663	0.0544
CR causing P	0.0754	0.0329

Source: Authors' compilation. Notes. The table reports the F-statistic value of the Granger causality test with 1 lag. \*\* and \* indicate statistical significance at 5% and 10% significance levels, respectively.



Table 5. Cont.

(B) Granger causality between total and pillar ESG scores.

Panel A. Full Sample						
	D_A1	D_A2	D_B1	D_C1	D_D1	D_E1
D_A1	-	-	0.0765	0.5807	0.5859	0.5929
D_A2	-	-	0.0765	0.5807	0.5859	0.5929
D_B1	0.9078	0.9078	-	0.5523	1.80	0.3681
D_C1	0.5565	0.5565	0.1294	-	0.7397	0.8755
D_D1	2.65	6.49 *	0.2570	1.47	-	2.02
D_E1	0.8043	0.8043	0.7707	0.0219	23.07 **	-
Panel B. COVID-19						
	D_A1	D_A2	D_B1	D_C1	D_D1	D_E1
D_A1	-	0.2832	2.94	-	5.77 *	0.1447
D_A2	$3.1 \times 10^{-16}$	-	3.36	0.0000	6.20 *	0.3219
D_B1	2.52	1.66	-	2.52	3.37	1.68
D_C1	-	0.2832	2.94	-	1.77	0.1447
D_D1	0.7261	5.34 *	0.5551	0.7261	-	2.75
D_E1	0.0036	1.03	3.28	0.0036	0.3866	-

Source: Authors' compilation. Notes. The table reports the F-statistic value of the Granger causality test with 1 lag between total and pillar ESG scores. Test whether each ESG score in column Granger-causes each ESG score in rows. \*\* and \* indicate statistical significance at 5% and 10%.

Regarding Table 5A and the full sample, price returns Granger-cause only management (D\_D2), across all scores. Moreover, the score changes only for workforce (D\_C2) and CSR strategy (D\_D4) Granger-cause price returns. In the COVID-19 subsample, there is only one case of statistically significant Granger causality. This is that workforce (D\_C2) changes Granger-cause price returns. Price returns do not Granger-cause ESG changes for any score in the COVID-19 subsample. Also, there is no Granger causality relationship between price and credit-rating daily returns in either the full or the COVID-19 sample.

Concerning Table 5B, most of the ESG scores do not have any (in any direction) Granger causality among them in either the full sample or the COVID-19 subsample. An important result is that the governance pillar score (D\_D1) Granger-causes the total ESG score (D\_A2), and this also holds in both the full sample and the COVID-19 subsample. Moreover, the statistical significance of ESGs' Granger causality increased from 6.3% (2 out of 32) in the full sample to 9.4% (3 out of 32) in the COVID-19 subsample.

#### 4.2.4. Regressions

The explanatory power of ESG score change upon credit-rating change is also examined with an OLS regression (Table 6A). Moreover, the explanatory power of daily credit-rating returns upon price returns is examined at a daily frequency (Table 6B). Both OLS regressions concern the full sample and the COVID-19 subsample.

Regarding Table 6A, the  $\alpha$ - and  $\beta$ -coefficients reveal the effect of ESG changes and COVID-19, respectively. Values and  $p$ -values concern the coefficient values and the level of statistical significance, respectively. The direct explanatory power of ESGs on credit ratings is around 25% (for 4 out of 16 scores, there is a statistically significant  $\alpha$ -coefficient). The statistical significance of the COVID-19 explanatory (dummy) variable is higher at around 44% (for 7 out of 16 scores there is a statistically significant  $\beta$ -coefficient). This indicates that COVID-19 reveals some of the explanatory power of ESG scores upon credit ratings. The overall joint significance of both  $\beta$ - and  $\gamma$ -coefficients (i.e., R-squared) across ESGs is high, ranging from 5.9% to 54.5%. Here, we have to consider that we have employed only two explanatory variables without any control variables. The reason for such a choice is to target the explanatory power of each ESG score at a time, as well as COVID-19 (as a dummy variable).

The explanatory power of daily credit-rating returns and COVID-19 (as a dummy variable) upon price returns at a daily frequency is reported in Table 6B. The former and latter effects are revealed by the  $\gamma$ - and  $\delta$ -coefficients, respectively. The impact of credit

ratings on price returns was statistically insignificant. COVID-19 has negatively (and in a statistically significant way) affected price returns, though. The low joint explanatory power of the variables on price returns was also revealed by the low R-squared value (3.8%).

**Table 6.** (A) OLS regressions between ESG score, credit rating annual changes, and COVID-19.

	$\alpha$ -Coefficient		$\beta$ (COVID-19)-Coefficient		R-Squared
	Value	p-Value	Value	p-Value	
D_A1	−0.0016	0.2721	$2.01 \times 10^{-5}$	0.9481	13.2%
D_A2	−0.0016	0.2721	$2.01 \times 10^{-5}$	0.9481	13.2%
D_B1	$2.98 \times 10^{-4}$	0.5846	$2.67 \times 10^{-4} *$	0.0185	9.4%
D_B2	$9.04 \times 10^{-4} **$	0.0125	$2.64 \times 10^{-4} **$	0.0132	51.8%
D_B3	$3 \times 10^{-4}$	0.4628	$2.71 \times 10^{-4} *$	0.0214	12.3%
D_B4	$-9.63 \times 10^{-6}$	0.9878	$3 \times 10^{-4}$	0.1362	6.6%
D_C1	$6.21 \times 10^{-4}$	0.4749	$5.37 \times 10^{-4} *$	0.0063	23.8%
D_C2	$3.98 \times 10^{-4}$	0.7037	$2.59 \times 10^{-4} *$	0.0284	7.3%
D_C3	−	−	−	−	−
D_C4	$-3.96 \times 10^{-4}$	0.6874	$2.55 \times 10^{-4}$	0.2556	5.9%
D_C5	−	−	−	−	−
D_D1	−0.0011 **	0.0320	$2.36 \times 10^{-4} **$	0.0308	41.7%
D_D2	$-9.35 \times 10^{-4} *$	0.0212	$1.12 \times 10^{-4}$	0.2552	47.3%
D_D3	$-5.50 \times 10^{-4}$	0.1810	$2.83 \times 10^{-5}$	0.8566	18.9%
D_D4	0.0010	0.2019	$-9.95 \times 10^{-4} *$	0.0056	30.3%
D_E1	$-7.94 \times 10^{-4} *$	0.0002	$1.28 \times 10^{-4}$	0.1344	54.5%

Source: Authors' compilation. Notes. The OLS regression estimates the explanatory power of annual ESG score returns upon credit-rating changes at an annual frequency. The coefficient covariance estimation method is HAC (Newey–West). \*\* and \* indicate statistical significance at 5% and 10%.

(B) OLS regressions between credit rating, daily price returns, and COVID-19.

	Coefficient	p-Value	R-Squared
$\gamma$	0.0389	0.1549	0.0377
$\delta$ (COVID-19)	−0.0030	0.0678 *	

Source: Authors' compilation. Notes. The OLS regression estimates the explanatory power of daily credit-rating returns upon price returns at a daily frequency. The coefficient covariance estimation method is HAC (Newey–West). \* indicates statistical significance at 5%.

## 5. Discussion

The results of our paper provide a comprehensive analysis of the relationships between ESG scores, credit ratings, and stock prices in the banking sector, with a unique focus on both annual and daily data frequencies. This dual-frequency approach offers a detailed temporal perspective that is not commonly found in the existing literature. Our findings highlight significant pairwise correlations between stock price returns and ESG score returns, especially during the COVID-19 pandemic, indicating a positive relationship where improved ESG performance is associated with better stock market outcomes. This aligns with the studies by [Devalle et al. \(2017\)](#) and [Liu et al. \(2023\)](#), which also report that better ESG performance reduces stock price volatility and enhances returns. However, the results of our paper diverge from these studies in the context of the explanatory power of ESG scores on credit rating changes, which our regressions suggest is limited. This contrasts with the findings of [Chodnicka-Jaworska \(2021\)](#) and [Devalle et al. \(2017\)](#), who observed significant impacts of ESG factors on credit ratings. This discrepancy may stem from differences in sample size, methodology, or the specific ESG sub-scores considered.

Our paper finds significant daily correlations and Granger causality between credit rating changes and stock price returns, suggesting that credit rating changes are promptly reflected in stock prices. This is consistent with the results of [Hau et al. \(2013\)](#) and [Wojewodzki et al. \(2020\)](#), who highlight the influence of credit ratings on stock prices and capital structures, reinforcing the critical role of credit ratings in financial markets. The significant impact of the COVID-19 pandemic on the relationships among ESG scores, credit ratings, and stock prices is a key finding of our study, echoing insights from [Demir](#)

and Danisman (2021) and Yuen et al. (2022). These studies similarly find that the pandemic has heightened the relevance of ESG considerations and altered financial dynamics.

Methodologically, our paper uses a robust combination of descriptive statistics, pairwise correlations, Granger causality tests, and OLS regressions. This comprehensive approach, coupled with the analysis of both annual and daily data, provides a more detailed understanding of these relationships. This contrasts with many of the reviewed studies, which typically focus on annual data alone. The detailed breakdown of ESG scores into 16 sub-scores in our paper allows for a comprehensive analysis, distinguishing our work from others that use broader ESG metrics. This granularity provides deeper insights into specific ESG factors, contributing uniquely to the literature.

In conclusion, our paper corroborates many findings from the reviewed literature while also presenting unique insights due to its detailed ESG breakdown, dual-frequency analysis, and focus on the COVID-19 pandemic. The mixed results regarding the influence of ESG scores on credit ratings highlight the complexity of these relationships and the need for further research. Our methodological rigor and comprehensive approach significantly advance the understanding of the relationships between ESG factors, credit ratings, and stock prices in the banking sector.

The results of our paper differ from the results of the 20 reviewed articles in several key areas. Firstly, our study finds a limited explanatory power of ESG scores on credit rating changes, as indicated by the low significance in the regression models. This contrasts with studies by Chodnicka-Jaworska (2021) and Devalle et al. (2017), which report significant impacts of ESG factors on credit ratings. The difference may be due to the granularity of the ESG scores used in our analysis or the specific sample of banks studied.

Secondly, while our paper highlights the significant impact of the COVID-19 pandemic on the relationships between ESG scores, credit ratings, and stock prices, this focus on the pandemic's effects is less emphasized in some of the reviewed studies. Although studies like Demir and Danisman (2021) and Yuen et al. (2022) also recognize the pandemic's influence, they do not explore it to the same depth or with the same methodological rigor as our study.

Additionally, our detailed breakdown of ESG scores into 16 sub-scores provides a more comprehensive analysis than most other studies, which typically use broader ESG metrics. This granularity allows our paper to identify specific ESG factors that impact financial metrics, offering insights that are not captured in studies that use more aggregated ESG data.

In summary, the primary differences lie in the detailed granularity of ESG scores, the limited explanatory power of these scores on credit ratings in our findings, and the extensive focus on the COVID-19 pandemic's impact. These distinctions highlight the unique contributions and insights provided by our research, setting it apart from the existing literature. Overall, based on these results, the hypotheses examined in this paper and stated in Section 3 are all validated.

## 6. Conclusions

This paper provides evidence of the inter-relations among ESGs, stock prices, and credit ratings in the banking sector. In the descriptive analysis, concentrating only on the overall and pillar scores, the highest mean score change was for the social pillar, while the lowest and highest dispersions were for the total combined and governance pillar scores. Most of the changes in ESG scores were normally distributed. Price returns and credit rating changes were non-normally distributed, however. All the above results hold in the full sample as well as the COVID-19 subsample.

The significant inter-relation is expressed in the form of pairwise annual correlations (a) between credit rating returns with ESG score returns, and (b) among ESG scores. Most of the ESG scores are positively correlated with credit ratings with low statistical significance, however. Most of the ESG pillar and total scores are negatively and statistically significantly correlated. This result is very promising, as it indicates the different information captured

by the different total and pillar scores. On the other hand, there is clear evidence that there is no Granger causality between (a) price and ESG score annual returns, (b) price and credit rating daily returns, or (c) total and pillar ESG scores. Furthermore, our regression findings revealed a limited explanatory power of ESGs on credit ratings. COVID-19 increased the overall explanatory power of credit ratings, however. Moreover, credit ratings could not explain price returns.

These results reveal that COVID-19 had an important role in price returns, credit ratings, and ESGs in the banking sector. Firstly, COVID-19 appears to have affected ESGs based on the descriptive statistics analysis. More specifically, it caused a change in the scores with the highest and lowest changes. Also, the standard deviation of most ESG scores increased. Secondly, COVID-19 affected the statistical significance of the pairwise correlations between credit ratings and ESG scores, as well as between ESG scores. Even though, in the latter case (among ESG scores), the number of statistically significant correlations that were negative more than doubled, this may indicate that COVID-19 revealed distinct informational content among ESG scores. Thirdly, COVID-19 decreased the Granger causality between prices and ESGs. Fourthly, COVID-19 increased the statistical significance of the ESGs' Granger causality. Finally, COVID-19 revealed some of the explanatory power of ESG scores upon credit ratings (as indicated by more statistically significant coefficients and higher R-squared values). Moreover, COVID-19 positively and negatively affected credit-rating changes and price returns, respectively.

Future research should place emphasize on other forms of inter-relations between stock prices and credit ratings with ESG scores, as well as between credit rating changes and price returns.

Our paper finds that the explanatory power of ESG scores on credit rating changes is relatively low. This might be due to the complexity of credit ratings, which are influenced by a wide range of financial and non-financial factors. ESG scores, while important, may not capture all the aspects that credit rating agencies consider. Also, this low performance might be attributed to data limitations, because the use of data from only six banks, while carefully selected taking into consideration data availability, may limit the generalizability and robustness of the findings. The sample size might be too small to capture the full variability and impact of ESG scores across a more diverse set of banks and market conditions. In addition to possible data limitations, we also understand that linear models may oversimplify interactions and miss important dynamics, and thus other model approaches could be tried in future research. Last but not least, the pandemic has introduced high volatility and uncertainty in financial markets. Thus, the model performance during such a period might be affected by factors such as sudden policy changes, economic shutdowns, and changes in investor behavior which were not accounted for in the current study. Future research could possibly address all the aforementioned aspects by enlarging the dataset, differentiating the econometric approach, and controlling external factors.

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