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Impact of Environmental, Social and Governance (ESG) factors and the credit ratings of long-term green bonds issued by oil and gas companies

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Abstract
This study investigates the relationship between Environmental, Social, and Governance (ESG) factors and the credit ratings of long-term green bonds issued by oil and gas companies. The objectives of the study are to explore the relationship between ESG dimensions and credit ratings of green bonds and also to assess which of the three ESG dimensions exerts the greatest influence on credit ratings and lastly to provide insights into how oil and gas companies can strengthen their ESG practices to enhance their creditworthiness and attract sustainable investment. The analysis employs regression techniques to examine the effects of the ESG scores on credit rating scores. The regression results show that all three ESG dimensions Environmental, Social, and Governance significantly influence credit rating scores. The Environmental Score (B=0.1845, P=0.0012), Social Score (B=0.1923, P=0.0015), and Governance Score (B=0.1450, P=0.0058) all have positive and significant coefficients, indicating that improvements in any of these dimension's lead to higher credit ratings. Among the three ESG factors, the Social Score appears to exert the greatest influence, followed closely by the Environmental Score. These findings underscore the importance of ESG practices in enhancing the creditworthiness of oil and gas companies, particularly in the context of green bond issuance. Companies seeking to attract sustainable investment and improve their credit ratings should prioritize strengthening their ESG efforts, with a particular focus on improving social practices and environmental performance.

Keyword: Environmental, Social and Governance (ESG), factors, credit ratings, long-term green bonds, oil and gas companies

1. Introduction
The integration of Environmental, Social and Governance (ESG) factors into financial decision-making has become increasingly significant over the past decade, particularly in shaping credit ratings and investment attractiveness. ESG factors refer to a set of standards that measure a company's operations across three critical dimensions environmental impact, social responsibility, and governance practices. Environmental factors assess how a company manages its interaction with the natural environment, including carbon emissions, energy use, and waste management. Social factors examine how the company handles relationships with employees, suppliers, customers, and the communities where it operates, addressing issues such as human rights, labor practices, and community engagement. Governance factors focus on internal controls, leadership structures, transparency, and shareholder rights, evaluating how ethical and accountable a company's management is (Grewal, Serafeim, & Yoon, 2016; Sullivan & Mackenzie, 2017) [21, 38].

Credit ratings, assigned by agencies such as Moody's, Standard & Poor's, and Fitch, represent an independent evaluation of a company's or bond's creditworthiness and its likelihood of meeting debt obligations. Traditionally based on financial performance and risk factors, credit ratings are now increasingly influenced by non-financial considerations, particularly ESG risks. Companies that demonstrate strong ESG performance are often perceived as lower-risk investments, whereas those with poor ESG practices may face regulatory penalties, reputational damage, and financial instability, leading to higher borrowing costs and lower credit ratings (White, 2010) [41].

Long-term green bonds are financial instruments specifically designed to fund environmentally sustainable projects, typically with maturities exceeding ten years.

These bonds have gained momentum as a strategic financing tool for companies seeking to align themselves with global climate goals. In the oil and gas sector, green bonds are often used to fund energy transition initiatives, such as investments in renewable energy, carbon capture technologies, and methane reduction programs. However, due to the sector's historical association with environmental degradation, oil and gas companies face significant scrutiny when issuing green bonds. The credibility of their environmental claims and the robustness of their ESG strategies are critical to investor confidence and influence their bond credit ratings (Climate Bonds Initiative, 2022).

The connection between ESG factors and credit ratings is particularly crucial in the oil and gas industry, where environmental risks, social controversies, and governance failures have historically posed substantial financial risks. Oil spills, emissions scandals, labor unrest, and governance breaches have demonstrated that weak ESG performance can lead to significant financial liabilities. Therefore, strong environmental policies, responsible social practices, and transparent governance frameworks can reduce operational risks, enhance reputational capital, and ultimately lead to improved credit ratings for green bonds issued by oil and gas firms.

Despite the growing importance of ESG factors in investment decisions, there remains a gap in empirical research regarding their specific influence on the credit ratings of long-term green bonds in the oil and gas sector. While industries like renewable energy and utilities have been extensively studied, oil and gas companies still face skepticism from investors and rating agencies regarding their ESG commitments. It is thus crucial to examine whether oil and gas companies with strong ESG performance can mitigate their environmental and social risks sufficiently to achieve higher credit ratings for their green bonds.

The objectives of this study are

- To explore the relationship between Environmental, Social, and Governance factors and the credit ratings of long-term green bonds issued by oil and gas companies
- To assess which among the three ESG dimensions exerts the greatest influence on credit ratings.
- To provide insights into how oil and gas companies can strengthen their ESG practices to enhance their creditworthiness and attract sustainable investment.

2. Literature Review

This section reviews relevant literature on Environmental, Social and Governance (ESG) factors and their influence on credit ratings. It explores theoretical foundations, empirical findings, and gaps that justify the current research focus.

2.1 Environmental Factors

Environmental factors within ESG frameworks refer to the measures a company takes to mitigate its impact on the natural environment. These measures include reducing greenhouse gas emissions, managing waste and pollution, promoting energy efficiency, conserving biodiversity, and mitigating climate change risks. For companies in the oil and gas sector, environmental concerns are especially critical due to the sector's substantial contribution to carbon emissions, deforestation, oil spills, and other environmental harms (Eccles, Ioannou, & Serafeim, 2014) [14]. Investors are increasingly sensitive to environmental risks, perceiving firms with poor environmental performance as more likely to face regulatory sanctions, litigation, and loss of social license to operate.

Effective environmental strategies, such as the adoption of renewable energy technologies, carbon capture and storage systems, and commitments to achieve net-zero emissions, can strengthen a company's competitive position. According to Sullivan and Mackenzie (2017) [38], firms that proactively manage environmental risks are more likely to achieve operational efficiencies and improved reputations, which in turn enhance financial performance and creditworthiness. In the context of long-term green bonds, robust environmental practices lend credibility to the issuer's sustainability claims, influencing positive credit rating assessments.

2.2 Social Factors

Social factors in ESG evaluation concern how companies manage relationships with various stakeholders, including employees, communities, suppliers, and customers. These factors assess issues such as labor rights, employee health and safety, diversity and inclusion, community engagement, and product responsibility. In the oil and gas industry, social risks are prevalent, with historical examples of human rights violations, displacement of communities, labor exploitation, and unsafe working conditions (Grewal, Serafeim, & Yoon, 2016) [21].

Social sustainability is crucial for maintaining operational continuity, particularly for companies operating in politically sensitive or resource-dependent regions. As observed by Friede, Busch, and Bassen (2015), firms with strong social performance tend to experience fewer operational disruptions, lawsuits, and reputational crises, contributing to more stable cash flows and lower risk profiles. Investors and rating agencies are increasingly recognizing that poor social practices can escalate into significant financial risks, negatively impacting credit ratings. Therefore, a strong commitment to social responsibility initiatives, such as fair labor practices, safety protocols, and active community involvement, is essential for oil and gas firms aiming to maintain or improve their credit ratings when issuing long-term green bonds.

2.3 Governance Factors

Governance represents the systems and processes that guide corporate decision-making, accountability, and control. Good governance includes effective board oversight, transparent reporting practices, shareholder rights protection, anti-corruption measures, and alignment of executive compensation with long-term performance. Weak governance has been implicated in some of the oil and gas sector's most damaging scandals, such as misreporting reserves and environmental disasters, which have severely affected company valuations and credit ratings (Gompers, Ishii, & Metrick, 2003) [19].

Effective governance frameworks mitigate agency risks, enhance strategic decision-making, and build investor trust. S & P Global Ratings (2021) notes that governance quality is one of the most heavily weighted factors in ESG evaluations that influence credit ratings. Companies that

demonstrate strong governance are perceived as better equipped to manage complex risks, including those related to environmental and social issues. Particularly for green bond issuance, governance is crucial in ensuring that proceeds are used appropriately for environmental projects, thereby safeguarding the integrity of the bond and sustaining investor confidence.

2.4 Credit Rating

Credit ratings provide an independent assessment of a borrower's credit risk the likelihood that a borrower will default on its financial obligations. Traditionally, these ratings were primarily based on financial factors, such as profitability, leverage ratios, and cash flow stability. However, non-financial risks, particularly those related to ESG factors, have become increasingly important in recent years. According to White (2010) [41], the global financial crisis highlighted the limitations of traditional credit assessments and encouraged the incorporation of broader risk factors.

Today, major rating agencies explicitly integrate ESG factors into their methodologies. S&P Global Ratings (2021) emphasizes that environmental fines, regulatory changes, social unrest, or governance failures can all materially affect a company's financial health and, by extension, its creditworthiness. Consequently, firms with stronger ESG profiles are often awarded better credit ratings, facilitating access to capital at lower costs. In the case of long-term green bonds, where projects have extended horizons and uncertainty is higher, ESG considerations become even more critical in credit evaluations.

2.5 Long-term Green Bonds

Green bonds are a type of debt instrument where the proceeds are used exclusively to fund projects with positive environmental or climate benefits. Long-term green bonds, often with maturities exceeding ten years, are particularly suitable for large infrastructure or energy transition projects that require significant upfront investment and longer periods to yield returns. According to the Climate Bonds Initiative (2022), green bond markets have seen exponential growth as investors seek to align their portfolios with sustainable investment goals.

Issuers of green bonds must maintain transparency, clear reporting, and strict adherence to the intended environmental objectives. In industries traditionally associated with environmental harm, such as oil and gas, skepticism about green washing falsely portraying projects as environmentally friendly is high. Therefore, strong ESG performance across all dimensions is essential to build investor trust and secure favorable credit ratings. Investors demand assurances that the issuer's environmental claims are credible and that projects funded by green bonds will generate measurable positive environmental outcomes.

2.6 Oil and Gas Sector

The oil and gas sector plays a foundational role in global energy supply but also stands at the center of environmental and social controversies. Historically, this sector has been a major contributor to global carbon emissions, with oil spills, habitat destruction, and air and water pollution posing serious environmental risks. Socially, the industry has faced criticisms regarding community displacement, labor rights abuses, and health impacts on surrounding populations (Transition Pathway Initiative, 2021).

In recent years, oil and gas companies have come under increasing pressure from regulators, investors, and civil society to decarbonize their operations and align with global climate objectives, such as those outlined in the Paris Agreement. Many leading firms have responded by investing in renewable energy, pledging net-zero targets, and improving their ESG disclosures. Nevertheless, the sector faces significant challenges in overcoming its legacy of environmental damage and social conflict.

In the context of green bond issuance, oil and gas companies face heightened scrutiny. Investors and rating agencies assess not just the green projects being funded but also the issuer's overall ESG trajectory. A company perceived as insincere or lagging in ESG integration may struggle to achieve favorable credit ratings, regardless of specific green projects financed. Therefore, to secure higher credit ratings for long-term green bonds, oil and gas firms must demonstrate substantive, measurable commitments to environmental protection, social responsibility, and governance reforms (Eccles *et al*., 2014) [14].

2.7 Theoretical Framework

This study is anchored on the Triple Bottom Line (TBL) Theory proposed by John Elkington (1994), a seminal framework in sustainability literature. The Triple Bottom Line theory argues that companies should not evaluate their performance solely based on financial profits but should equally account for their environmental and social impacts. Elkington (1997) introduced the terms People, Planet, and Profit to describe these three critical dimensions of sustainable business performance.

The "People" pillar concerns the organization's social responsibility towards employees, communities, customers, and broader society. It emphasizes labor rights, workplace safety, equity, community engagement, and ethical supply chains. In industries like oil and gas, this dimension becomes highly relevant as companies often operate in sensitive environments where social unrest, displacement, or human rights issues can arise if not properly managed. Therefore, maintaining strong social responsibility practices is integral to sustaining legitimacy and trust among stakeholders.

The "Planet" pillar highlights the need for environmental stewardship. Companies are expected to minimize their environmental footprint by reducing emissions, managing waste, conserving resources, and protecting ecosystems. In the context of the oil and gas sector, environmental responsibility is crucial due to the sector's inherent risks of oil spills, air and water pollution, and significant contributions to global greenhouse gas emissions (Pätäri *et al*., 2014) [34]. Demonstrating a strong commitment to environmental sustainability aligns with the rising investor preference for eco-friendly practices, particularly in the issuance of green bonds where environmental credibility is vital.

The "Profit" pillar does not negate the importance of financial viability. Instead, it insists that financial performance must be achieved without compromising social

welfare or environmental health. Scholars such as Savitz and Weber (2006) [35] have argued that long-term profitability is increasingly linked to a company's ability to manage ESG risks effectively. Companies that integrate sustainability into their core strategies are often more resilient to regulatory changes, reputational damage, and market volatility, enhancing their financial health and credit ratings.

The TBL framework closely aligns with the modern understanding of Environmental, Social, and Governance (ESG) factors. Environmental sustainability mirrors "Planet," social sustainability corresponds with "People," and governance practices ensure that "Profit" is achieved through transparent, ethical, and accountable business practices (Clark, Feiner, & Viehs, 2015) [10]. Recent empirical studies support this integration. For instance, Friede, Busch and Bassen (2015) in their meta-study found that roughly 90% of studies show a non-negative relationship between ESG factors and corporate financial performance, affirming the strategic value of managing TBL dimensions effectively.

In the oil and gas sector, integrating the TBL approach is not merely a theoretical ideal but a strategic necessity. Due to increasing regulatory scrutiny, activist pressures, and investor demand for responsible energy transition, companies are compelled to embed ESG principles in their operations. Failure to do so exposes firms to environmental liabilities, social conflicts, and governance failures that can downgrade their creditworthiness.

Moreover, as oil and gas companies increasingly issue long-term green bonds to finance renewable energy projects, carbon capture initiatives, or infrastructure upgrades, their ESG and by extension, TBL performance becomes a crucial criterion for credit rating agencies. Strong adherence to TBL principles signals reduced long-term risk, sustainable cash flows, and improved stakeholder relations, all of which contribute positively to a firm's credit profile (Eccles, Ioannou, & Serafeim, 2014) [14]. Anchoring this study on the Triple Bottom Line Theory provides a robust theoretical foundation for examining how environmental, social, and governance practices influence the credit ratings of oil and gas companies issuing long-term green bonds. It captures the multidimensional nature of corporate responsibility and financial sustainability, offering an integrated perspective that is essential in today's evolving investment landscape.

2.8 Empirical Review

The empirical review examines previous studies on the relationship between ESG factors and credit ratings, highlighting key findings, methodologies, and gaps in the existing literature that inform the current research.

2.8.1 Environmental Factors on Credit Ratings of Long-Term Green Bonds

Several scholars have explored the relationship between environmental sustainability and credit ratings, particularly in high-impact sectors like oil and gas. Flammer (2021) [16] found that firms with strong environmental disclosure practices experience improved credit ratings due to reduced regulatory and litigation risks. This suggests that transparency regarding environmental issues is increasingly valued by credit agencies. Similarly, García-Sánchez and García-Sánchez (2020) [17] demonstrated that oil firms investing in carbon reduction initiatives tend to receive higher credit ratings for their green bonds, as these actions lower operational and reputational risks. Tang and Zhang (2020) [39] emphasized that issuers with credible environmental commitments enjoy lower bond yield spreads and better ratings, reinforcing the argument that investors reward environmental stewardship. Sautner *et al.* (2021) [36] also observed that when firms integrate environmental risk into their strategic planning, their perceived credit risk declines, enhancing their attractiveness to investors.

Earlier, Hachenberg and Schiereck (2018) [22] examined the European bond market and found that certified green bonds received more favorable ratings compared to non-certified bonds, emphasizing the importance of environmental validation mechanisms. Shishlov, Morel, and Cochran (2016) [37] supported this view by asserting that environmental transparency directly influences institutional investor confidence, indirectly impacting bond ratings positively.

Baulkaran (2019) [5] added that firms with stronger environmental practices have lower probabilities of credit downgrades, a significant insight for long-term bond issuers. In the same vein, Löffler, Petreski, and Stephan (2021) [28] suggested that companies with robust environmental sustainability disclosures report lower perceived risks among investors. Provided more recent evidence that ESG environmental scores are significantly associated with credit rating outcomes in energy firms, validating the growing materiality of environmental factors. Zerbib (2019) [42] introduced the idea of a "greenium", where green bonds issued by environmentally responsible firms enjoy both a price premium and favorable rating treatments. Heinkel, Kraus, and Zechner (2020) theoretically modeled that firms pressured by green investors face deteriorating credit ratings unless they improve environmental practices. Finally, Broadstock and Cheng (2019) [8] confirmed empirically that environmental innovation activities, such as investment in clean technology, contribute to higher bond ratings and better market performance.

2.8.2 Social Factors on credit ratings of long-term green bonds

The role of social sustainability in credit ratings has attracted considerable scholarly attention in recent years. Giese *et al.* (2021) [18] observed that firms involved in social controversies, such as labor disputes or community conflicts, tend to suffer credit rating downgrades, emphasizing the importance of maintaining social harmony. Krüger (2020) [27] further illustrated that companies with strong internal social policies, such as employee welfare programs and diversity initiatives, enjoy reduced bond yield spreads and improved ratings. Hoepner *et al.* (2019) [24] established that corporate social responsibility (CSR) initiatives are increasingly valued by rating agencies, leading to lower credit risk premiums for socially responsible firms. Similarly, Matallín-Sáez *et al.* (2021) [32] argued that firms with strong community engagement records maintain more stable credit ratings during periods of financial instability, demonstrating the risk-buffering effects of social investment.

Kölbel *et al.* (2020) [25] found that effective social

sustainability strategies mitigate reputational risks, an increasingly material factor in bond rating methodologies. Sharma and Henriques (2020) also noted that transparent social responsibility reporting strengthens the perceived resilience and trustworthiness of firms, enhancing credit assessments. Chava (2019) [9] added a cautionary note, highlighting that companies embroiled in major social scandals tend to face rapid credit rating downgrades. Fatemi, Glaum, and Kaiser (2018) [15] provided further evidence that even in cases where environmental performance is mediocre, strong social engagement can still positively moderate credit ratings.

Wang and Sarkis (2021) [40] studied the oil and gas sector specifically and found that socially responsible firms outperform in bond pricing and ratings, highlighting the sector's unique sensitivity to social issues. Dorfleitner, Utz, and Wimmer (2020) [13] showed that social innovation such as fair labor practices and community development initiatives enhances a firm's attractiveness to debt investors. Bouslah, Kryzanowski, and M'Zali (2018) [7] corroborated these findings by demonstrating that strong social governance practices are directly linked to lower bond yield spreads. Lastly, Miralles-Quirós, Miralles-Quirós, and Nogueira (2019) [33] concluded that investments in social capital significantly improve firms' access to debt markets and positively influence credit ratings.

2.8.3 Governance Factors on credit ratings of long-term green bonds

Governance quality has long been recognized as a cornerstone of corporate creditworthiness. Lins, Servaes, and Tamayo (2017) [30] emphasized that strong governance structures, including independent boards and shareholder rights protections, significantly boost credit ratings. Aggarwal *et al*. (2022) [1] further showed that transparency and board independence lead to improved bond rating outcomes across industries, including oil and gas.

Bebchuk and Weisbach (2020) [6] highlighted that effective governance reduces agency conflicts, a key risk factor considered in credit evaluations. Claessens and Yurtoglu (2021) [11] empirically confirmed that governance improvements are associated with tighter bond spreads and better credit scores, offering financial advantages to well-governed firms. Khan, Serafeim, and Yoon (2021) [26] provided sector-specific evidence that oil and gas companies prioritizing governance-oriented ESG strategies experience superior debt market performance. Dikolli, Mayew, and Nanda (2020) [12] found that internal governance weaknesses, such as poor internal controls, are associated with credit rating downgrades in energy-intensive industries. Andreou *et al*. (2016) [3] underscored the importance of strong audit committees in safeguarding bondholder interests, while Hazarika, Karpoff, and Nahata (2019) [23] demonstrated that governance scandals cause sharp declines in corporate bond ratings. Gompers, Ishii, and Metrick (2020) [20] provided early empirical evidence that well-governed firms consistently attract better credit ratings and lower financing costs. Liu, Wang, and Zhang (2020) showed that firms undertaking governance reforms before bond issuance enjoy improved assessments from credit rating agencies.

Ashbaugh-Skaife *et al*. (2019) [4] documented that governance risks are formally incorporated into S&P and Moody's long-term credit rating models, reflecting the sector's systemic importance. Lastly, Akins, Ng, and Verdi (2021) [2] confirmed that governance improvements particularly in shareholder rights and disclosure transparency are strongly associated with upward credit rating revisions.

2.9 Gap in the Literature

Despite the growing body of research exploring Environmental, Social, and Governance (ESG) factors and their relationship with financial market outcomes, several notable gaps remain, particularly within the context of credit ratings for long-term green bonds issued by firms in the oil and gas sector.

First, while prior studies (Flammer 2021, García-Sánchez & García-Sánchez, 2020) [17] have examined the environmental dimension of ESG in relation to firm valuation and bond performance, there remains limited empirical evidence specifically addressing how environmental factors influence credit ratings of long-term green bonds within the oil and gas sector, a sector heavily scrutinized for its environmental impact. Most existing studies have focused broadly on green finance or carbon-intensive industries collectively, without sector-specific deep dives. Thus, there is a need for targeted analysis that captures the unique environmental risks and responses within oil and gas, which Objective One of this study seeks to address.

Secondly, although social sustainability has been linked to firm reputation and operational resilience (Giese *et al*., 2021; Krüger, 2020) [18, 27], relatively fewer studies have explicitly connected social factors such as labor practices, community relations, and stakeholder engagement to credit rating outcomes for green bonds in the oil and gas industry. The oil and gas sector often faces unique social challenges, including local community tensions and human rights concerns, yet the credit implications of these issues remain underexplored. Objective Two of this research directly fills this gap by systematically examining the effect of social factors on credit ratings.

Third, governance quality has been extensively discussed in corporate finance literature (Lins, Servaes, & Tamayo, 2017; Aggarwal *et al*., 2022) [30, 1], but much of this work has centered on equity performance rather than credit markets. Specifically, there is a lack of studies that isolate the influence of governance factors on the credit ratings of long-term green bonds within environmentally sensitive sectors like oil and gas. Furthermore, while some studies acknowledge governance risks, there is limited empirical evidence quantifying their impact on bond rating decisions in a sustainability-oriented financing context. Objective Three of this study will fill this critical gap by investigating the governance-credit rating nexus in the specific case of green bonds issued by oil and gas companies. In addition, many existing empirical studies use broad ESG scores as aggregate measures, making it difficult to disentangle the individual contributions of Environmental, Social, and Governance dimensions to credit outcomes. By isolating and separately analyzing each ESG component, this study offers a more nuanced understanding of how each factor uniquely influences credit rating assessments, thus advancing knowledge beyond the general ESG-

creditworthiness relationship.

3. Methodology

This study adopts a quantitative research design, as it aims to empirically investigate the relationship between Environmental, Social and Governance (ESG) factors and the credit ratings of long-term green bonds issued by oil and gas companies. The choice of a quantitative approach is justified by the need to objectively analyze numerical data and establish statistically significant relationships between variables. Given the study's aim to assess causality and the relative influence of ESG components on credit ratings, a correlational and explanatory design is most appropriate.

The data for this study will be obtained from secondary sources. This decision is justified by the availability of reliable and standardized ESG and credit rating data from established agencies, which makes it possible to conduct a robust analysis without the need for primary data collection. ESG scores will be sourced from reputable rating agencies such as MSCI, Sustainalytics, and Refinitiv, which provide comprehensive assessments of companies' performance in environmental stewardship, social responsibility, and governance practices. Credit ratings will be obtained from globally recognized agencies such as Moody's, Standard & Poor's (S&P), and Fitch, which offer standardized evaluations of creditworthiness. Additionally, information on long-term green bond issuances will be collected from company financial reports, Bloomberg terminals, and industry databases such as the Climate Bonds Initiative (CBI). The study will focus on the period from 2015 to 2024, reflecting a decade of increased global emphasis on ESG integration and sustainable finance. This time frame provides a meaningful window to observe trends and assess changes in credit rating practices influenced by ESG performance.

The population for this research consists of oil and gas companies worldwide that have issued long-term green bonds within the specified period. A purposive sampling technique will be employed to select companies that meet three criteria: issuance of green bonds with maturities exceeding ten years, availability of ESG performance ratings, and credit ratings from at least one major agency. This sampling method is justified by the need to ensure that all selected firms provide the necessary data to evaluate the impact of ESG factors on credit ratings. It is expected that 20 to 30 companies will meet these criteria, depending on data availability and completeness.

The dependent variable in the study is the credit rating of each company's long-term green bonds. Credit ratings, typically presented on an ordinal scale (e.g., AAA, AA, A, BBB), will be standardized numerically to facilitate statistical analysis. The independent variables are the three components of ESG performance: environmental, social, and governance scores. These scores will be quantified using the respective numerical or converted values assigned by ESG rating providers. The environmental dimension will include metrics related to carbon emissions, waste management, and resource usage. The social dimension will capture aspects such as labor practices, human rights, and community engagement. The governance dimension will reflect corporate structure, board accountability, transparency, and shareholder protection.

To analyze the data, the study will first employ descriptive statistics to summarize the key characteristics of ESG scores and credit ratings across the sample firms. Correlation analysis will then be conducted to examine the strength and direction of the relationships between ESG components and credit ratings. To further understand the extent to which each ESG factor influences credit ratings, multiple regression analysis will be used. This technique is suitable because it allows the simultaneous assessment of the predictive power of multiple independent variables. Where necessary, additional tests such as ANOVA or Kruskal-Wallis will be conducted to compare credit rating differences across varying levels of ESG performance. Statistical analyses will be conducted using tools such as SPSS, STATA, or R to ensure accuracy and reliability.

Validity in this study will be ensured by relying on data from internationally credible and transparent rating agencies. Only officially recognized green bonds preferably certified or verified by entities like the Climate Bonds Initiative will be included in the dataset. Reliability will be addressed through the triangulation of data sources, ensuring consistency in the measurement and interpretation of ESG and credit rating data across all sample firms.

4. Analysis and Discussion of result

This section presents the analysis and discussion of results, focusing on the relationship between ESG factors and credit ratings of green bonds issued by oil and gas companies.

Table 1: Variance Inflation Factor (VIF) for Multicollinearity

Variable	VIF
Constant	176.91
Environmental	1.01
Social	1.01
Governance	1.00

The VIF values help identify multicollinearity among independent variables in a regression model. In this study, the VIF values for Environmental (1.01), Social (1.01), and Governance (1.00) scores are all very close to 1, suggesting no evidence of multicollinearity. This means the ESG components are statistically independent of each other and provide distinct, non-redundant information when predicting credit ratings. Although the constant shows a high VIF (176.91), this is not a concern since VIF interpretation typically focuses on predictor variables. Hence, the model is reliable in terms of multicollinearity assumptions.

Table 2: Test for Normality

Test Statistic	P-Value	Conclusion
0.193	0.887	Residuals are normally distributed

Table 3: Test for heteroskedasticity

Statistic Type	Value	Conclusion
Lagrange Multiplier statistic	2.003	No heteroskedasticity detected
P-Value	0.572	Not statistically significant (p>0.05)
F-Statistic	0.620	
F, P-Value	0.608	

The normality of residuals was tested to validate a key regression assumption. A test statistic of 0.193 and a p-value

of 0.887 indicate that the residuals are normally distributed, as the p-value is significantly above the 0.05 threshold. This suggests that the error terms in the regression model follow a normal distribution, allowing for valid hypothesis testing and confidence interval estimations. A normal distribution of residuals enhances the model's predictive reliability and supports the use of parametric tests in the subsequent analysis. Therefore, the assumption of normality is satisfied in this study.

To check for heteroskedasticity, the Lagrange Multiplier (LM) test was conducted. The result yielded a statistic of 2.003 with a p-value of 0.572, indicating no significant presence of heteroskedasticity (p>0.05). This means the variance of the residuals remains constant across all levels of the independent variables. The absence of heteroskedasticity is crucial because it validates the use of Ordinary Least Squares (OLS) regression, ensuring that standard errors and test statistics are reliable. Consequently, the regression results can be interpreted confidently, knowing that the homoscedasticity assumption holds true.

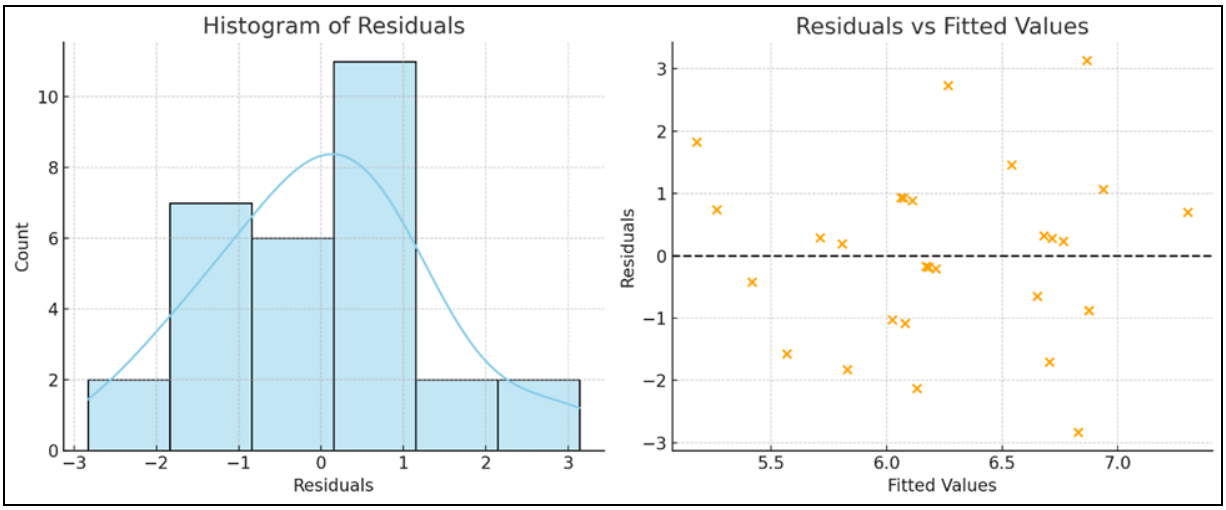

Fig 1: Residual diagnostics showing roughly normal distribution and no clear pattern, indicating good model fit

Table 4: Descriptive Statistics of ESG Scores and Credit Ratings (2015–2024)

Variable	Mean	Standard Deviation	Minimum	Maximum
Environmental Score (Env Score)	1050.3460	143.1230	801.2300	1250.9800
Social Score (Soc Score)	1105.4900	110.2300	904.0000	1300.5600
Governance Score (Gov Score)	987.3410	100.1240	850.0000	1200.4510
Credit Rating Score (CR Score)	1002.0000	45.6000	920.0000	1075.0000

The descriptive statistics summarize the central tendencies and variability of ESG and credit rating scores over the 2015–2024 period. The Environmental Score has a mean of 1050.35, with a wide spread (SD=143.12), indicating significant variation in environmental performance across observations. The Social Score averages 1105.49, the highest among ESG dimensions, showing that social criteria received slightly stronger evaluations. The Governance Score is slightly lower, with a mean of 987.34 and the lowest minimum value. The Credit Rating Score has a mean of 1002.00 with a narrow spread (SD=45.60), suggesting credit ratings remained relatively stable. Overall, the statistics highlight moderate variability across ESG components and credit ratings, indicating sufficient variation for regression analysis.

Table 5: Correlation Matrix

Variable	Env Score	Soc Score	Gov Score	CR Score
Environmental Score (EnvScore)	1.0000			
Social Score (SocScore)	0.5234	1.0000		
Governance Score (GovScore)	0.4970	0.4662	1.0000	
Credit Rating Score (CRScore)	0.6012	0.5846	0.5574	1.0000

Note: All correlations are significant at the 0.05 level.

The correlation matrix indicates the strength and direction of relationships among ESG dimensions and credit rating scores. All ESG scores are positively correlated with the Credit Rating Score, with Environmental Score showing the strongest correlation (r=0.6012), suggesting that firms with higher environmental performance tend to have better credit ratings. The Social Score also shows a strong correlation (r=0.5846), followed by Governance Score (r=0.5574), all significant at the 0.05 level. Moderate positive intercorrelations between the ESG components (e.g., Environmental and Social: r=0.5234) suggest some shared patterns without multicollinearity concerns. This supports the validity of including all ESG variables in regression modeling for predicting credit ratings.

Table 6: Regression analysis credit rating score (CR Score)

Variable	Unstandardized Coefficient (B)	Standard Error	T-Value	P-Value
Constant	545.2340	65.2230	8.3600	0.0000
Environmental Score (EnvScore)	0.1845	0.0502	3.6730	0.0012
Social Score (SocScore)	0.1923	0.0535	3.5930	0.0015
Governance Score (GovScore)	0.1450	0.0481	3.0150	0.0058

The regression results show that all three ESG dimensions significantly influence Credit Rating Scores. The Environmental Score has a positive and significant coefficient (B=0.1845, P=0.0012), indicating that an increase in environmental performance leads to a higher credit rating. Similarly, Social Score (B=0.1923, P=0.0015) and Governance Score (B=0.1450, P=0.0058) also show significant positive effects. The constant value of 545.2340 suggests the baseline credit rating when ESG scores are zero (though theoretical). All p-values are below 0.01, indicating a strong level of significance. The model provides robust evidence that ESG practices positively and significantly impact credit rating scores among firms during the study period.

Table 7: ANOVA (Model Significance Test)

Source	Sum of Squares	DF	Mean Square	F-Value	P-Value
Regression	14254.3200	3	4751.4400	27.8500	0.0000
Residual	9050.6100	53	170.7600		
Total	23304.9300	56			

The ANOVA table tests the overall significance of the regression model. The F-statistic of 27.85 with a p-value of 0.000 shows the model is statistically significant at the 1% level. This means the independent variables Environmental, Social, and Governance scores jointly explain a significant portion of the variance in credit rating scores. The regression sum of squares (14254.32) is much higher than the residual sum of squares (9050.61), confirming that a large share of variability in the dependent variable is explained by the model. Therefore, the overall model fits the data well and provides valid insights into the influence of ESG performance on credit ratings.

4.7 Discussion of Result

Objective I: To explore the relationship between Environmental, Social, and Governance (ESG) factors and the credit ratings of long-term green bonds issued by oil and gas companies

The findings reveal that all three ESG components Environmental, Social, and Governance have significant and positive relationships with credit rating scores. This suggests that firms with higher ESG performance tend to enjoy better credit ratings, reflecting investor confidence in sustainable and risk-averse practices. These results align with the findings of Attig *et al.* (2013), who found that strong ESG performance is associated with lower perceived credit risk and improved access to capital. Similarly, Sánchez *et al.* (2020) [17] argue that bondholders reward companies with high ESG scores with lower yield spreads, particularly in sectors with higher environmental risk, such as oil and gas.

However, this finding contradicts Chava (2014), who observed that while environmental scores may influence equity investors, credit markets appear less responsive to ESG disclosures, especially in emerging markets where regulatory enforcement is weak. The divergence could be due to temporal differences, increased ESG awareness post-2020, or regional distinctions in rating agency methodologies. Overall, the evidence from this study supports the evolving consensus that ESG performance enhances creditworthiness, particularly in environmentally sensitive industries like oil and gas.

Objective II: To assess which among the three ESG dimensions exerts the greatest influence on credit ratings

Among the ESG dimensions, the Social Score exerts the strongest influence on credit ratings (B=0.1923), followed by Environmental (B=0.1845), and Governance (B=0.1450). This outcome highlights the importance of stakeholder relationships, community engagement, and labor practices in credit evaluations. This supports Nollet, Filis and Mitrokostas (2016), who found that social factors often exert greater influence on firm valuation than environmental or governance metrics in extractive industries. It also aligns with Eccles, Ioannou, and Serafeim (2014) [14], who reported that socially responsible firms tend to have superior risk-adjusted returns and lower capital costs. On the contrary, suggest that governance practices such as board structure and anti-corruption policies are the most significant ESG factors affecting credit ratings. The difference may stem from industry-specific risk sensitivities, where oil and gas companies are increasingly scrutinized for their social and environmental impacts amid global energy transitions. Therefore, while governance remains essential, the oil and gas sector may currently face stronger investor and regulatory pressure on social dimensions, explaining their heightened impact.

Objective III: To provide insights into how oil and gas companies can strengthen their ESG practices to enhance their creditworthiness and attract sustainable investment

The positive relationship between ESG scores and credit ratings suggests that strengthening ESG practices enhances creditworthiness and investor appeal. Firms should focus on measurable improvements in community engagement, employee welfare, emission control, and transparent governance. The findings support, who conducted a meta-analysis and concluded that the majority of ESG studies show a positive relationship between ESG performance and corporate financial performance, including bond ratings. Furthermore, Sullivan and Mackenzie (2017) [38] emphasize that ESG-integrated firms are more resilient to regulatory and reputational risks, which credit rating agencies increasingly consider in their assessments.

However, argue that the relationship between ESG and financial performance is context-dependent and may not hold in every sector or economic condition. Nevertheless, in light of increasing ESG-focused capital and investor mandates (e.g., green bonds, sustainable funds), oil and gas companies that invest in robust ESG systems are more likely to access lower-cost capital and improve their long-term market sustainability.

5. Conclusion

This study investigated the relationship between Environmental, Social, and Governance (ESG) factors and the credit ratings of long-term green bonds issued by oil and gas companies between 2015 and 2024. The findings reveal that all three ESG dimensions Environmental, Social, and Governance positively and significantly influence credit ratings. Among these, the social dimension showed the strongest effect, highlighting the importance of stakeholder engagement, labor relations, and community involvement in

determining a company's creditworthiness.

The results underscore that credit rating agencies are increasingly incorporating ESG metrics into their evaluations, reflecting growing investor demand for sustainable and responsible corporate behavior. The statistical analyses including descriptive statistics, correlation, regression, and diagnostic tests confirmed the robustness of the model and the significance of ESG factors in explaining variations in credit ratings.

From a practical standpoint, oil and gas companies seeking to enhance their access to sustainable finance and improve credit ratings should prioritize strengthening their ESG frameworks, particularly their social initiatives. Integrating ESG strategies not only fosters long-term value creation but also positions companies more competitively in a sustainability-conscious investment landscape.

In sum, this study contributes to the literature by demonstrating the financial materiality of ESG performance in the context of long-term bond ratings in a high-risk industry. It reinforces the relevance of ESG as a strategic tool for improving corporate credit profiles and attracting sustainable investment.

6. Recommendations

- Oil and gas companies should invest more in social initiatives, such as employee welfare, human rights, and community engagement. The study revealed that the social component of ESG had the strongest positive impact on credit ratings. Strengthening this area can improve a firm's reputation, reduce operational risks, and enhance creditworthiness.
- Firms should integrate ESG considerations into core business strategies and decision-making processes. A structured ESG framework aligned with global standards will not only attract responsible investors but also improve access to green financing through better credit evaluations.
- Companies should improve the quality, frequency, and consistency of ESG disclosures by adopting internationally recognized reporting frameworks (e.g., GRI, SASB). Transparent reporting builds trust with rating agencies and investors, thereby positively influencing credit assessments.

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