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Exploring the impact of ESG factors on corporate risk: empirical evidence for New York Stock Exchange listed companies

Silvia-Andreea Peliu[1*]

Abstract

This paper aims to investigate the impact of influential ESG factors on risk, focusing on debt risk and liquidity risk. The influence on a sample of companies listed on the New York Stock Exchange belonging to the NYSE index is analyzed over a 10-year period, 2012–2021. The quantitative framework covers a multitude of indicators regarding debt, liquidity, corporate governance, the environment, CEO characteristics, performance, and other variables, and the research methodology uses the method of least squares to highlight their impact, using regression models with fixed and random effects, both linear and nonlinear. By estimating regression models, the empirical results confirm the hypotheses found in the existing knowledge stage that debt risk and liquidity risk are significantly influenced by asset profitability, the CEO duality significantly influences debt, while CEO gender diversity has a negative influence on corporate risk, specifically debt and liquidity risk. Additionally, it is shown that the emergence of COVID-19 brings significant changes to company autonomy and their financial performance, the COVID-19 pandemic has negatively influenced corporate risk through restrictions, economic uncertainty, and the amplification of risks. These research results are crucial for practitioners by the necessity of integrating ESG criteria into the risk assessment process and decision-making. Furthermore, concerning policy decision-makers, they help promote sustainability and a responsible approach. Therefore, ESG factors can impact companies' financial performance and influence how they are perceived by investors. By understanding and correctly evaluating these ESG factors, one can identify and manage risks more efficiently, achieve better long-term returns, make appropriate decisions, and promote sustainability in the business environment.

Keywords Performance, Risk, Liquidity, ESG, Debt, Social responsibility, CEO duality, Gender diversity

Introduction

Risks are perceived as uncertain, possible, and undesirable events, unpredictable in nature, which generate the possibility of loss, failure to achieve expected outcomes, and declines in financial performance, especially when influenced by other external factors such as governance, political, technological, social, and environmental factors. Adeleke et al. [2] analyze external factors and their influence on risk management, finding a significant positive relationship between organizational external factors and risk management, as well as between rules and regulations and risk management. Additionally, the study by Chen et al. [15] analyzes the external impact of corporate governance on corporate social sustainability and debt risk to investigate the risk reduction effect and the mediating role of corporate social sustainability.

There are multiple types of risks and various internal and external factors that influence them. As categories of risks, we encounter operational, IT, financial, political, security, technological, industrial, climatic, liquidity, market, strategic risks, and so on. Fu et al. [20] discuss the liquidity-risk-insolvency relationship and the impact

*Correspondence:
Silvia-Andreea Peliu
peliu.silvia@gmail.com
[1] Department of Finance, Bucharest University of Economic Studies, 6 Romana Square, 010374 Bucharest, Romania

of liquidity on corporate insolvency risk, using a sample of companies listed on the Chinese A-share market from 2009 to 2019.

Risk management is also of utmost importance. Firstly, risks need to be identified, prevented, and evaluated, then monitored, and finally, damages caused by them should be minimized as much as possible. Sun et al. [44] show that risk disclosure indicates that companies face uncertainties in their future development, and managing them requires good management. Additionally, Yun [47] discusses the effect of enterprise risk management on corporate risk management, concluding that enterprise risk management enhances corporate risk management as it allows for better identification and evaluation of risks and the development of appropriate strategies.

After presenting the idea of risks, types of risks, and the concept of risk management, let's get back to the central topic, which is the environmental, social, and corporate governance factors. These ESG factors refer to the criteria used to evaluate a company's performance in terms of sustainability and social responsibility. They are becoming increasingly important in investment decision-making because investors want to allocate capital to companies that take responsibility for the environment. They can support companies that adopt sustainable practices, reduce their environmental impact, promote diversity and inclusion, and have strong governance, generating a positive impact on society. Furthermore, regardless of the size of a company, small, medium, or large, adopting ESG practices can bring long-term benefits, both financially and in terms of reputation and sustainability. We find numerous studies discussing governance such as Affes et al. [3] addressing the impact on performance, Al-Hadi et al. [6] associating governance with market risks, Li et al. [29] aiming to show if corporate social sustainability influences the business environment, as well as studies focusing more on the risk combined with ESG elements like the environment or the board of directors. Thus, the study by Li et al. [30] talks about climate risk, while Li et al. [31] discusses risk and gender diversity on the board. Other studies detail risk from various perspectives such as Mansi et al. [33], Otero Gonzales et al. [39], Ricca et al. [41], and Yingfan et al. [46].

As for empirical studies on the impact of ESG factors on corporate risks, it is quite challenging to identify and precisely measure this impact. Although there is evidence from previous research that ESG factors influence risk, we still have uncertainties about how these factors interact and the mechanisms through which they influence risks. However, it is relevant to investigate the impact of ESG factors on corporate risk, especially for companies listed on the NYSE, as these companies have a significant influence on the global economy. By understanding how ESG factors affect corporate risks in these companies, we can develop more effective strategies for risk management and sustainability growth in the corporate sector, for any type of stock exchange.

Therefore, this issue is extensively researched and addressed in numerous studies and articles that develop the theoretical aspect regarding types of enterprise risks, analysis of factors influencing risks, as well as the practical aspect through case studies. For example, He [25] discusses ESG aspects and corporate risk-taking, and it has been found that ESG rating significantly reduces corporate risk-taking.

The topic is significant for both the private sector, the financial-banking system, and the entire economy. This is normal considering that the main objectives of a company are to maximize profit, gain a larger market share, provide excellent service quality, have efficient control over the environment and pollution, and last but not least, satisfy customers, fowever, the research problem is to obtain empirical evidence and investigate how these factors influence the level of risk of companies and their market performance in order to achieve the best return values, which is necessary for each company because significant problems within the firm related to management and more can be resolved, which can generate truly harmful risks to profit or value.

The main purpose of this paper is to show to what extent certain variables that are based on elements related to corporate governance, performance, and the environment, modify or are modified by the selected risk indicators for the study. In other words, the paper aims to explore the impact of ESG factors on corporate risk for companies listed on the New York Stock Exchange and provide empirical evidence to support this relationship. This can be achieved through data analysis and examining the performance of companies, aiming to understand how ESG factors can influence the level of risk and market performance of these companies. The research questions provide answers formulated in hypotheses: the debt risk and liquidity risk are significantly influenced by asset profitability; CEO duality significantly influences debt, while CEO gender diversity has a negative impact on corporate risk.

The objectives of such a study are to evaluate the relationship between ESG factors and corporate risks to understand how they influence each other, to identify mechanisms through which these factors can affect corporate risk, to examine how ESG factors can also impact the financial performance of companies and, lastly, to identify gaps and challenges regarding ESG factors, their transparency, and reporting methods. It aims to confirm hypotheses regarding the impact of ESG factors and deduce that in enterprises with good ESG performance, the level of risks is lower. By integrating ESG factors into decision-making processes and corporate governance,

it will lead to more efficient risk management. Investors will pay more attention to companies with better ESG performance, and lastly, greater transparency and accurate reporting of ESG factors will result in better risk assessment and investor trust.

The research method uses the least squares method to highlight its effects, using regression models with fixed and random effects, both linear and nonlinear. To estimate the regression model's effect, the general form of the independent variables includes performance factors, governance, environmental responsibility, CEO characteristics, and control variables. The empirical results aim to show that a company's asset profitability level has a significant impact on debt risk and liquidity risk, and the higher the profitability, the lower the debt and liquidity risks. Also, the presence of duality in the CEO role of a company has a significant impact on the debt level because when the same person holds both the CEO role and a position on the board of directors, the company's debt level can be significantly influenced. Additionally, the gender diversity of a company's CEO has a negative impact on debt risk and liquidity risk because greater gender diversity in the CEO role can contribute to risk reduction.

The goals that need to be met are to demonstrate that there are numerous variables that can cause changes in risk and it seeks to uncover and assess how ESG factors influence the level of corporate risk for companies listed on the New York Stock Exchange. Additionally, companies listed on the NYSE were chosen for the case study due to the accessibility of relevant financial data and the transparency of this information on official websites and beyond. Moreover, the size and diversity of these companies provide a comprehensive framework to analyze various practices related to ESG factors and corporate risk. Their study can offer a broad perspective on how ESG factors influence companies' performance and risk, significantly impacting the market and the business environment, with the American market being one of the most developed in the world.Therefore, it is shown that the analyzed variables modify the debt risk and liquidity risk, which can lead to bankruptcy. At the same time, the research hypothesis assumes that there is a positive relationship between ESG factors and the level of corporate risk, and that adopting responsible practices in the environmental, social, and governance domains can significantly reduce the corporate risk of these companies.

To demonstrate the strengthening of the link between ESG factors and corporate risk, we can clearly argue that integrating ESG factors into a company's decision-making and management processes can help reduce corporate risk. By considering environmental, social, and governance aspects in the company's activities, one can manage the risk associated with these areas more effectively and identify opportunities to improve the company's financial and operational performance. Therefore, this strengthening of the link between ESG factors and corporate risk can bring significant benefits both to the company and the environment or society in which it operates.

Therefore, the results of the empirical research study on the impact of ESG factors on corporate risks and their potential implications for various stakeholders aim to show that there is a positive correlation between environmental, social, and governance (ESG) practices and the reduction of corporate risks. This is because businesses that adopt sustainable and socially and environmentally responsible practices tend to have lower risks in terms of financial, reputational, and compliance aspects. These findings have significant implications for various stakeholders, such as investors who may consider ESG factors when making investment decisions, as well as consumers and communities who benefit from companies' involvement in social and environmental issues, job creation, environmental protection, and support for local communities.

As for the study, there are still research gaps regarding the effectiveness of strategic risk management implementations, their evaluation in different industries, and the influence of external factors such as political or economic factors. Additionally, another element considered a research gap is the lack of specific research focusing on this topic in the context of companies listed on the New York Stock Exchange. While there are studies exploring the impact of ESG factors on financial performance, I haven't come across more detailed research to understand how these factors influence the level of corporate risk for these NYSE companies. This study aims to fill this gap by providing empirical evidence in this specific area.

On the other hand, as for the paper's novelty of the article is the exploration of the impact of environmental factors on risks, specifically the impact of variables related to water resources utilization, energy consumption, CO2 emissions, which are variables of current interest, wanting these factors used in the case study to bring empirical evidence and detailed analysis of these NYSE companies, environmental issues and responsibility being a sensitive topic nowadays.

Regarding the contribution of the paper to the research field, the study attempted to develop a model and research methodology to assess the impact of independent variables on those that quantify risk, investigate internal factors on risks, as well as some external factors. Lastly, it examined the relationship between financial performance and enterprise risk management.

As a "paper outline" this is structured into four main parts, namely the theoretical part which includes numerous studies, the research methodology in the second part, the practical part through a complex case study, and the conclusions. In the first part, the state of knowledge,

a multitude of articles that study the topic at hand are reviewed, presenting some theoretical aspects regarding the concept of risk and the influencing factors of risks in relation to environmental, social, and corporate governance elements, as well as corporate social responsibility, considering the impact of ESG factors on risks. It closely follows the influence of CEO characteristics, the influence of the board of directors, and the impact of board gender diversity on risks. Additionally, the paper analyzes the connection between financial performance and its influence in relation to debt and also discusses the COVID-19 pandemic and its impact on enterprise risks. The second part of the paper presents the methodology of quantitative research, specifically the description of the database and variables that will be used in the econometric study, as well as the presentation of the quantitative methods to be conducted. The third part is represented by a case study that combines theoretical notions with practical ones, conducted through a personal econometric study that includes multiple regressions and tests to demonstrate the hypotheses established in the research. There are numerous statistical and economic interpretations, as well as comparisons between the obtained results and the reviewed studies. The last part is dedicated to the conclusions and final results.

Empirical literature review and hypothesis development

Regarding the state of knowledge, several representative subchapters will be created for the research hypotheses to emphasize the fact that there is a wide variety of articles that correspond to the current research, depending on the multitude of independent variables. Currently, only a small part of the impact that ESG factors have on enterprise risk will be demonstrated.

The impact of ESG factors: the relationship between the independence of the board of directors and the company's risks: on company risks

The specialized literature begins by describing the impact that environmental, social, and governance elements have on company risks, using relevant studies that discuss corporate governance as a whole, corporate responsibility, and their component elements such as the importance of directors, the board of directors, duality and so on. Good corporate governance helps a company by providing effective leadership and control to manage risks and challenges, all with the goal of maximizing profitability. The current study's necessity regarding the impact of ESG factors on corporate risks is crucial to understand how environmental, social, and governance practices influence companies' performance and risk. This study can provide valuable information for investors, managers, and other stakeholders in identifying the link between ESG approaches and a company's financial results. Additionally, it can contribute to promoting sustainable and responsible practices in the business environment, having a positive impact on both companies and society and the environment. There are extensive research studies exploring the relationship between ESG factors and corporate risk, analyzing how environmental, social, and governance practices can influence a company's performance and risk, offering a deeper understanding of how ESG approaches can impact investment decisions and risk.As a result, Ahmad et al. [5] emphasize the importance of ESG and provide insights into how risk-taking is affected by non-compliance with corporate governance systems. Corporate governance codes have been introduced in most countries to promote effective management of firms in order to generate high performance.

The article by Chen [16] shares similarities with the previous study and adds value by addressing the topic of ESG in close connection to social responsibility. It explores the effect of managerial capacity on CSR and the risk of default of the enterprise, using the same positive influences of corporate governance as previous author in terms of risk mitigation and performance enhancement. The emphasis is on the term "corporate responsibility" because through it, a company acts responsibly and takes responsibility for contributing to a positive impact on the environment, employees, and the community.

Building on these two studies that provide more general information about ESG elements and social responsibility, there is a desire to analyze articles that delve deeper into these environmental, social, and governance aspects. As a result, numerous studies complement each other. For example, Hao et al.'s study [22] investigates how the experience of executive directors influences companies' financing decisions. This research adds to existing knowledge and highlights how economic shocks can affect directors' individual risk preferences and decision-making behavior to achieve better financial performance. Thus, a key component of ESG factors is the directors, specifically the most important factor of corporate governance around which all choices revolve, also known as CEOs. They play an essential role in how the company is led and controlled as they can make ethical decisions that contribute to the social sustainability of the company.

Haw [24] approaches the same subject of the CEO, but in a completely different way, examining firms that share the same directors as other bankrupt firms to see their reaction. It investigates whether overlapping directors are actually the cause of bankruptcy transmission from one firm to another and the contagion effect on the bank credit market. It is found that firms experience higher credit spreads in the period following the bankruptcy of a firm with a common director, as banks perceive higher risk due to the reputation and decisions

made by directors and seek to protect themselves. The sample uses US firms, 19,461 observations from 1999 to 2017. The variables include loan spread, maturity, ROA, leverage, FCF, Z-score, spread, CEO characteristics, etc. The connection between the variables is close, as the spread reflects the company's risk, ROA represents asset efficiency, leverage covers the level of indebtedness, FCF is the cash flow, CEO includes experience and leadership skills, and all of these can interact and complement each other. For example, a high credit spread level can indicate higher risk, thus influencing leverage, at which point the CEO comes into play with decisions that can affect ROA.

Li and Zhang [28] also discuss the ESG elements in relation to risks, investigating the implications of environmental practices, social, and governance practices on risks. The key idea is that a higher ESG rating reduces the default risk and helps achieve higher performance. Therefore, investors are implementing stricter requirements regarding corporate social responsibility and ESG elements, as their performance has a significant impact on risk management, especially credit risk, as sustainability becomes increasingly important. In this context, the CEO plays a crucial role with strong commitments to social responsibility. Therefore, the involvement and leadership of a responsible CEO regarding CSR and ESG can contribute to improving performance and risk management in a company through well-developed risk management.

Pu et al. [40] also examines the impact of ESG factors, but focuses on the environmental aspect, specifically the impact of risk-taking on firm performance under extreme temperatures and pollution from a corporate governance perspective. In terms of ESG elements, carbon dioxide, energy, water consumption, and climate change are crucial in terms of the risks associated with the firm's activities. For example, climate change leads to the occurrence of extreme weather, which has become a significant risk factor for businesses. However, an enlightened CEO can implement strategies to reduce the negative impact on the environment and minimize the risks associated with these aspects. For example, an environmentally conscious CEO can invest in sustainable technologies and practices..

In the article written by Chowdhury et al. [17], they explore the risk preferences of CEOs and their impact on firm market value. The link between derivative instrument coverage and CEO risk preference is analyzed. The study suggests that firms led by risk-averse CEOs have higher derivative instrument coverage, which can generate greater value and better firm performance. So, starting from the term "CEO," there are several studies related to them and the board of directors, such as CEO duality, gender diversity, specific skills, and independence.

In further research, studies like the one written by Muhammad et al. [36] supporting the significant relationship between CEO duality and firm debt risk, and the one written by Fareed et al. [19] discussing the benefits of good board governance, the idea that is being conveyed is that effective corporate governance will significantly reduce firm risks and enhance its performance, leading to a primary hypothesis:

H1: There is a significant inverse correlation between CEO duality and the debt level of a company.

The mentioned studies provide a variety of ideas regarding the introduction of ESG factors into the corporate world. They then transition to discussing the involvement of directors, the board of directors, and the management of a company, leading up to the concept of duality. Therefore, existing research on the ESG topic and its relationship with corporate risk is critically examined, offering an overview of the approach used and the empirical findings from previous studies. This includes describing the methodology, variables used, hypotheses tested, and the conclusions drawn by each individual study. All of these gradually shape a detailed picture, also highlighting gaps or inconsistencies within them. That is why the current study aims to provide added value and justify its necessity by offering valuable contributions through concrete data and analyses. These can provide a deeper and more detailed understanding of the link between ESG factors and corporate risks, particularly in one of the most important stock exchanges, the New York Stock Exchange. This is achieved by including new variables compared to those already used in previous articles. So, the current study contributes to filling gaps in the literature by addressing specific and relevant aspects that haven't been explicitly covered. It does so by using a rigorous methodology and analyzing updated data. This study can bring new perspectives and conclusions regarding the impact of ESG factors on corporate risks, as well as aspects or variables that haven't been sufficiently investigated in previous studies. For example, the relationship between certain more current variables such as total energy consumption, water, and carbon dioxide.

One of the most studied corporate governance characteristics is CEO duality, where the CEO also serves as the chairman of the board. CEO duality gives the CEO greater control over the company and its external policies. However, in recent decades, the CEO duality in public companies has decreased as companies have expressed a growing desire to reduce agency costs, as mentioned by Muhammad et al. [36]. Therefore, one of the theories underlying previous studies includes the agency cost theory, which focuses on the relationship between shareholders and managers, suggesting that managers may act in their own personal interest at the expense of shareholders. CEO duality, which occurs when the same person holds both the CEO and chairman positions, can

influence decision-making and the level of company debt. The agency cost theory refers to the costs associated with monitoring and controlling managers by shareholders, and CEO duality can affect these costs and, consequently, the level of debt.

Another theoretical implication is that there are two different approaches regarding the effect of CEO duality on firm performance. The agency theory suggests that CEO duality can lead to higher monitoring and control costs for the company. On the other hand, the stewardship theory suggests that CEO duality can enable management to provide strong and efficient leadership.

Thus, Fareed et al. [19] argue that firms with CEO duality experienced lower bankruptcy probabilities and earnings volatility, while also achieving higher profitability compared to firms without CEO duality. They discuss the benefits of good board governance, emphasizing that effective corporate governance significantly reduces firm risks and improves performance.

Moving on, studies addressing the ESG aspect, this time focusing on the board of directors, specifically gender diversity. In the study written by Mohsni et al. [35], they discuss the general issue of the board of directors, adding elements about gender diversity, firm performance, and risk-taking in developing countries. The study analyzes the effects of the relationship between gender diversity on the board of directors and corporate risk-taking. It is found that gender diversity is negatively associated with both operational risk and financial risk, but positively related to firm performance. An essential aspect of the study focuses on gender diversity theory within the corporate board. Previous research has shown that homogeneous gender management groups tend to delay bad news, leading to informational asymmetry. On the other hand, gender diversity in the corporate board plays a crucial role in managing accident risk and informational asymmetry.

Sattar [43] also examines the impact of gender diversity on the board of directors on firm indebtedness. Additionally, there is a reported negative association between gender diversity and firm risk. Risk reduction is associated with female directors because they have a stronger incentive for better and quality risk management. There are differences in risk-taking behavior between women and men, as well as in how they receive and interpret information to make important decisions that contribute to the company's faster development and better performance.

Safiullah [42] fully supports gender equality on the board through his study, complementing existing research, especially since Spain is the first European country to adopt such a law to improve balance in corporate boards. The main hypothesis of the study is that firms with greater gender diversity on the board of directors experience better performance and lower risks. Therefore, it is evident that there is a positive diversity-performance relationship in firms, as women strive to be empathetic regarding the potential effects of their decisions.

Existing literature suggests that board gender diversity is crucial in reducing informational asymmetry, which, in turn, reduces the ability to manage risks. When there is an asymmetry in available information, some parties may be less aware of the risks involved in a particular situation, leading to poor decision-making. By reducing informational asymmetry, understanding and managing risks can be improved, contributing to more informed and efficient decision-making. Li [30] also uses similar premises in their research and addresses the idea that gender diversity on the board is closely related to firm risk and performance, with a focus on liquidity risk and its positive influence. The study adds value by investigating how country characteristics affect the relationship between board diversity and firm risk. Thus, based on previous studies and the current focus, the hypothesis emerges:

H2: The presence of gender diversity within a company has a positive impact on liquidity and debt levels.

The influence of performance on enterprise risks

The study continues with another important chapter to further develop the research. Starting from the ESG factors, which directly influence a company's performance, we aim to examine the chain effect of ESG factors-performance-risk. Thus, we will analyze the impact of the financial performance value generated by these aforementioned influencing factors, such as board duality and diversity. So, with a still developing approach on the link between performance, risk and ESG, Mohammeda's study [34] begins to develop an understanding of the subject of company performance on risks and their management. The relationship between performance and total management is investigated, and the effect of risks on company performance is examined. Being at the beginning of the journey, there are a few limitations, focusing on risk management in general, without specifically considering ESG factors. Additionally, the case study refers to companies in Ethiopia, which may limit the generalization of the results to other markets.

Similarly, Angel and Menendez Plans [12] used 79 firms in the US industry for the years 2004–2013, considering variables such as current liquidity, leverage, ROA, firm size, cash flow, and ETR, to hypothesize that there is a negative relationship between risk and ROA, and systematic risk is positively determined by firm size. Therefore, it can be said that performance and risk management are significantly influenced by the ESG approach. This study conducted by Bai et al. [14] empirically investigates how corporate ESG performance

influences the risk of stock pledging during the period 2017–2021. The study's conclusion indicates that a strong ESG performance of listed companies can reduce the risk and performance increases. Also, In the context of the double carbon, the ESG performance of companies and sustainable development capacity have become significant concerns across all sectors of society. This study empirically written by Chen et al. [15] examines the impact of firms' ESG performance on their business risk, highlighting the reduction in business risk for companies with strong ESG performance due to lower financing constraints and agency costs, with the moderating role of economic policy uncertainty. This study by Mandas et al. [32] examines the possible connection between exposure to reputational risk associated with environmental, social, and governance (ESG) factors and market valuation. The results highlight a two-way causality between exposure to ESG reputational risk and market value. Nicolas et al. [38] investigate shareholder reactions to environmental, social, and governance (ESG) reputational risk, focusing solely on the impact of social networks. Using a dataset of 114 million tweets about firms listed on the S&P100 index between 2016 and 2022, our results show that the occurrence of an ESG risk event leads to a statistically significant average reduction of 0.29% in abnormal returns. Additionally, the study suggests that this effect is primarily driven by the Social and Governance categories, along with the "Opportunities" subcategory.

Otero González et al. [39] evaluate the different effect of Enterprise Risk Management (ERM) on performance and financial stability. It is understood that to have the highest performance, the effects of risks must be minimal, which is why planning and control of outcomes are crucial. Activity needs to be controlled and planned to have a competitive advantage and desired results. To maximize performance, internal monitoring, cost optimization, and financial analysis must be conducted. So, ESG elements go hand in hand with these factors, internal monitoring can include assessing ESG risks and implementing sustainable policies and practices, and cost optimization can involve reducing resource consumption and energy efficiency, considering environmental aspects.

DasGupta and Deb [18] talk about enterprise performance, conducting correlations between performance and the role of corporate governance. They also investigate the association between risk and return due to managers' desire for good profitability and strong corporate governance. For high returns, there is a risk-return trade-off influenced by strategic decisions at the firm level, involving risks such as market risk, new product launches, cost reductions, and currency exchange. So, step by step, we see the connection between performance, risk, and corporate governance. These three elements blend perfectly. Effective corporate governance helps mitigate risks, leading to performance improvements. Next, we will address the influence of corporate governance on risks and performance.

There is a financial theory called "the trade-off theory" that addresses the negative relationship between asset profitability and liquidity. According to this theory, firms face a trade-off between profitability and liquidity, and the more liquidity a company has, the less efficiently it uses capital, resulting in a likely decrease in asset returns. On the other hand, lower liquidity can lead to higher returns, but it may come with higher risks in managing cash flow. Therefore, the theory suggests that there is a balance between liquidity and profitability, and companies need to find the best compromise between these two aspects. Hamid [21] tackles the same performance-risk-ESG connection, investigating the impact of the board of directors on financial performance and capital, directly or indirectly, through risk management, making the connection with the compromise theory. As a result, two hypotheses emerge from the concentration of studies:

H3: ROA and liquidity are in a negative relationship, which means that an increase in liquidity can lead to a decrease in ROA.

H4: The performance of a company exhibits a negative relationship with financial leverage.

The impact of the pandemic on business risks

To stay up to date and understand the impact of the COVID crisis on its influence on risks, we are researching the link between performance, COVID, and risk. Thus, we will observe the decisions that the board of directors makes under extreme conditions and how ESG factors impact this. To further explore the risk-performance relationship, Ye [45] discusses the same topic but in a different way, focusing on the risk of company performance decline during the pandemic. The author studies the heterogeneous effect of exogenous variables on different quantiles of company performance during the COVID-19 pandemic. It is observed that the interconnection of publicly listed firms has changed significantly after the outbreak of COVID-19, and factors such as the epidemic and company size, supply chain robustness, risks, and other variables significantly impact company performance. The key takeaway is that systemic risk caused by the pandemic should be approached with increased caution as it affects the autonomy and smooth operation of businesses. There is also a theory called "deglobalization" which suggests that the COVID-19 pandemic can have a negative impact on global autonomy, highlighting the vulnerabilities and risks posed by excessive dependence on imports and long international supply chains.

Arianpoor [13] also observes the relationship between firm risk, capital structure, cost of capital, and social and environmental sustainability during the pandemic. It is found that firms with insufficient leverage exhibited low overall risk during the pandemic. As limitations, the study focuses on the period of the COVID-19 pandemic, which may limit the generalization of the results to other periods.

Ali et al. [11] explore the relationship between the COVID-19 pandemic and the stock market in Pakistan using wavelet coherence analysis. The research variables include data on stock price movements in the Pakistani stock market and data on the evolution of COVID-19 cases in the country. The methodology is based on wavelet coherence analysis, which is a technique used to identify co-movement relationships between two time series in the time–frequency domain. It is shown that there is a significant relationship between the evolution of COVID-19 cases and stock market fluctuations in Pakistan, analyzing this relationship in different time periods and frequencies to better understand the impact of the pandemic on the stock market.

Jin et al. [26] have analyzed the impact of the COVID-19 pandemic on market risk and have established protective elements by using ESG disclosure score-based mimic portfolios as a measure of firms' exposure to COVID-19 risk. They found that firms that disclosed more ESG information experienced higher returns and reduced risk during the pandemic.

Ali et al. [7–10] explore the dynamic interconnectivity between green cryptocurrencies and G7 markets in terms of return transmission and volatility. Their findings demonstrate the significant diversification potential by adding the US dollar to a G7 stock portfolio. This research provides valuable insights for decision-makers and environmentally conscious investors, emphasizing the importance of ESG factors and highlighting significant fluctuations in results attributed to the impact of the COVID-19 crisis.

Lashkaripour [27] shows that a strong preference for ESG leads to higher risk during market crashes. Therefore, during the COVID-19 pandemic, strong ESG preferences caused investors to hold onto green stocks, despite expected negative returns. The COVID-19 pandemic had a significant impact on economies and highlighted the importance of resilience and the need to develop risk management strategies.

The conclusion is made with the hypothesis:

H5: The COVID-19 pandemic has a negative impact on global autonomy.

Moreover, other studies highlight external factors that can bring about changes and impact risk alongside ESG elements. Naveed et al. [37] discuss the role and impact of information in investment decision-making, analyzing how information provided by companies can influence individual investors' investment decisions by assessing the risks and opportunities associated with investments based on companies' financial performance, non-financial information such as sustainability reports and corporate responsibility practices that can influence investment decisions by providing information about companies' commitment to social, environmental, and governance aspects.

Abbas et al. [1] investigate the relationship between bank capital and risk-taking behavior in commercial banks in the US. The aim is to analyze whether the level of bank capital influences risk-taking decisions within these banks. The main hypothesis is that an increase in the level of bank capital will lead to a reduction in risk-taking behavior.

Aharon's study [4] initiates the series of analyses on the consequences of the Silicon Valley Bank (SVB) collapse and its impact on financial markets, focusing on how global capital markets reacted to events with a significant impact, resulting in negative reactions felt in many regions worldwide. The study concludes that capital markets in Europe, Latin America, the Middle East, and Africa had a negative reaction. The connection between the empirical study on the impact of ESG factors on corporate risks and David Y. Aharon's study (2023) depicts the reactions of various capital markets to impactful events, particularly the negative responses observed in different regions globally. Even though our study is focused on NY, the pandemic period emerges as an impactful event.

Ali et al. [7–10] also discuss the collapse of Silicon Valley Bank (SVB), where it was observed that banks in the US and Europe experienced negative returns, while Chinese banks were less affected. Assets such as oil, gold, and cryptocurrencies recorded positive returns, suggesting that investors turned toward safer investments. They emphasize the need for rapid risk management and regulatory interventions, especially through portfolio diversification, as a prudent strategy. The connection between the studies is highlighted by emphasizing the importance of rapid risk management and regulatory interventions, including portfolio diversification, as a prudent strategy.

In another study, Ali et al. [7–10] focus on Islamic gold-backed cryptocurrencies and stock markets in the GCC countries. They suggest that extreme news can amplify the relationship between Islamic cryptocurrencies and GCC markets. The variables studied include the gains or losses sustained by gold-backed cryptocurrencies and stock markets in the GCC region, which refer to stock exchanges and the trading of company stocks in Arab countries. The methodology used is the QVAR

method to determine the quantile connections between asset classes and identify optimal portfolio weights under different economic conditions. They propose optimal weights for portfolio managers and investors and present a protective strategy. The connection between the study on the impact of ESG factors on corporate risks and the research by Ali et al. [7–10] on Islamic gold-backed cryptocurrencies and stock markets in the GCC countries is evident in addressing various aspects of risk and the interconnections between different asset classes. The first study focuses on the impact of ESG factors in managing corporate risks, while the second study analyzes Islamic cryptocurrencies and GCC markets, highlighting how extreme news can influence the relationship between them.

Naveed et al. [37] revolves around the same themes, focusing on tracing the ripple effects of the Silicon Valley Bank collapse on global financial markets. It is observed that currency and metal markets had a positive reaction during and after the event, while the cryptocurrency market had a negative reaction but generated abnormal positive returns, indicating that investors can seek refuge in so-called safe havens. The conclusion is that investors and financial institutions need to diversify their portfolios across different asset classes, which can help mitigate the risks associated with such events.

Research methods

Description of the database and variables

The analyzed companies are listed on the New York Stock Exchange, and the most indicative variables for quantifying risk are: debt risk represented by the overall debt level, financial debt ratio, global autonomy ratio, and leverage, which, if very high, can cause the risk of company bankruptcy, and liquidity risk quantified by the current liquidity ratio and quick liquidity ratio, which is also an important indicator to monitor in terms of risk.

According to Table 1., the variables related to corporate governance are: the number of board meetings, board size, gender diversity of the board, specific board skills, non-executive board members, independent board members, total executive director compensation, and auditor tenure. The variables related to environmental responsibility are: total carbon emissions, total water consumption, and total energy consumption. The variables related to CEO characteristics are represented by dummy variables, specifically CEO duality and CEO board membership. The performance variables are represented by ROA, ROE, and ROIC. As control variables, we have effective tax rate, cash flow, reinvestment rate, tenure, COVID, etc.

The variable D/A is measured as total debt/total assets, LTD/A is measured as financial debt/total assets, EM as equity/total assets, and leverage is total debt/equity. For liquidity variables, current liquidity is calculated as current assets/current liabilities, and quick liquidity is (current assets-inventory)/current liabilities. The rest of the ESG variables are taken as provided by each company in their official reports and as entered into international search databases.

Quantitative methods

From a research methodology perspective, the method of least squares is used to highlight the impact that certain influencing factors have on the risks of companies listed on the New York Stock Exchange. I randomly selected 65 companies listed on the New York Stock Exchange that are part of the NYSE index. I chose this method to avoid selecting only the best or worst 65 companies, so as not to distort the results. I considered both high-profit and low-profit firms in an effort to get a comprehensive picture of the impact of ESG factors on corporate risk. However, as a limitation, the random selection of companies may not fully reflect the diversity and characteristics of the entire set of companies listed on the New York Stock Exchange, but it can provide a more general perspective on the dataset.

For this study, multiple regression models are constructed, both linear and nonlinear, fixed and random effects regression models. As analytical techniques the appropriate regression model is determined based on the Hausman test, all using panel data in the Stata program. For the nonlinear models, the inflection points of significant variables are calculated to observe at what threshold the influence on debt and liquidity risks changes.

Furthermore, in estimating the regression models, the correlations between the variables presented in the correlation matrix were taken into account. Therefore, variables with correlation coefficients above the threshold of ± 0.7 were included in separate regression models.

As data collection and analysis methods, data sources used are official, the articles for hypothesis development are taken from ScienceDirect, the case study data is sourced from Thomson Reuters, and the variables used are found in official company reports and on the Thomson Reuters website. Regression analysis is used to evaluate the relationship between ESG factors and corporate risks, using linear regression models as described above. The companies listed on the NYSE were chosen for study due to access to relevant financial data and transparency of this information, providing an extensive framework for analyzing ESG practices and corporate risk, with a significant impact on the business environment.

In the study, the measurement and operationalization of factors are done using specific data and indicators. For example, the environmental factor (*E*) is measured through indicators such as carbon emissions and water

Table 1 Description of variables

Variables	Acronym	Definition	Formula
Debt variables			
General debt ratio	D/A	Shows the debt in relation to total assets	Total debt/total assets
Financial debt ratio	LTD/A	Represents the percentage of financial debt to total assets	Financial debt/total assets
Global autonomy ratio	EM	Measures the proportion of equity to total assets	Equity/total assets
Leverage	LEV	Shows the influence of the debt ratio on capital profitability	Total debt/equity
Liquidity variables			
Current liquidity ratio	CR	Shows the company's ability to pay short-term debts	Current assets/current liabilities
Quick liquidity ratio	QR	Capacity to pay short-term obligations from current assets, excluding inventory	(Current assets–inventory)/current liabilities
Performance variables			
Return on assets	ROA	Measures asset efficiency	Net profit/total assets
Return on equity	ROE	Expresses the value generated for the company's shareholders	Net profit/equity
Return on invested capital	ROIC	Shows the value generated for investors	(Operating income * (1–tax rate))/book value of invested capital
Corporate governance variables			
Board size	BS	Shows the size of the board	
Number of board meetings	NBM	Represents the frequency of meetings	
Gender diversity of the board	BGD	Expresses gender identity: female or male	
Specific skills of the board	BSS	It refers to skills such as listening, communication, and thinking	
Non-executive members of the board	NEBM	Non-executive members of the board	
Independent members of the board	IBM	Independent members of the board	
Total compensation of executive directors	TSEC	The remuneration	
Auditor mandate	MA	It refers to the responsibility of conducting an audit for a certain period of time	
Environmental responsibility variables			
Total CO_2 emissions	CO_2	The consumption of carbon dioxide in carrying out activities	
Total water consumption	WU	The consumption of water in carrying out activities	
Total energy consumption	EU	The consumption of energy in carrying out activities	
CEO characteristics variables			
CEO Chairman Duality	CC DUALITY	It refers to the dual role of CEO and Chairman	
CEO Board Member	C.B. MEMBRE	It refers to the CEO being a member of the board	
Control variables			
Fixed asset turnover rate	CAPINT	The proportion of fixed assets to total assets as a measure of capital investment	Fixed assets/total assets
Current asset turnover rate	INVINT	It represents the proportion of current assets to total assets	Current assets/total assets
Effective tax rate	ETR	The tax obligation	Total tax expenses/EBT (Earnings Before Taxes)
Free cash flow	FCF	Cash flow of the company	Cash Flow from Operating Activities–Investments in Fixed Assets–Dividends Paid
Reinvestment rat	RR	It represents the expected return for investors	(Reinvested Profit/Net Profit) × 100
Years since establishment	vechime	The number of years since the company was founded	Current year–Year of company establishment
Coronavirus pandemic	COVID-19	The coronavirus infection	

Source: Own estimates

and energy consumption. The social factor (*S*) is measured through indicators like diversity, and the governance factor (*G*) is measured through indicators such as board structure. The calculation method for these indicators, where applicable, is provided in the "Table 1. Description of Variables." However, for indicators without a specific calculation formula, the results are taken as they are from official reports found on the Thomson Reuters website.

So, for the empirical study on the impact of ESG factors on corporate risks, a longitudinal research design is used, collecting panel data from various companies belonging to the NYSE index over a period of 5 years. Statistical analysis is then used to evaluate the relationship between ESG factors and corporate risk, considering other control factors for more relevant results. This helps answer research questions and confirm established hypotheses. Categories of variables are created based on common characteristics to ensure validity and reliability of results and enable proper interpretation. This leads to the general form of regression equations:

$$\begin{aligned}\mathrm{DEP}_{it} = {} & a_0 + a_1 \times \mathrm{PERF}_{it} + a_2 \times \mathrm{GUV}_{it} \\ & + a_3 \times \mathrm{RESP}_{it} + a_4 \times \mathrm{CEO}_{it} \\ & + a_5 \times \mathrm{CNTRL}_{it}\end{aligned}$$

where a_0 = constant; $a_1 \ldots a_5$ = coefficients corresponding to variable categories; $i = [1,65]$; $t = [2012;2021]$; ε_{it} = error term; DEP = dependent variable; PERF = performance variables; GUV = corporate governance variables; RESP = environmental responsibility variables; CEO = CEO characteristic variables; CNTRL = control variables.

For the detailed exemplification of the regressions, the following regression models are estimated for the dependent variable, the degree of general indebtedness, as follows:

Linear regressions:

$$\begin{aligned}\mathrm{DA}_{it} = {} & a_0 + a_1 \times \mathrm{ROA}_{it} + a_2 \times \mathrm{BS}_{it} + a_3 \times \mathrm{LOGWU}_{it} + a_4 \times \mathrm{dummyccdual}_{it} + a_5 \times \mathrm{CAPINT}_{it} \\ & + a_6 \times \mathrm{INVINT}_{it} + a_7 \times \mathrm{ETR}_{it} + a_8 \times \mathrm{LOGFCF}_{it} + a_9 \times \mathrm{vechime}_{it} + a_{10} \times \mathrm{dummycovid}_{it} + \varepsilon_{it}\end{aligned} \tag{1}$$

$$\begin{aligned}\mathrm{DA}_{it} = {} & a_0 + a_1 \times \mathrm{ROA}_{it} + a_2 \times \mathrm{BS}_{it} + a_3 \times \mathrm{INVIT}_{it} + a_4 \times \mathrm{ETR}_{it} + a_5 \times \mathrm{LOGFCF}_{it} \\ & + a_6 \times \mathrm{vechime}_{it} + a_7 \times \mathrm{dummycovid}_{it} + a_8 \times \mathrm{NBM}_{it} + a_9 \times \mathrm{BGD}_{it} + a_{10} \times \mathrm{BSS}_{it} \\ & + a_{11} \times \mathrm{NEBM}_{it} + a_{12} \times \mathrm{LOGTSEC}_{it} + a_{13} \times \mathrm{MA}_{it} + a_{14} \times \mathit{LOGCO2}_{it} + a_{15} \times \mathrm{dummycb}_{it} + \varepsilon_{it}\end{aligned} \tag{2}$$

Nonlinear regressions:

$$\begin{aligned}\mathrm{DA}_{it} = {} & a_0 + a_1 \times \mathrm{ROA}_{it} + a_2 \times \mathrm{BS}_{it} + a_3 \times \mathrm{dummyccdual}_{it} \\ & + a_4 \times \mathrm{INVIT}_{it} + a_5 \times \mathrm{ETR}_{it} + a_6 \times \mathrm{LOGFCF}_{it} \\ & + a_7 \times \mathrm{vechime}_{it} + a_8 \times \mathrm{dummycovid}_{it} \\ & + a_9 \times \mathrm{LOGCO2}_{it} + a_{10} \times \mathrm{CO2\_sq}_{it} + \varepsilon_{it}\end{aligned} \tag{3}$$

$$\begin{aligned}\mathrm{DA}_{it} = {} & a_0 + a_1 \times \mathrm{ROA}_{it} + a_2 \times \mathrm{BS}_{it} + a_3 \times \mathrm{dummyccdual}_{it} \\ & + a_4 \times \mathrm{INVIT}_{it} + a_5 \times \mathrm{ETR}_{it} + a_6 \times \mathrm{LOGFCF}_{it} + a_7 \\ & \times \mathrm{vechime}_{it} + a_8 \times \mathrm{dummycovid}_{it} + a_9 \times \mathrm{BGD}_{it} + a_{10} \\ & \times \mathrm{LOGCO2}_{it} + a_{11} \times \mathrm{ROA\_sq}_{it} + \varepsilon_{it}\end{aligned} \tag{4}$$

where a_0 = constant; $a_1 \ldots a_{12}$ = coefficients corresponding to variable categories; $i = [1,65]$; $t = [2012;2021]$; ε_{it} = error term.

In the analysis of ESG factors and corporate risk, there can be limitations and biases in the data, such as data availability and quality, which can be limited or incomplete and may affect the analysis results. Subjectivity and interpretation can also be influenced because criteria may vary among different organizations and researchers. Additionally, there can be collinearity and confusion, as some ESG variables may be correlated or influenced by other factors, leading to collinearity or confusion in the analysis. That's why correlation matrix is performed, and variables with correlation coefficients above the threshold of ± 0.7 are included in separate regression models. Therefore, efforts are made to validate and verify the data and use appropriate statistical methods.

Results and discussion

Descriptive statistics and correlation matrix

An empirical study will be carried out to analyze the influencing factors on risks for a sample of 65 companies listed in New York, companies that belong to the

NYSE stock index. The data are taken from Thomson Reuters, for the 10-year period, 2012–2021.

Descriptive results

Table 2 reveals the descriptive statistics for the variables used in the empirical analysis of the study. We observed that the maximum value is recorded by the available cash flow, while it also had the lowest values, indicating that the level of receipts is lower than the expenses. As for the minimum average value, it is 0.074017 and belongs to the variable return on assets (ROA). The number of observations ranges from 520 to 650.

The correlations between variables are highlighted in Table 3. In order for there to be strong correlations between variables, the correlation coefficients must exceed the threshold of 0.5. Otherwise, there are weaker or weak relationships between variables.

Table 2 Descriptive statistics

Variables	Obs	Mean	Std Dev	Min	Max
D/A	586	0.662888	0.159993	0.341686	1.042679
LTD/A	585	0.244871	0.130019	0.011507	0.559567
EM	586	0.337112	0.159993	− 0.042679	0.658314
LEV	584	3.669377	2.247541	1.5	15.07
CR	580	1.45754	0.563497	0.71	3.45
QR	584	1.101695	0.511701	0.28	2.56
ROA	582	0.074017	0.057611	− 0.062	0.206
ROE	584	0.192192	0.177702	− 0.127	0.9078
ROIC	582	0.076994	0.063869	− 0.082	0.223
BS	576	11.03819	2.018678	7	15
NBM	523	9.281071	2.885982	6	17
BGD	575	0.225196	0.079658	0.015	0.4
BSS	580	0.536393	0.160774	0.2353	0.875
NEBM	567	0.853211	0.064796	0.6955	0.9286
IBM	576	0.836081	0.083888	0.56	0.9286
TSEC	584	4263.712	5089.056	250.28	21,780.16
MA	580	16.33034	6.780708	2.5	26
CO2	584	73.96745	115.9873	1.84	551.28
WU	584	551.8179	1149.551	12.645	7715.3
EU	584	773.184	1434.71	20	7562.15
CC DUALITY	650	0.767692	0.422629	0	1
C.B. MEMBRE	650	0.830769	0.375244	0	1
CAPINT	584	0.557024	0.341939	0.083967	1.328363
INVINT	586	0.334619	0.153675	0.052682	0.691118
ETR	582	0.226861	0.10053	0.002	0.412
FCF	584	3,503,699	4,505,639	− 695,810	17,777,000
RR	584	0.103462	0.133757	− 0.179	0.556
vechime	581	51.54733	36.49979	7	125
COVID-19	649	0.289676	0.453962	0	1

Source: Own estimates

Most of the variables are below the threshold of 0.5, indicating the presence of weak correlations, so multicollinearity is less likely to be a problem. We encounter strong correlations between return on invested capital and return on equity (0.652101), return on assets (0.952536), reinvestment rate (0.659642), current liquidity ratio and quick liquidity ratio of 0.853733, general debt ratio and leverage of 0.86251, non-executive board members and independent board members of 0.613874, and finally between total energy consumption and total CO_2 emissions of 0.834692.

Regression results

The case study is being developed using fixed and random effects models, where linear and nonlinear regression models with fixed and random effects have been constructed, and the appropriate regression model has been determined based on the Hausman test.

Therefore, we considered the 5% probability values for the Hausman test. Models below 5% are considered to have fixed effects, while those with probabilities above 5% are considered random effects models. Finally, we arrive at the table below, from which the appropriate regression model has already been selected. Thus, FE represents the fixed effects models, while RE represents the random effects regressions.

The results present findings of the study and interpret each table separately, with each table being dominated by an independent variable in relation to the dependent variables used, with emphasis on the significant ones. It is observed that some variables are significant only in certain regression models, with specific combinations of dependent variables. Analyzing the results in relation to the research hypotheses, it is confirmed, in particular, that there is a negative correlation between ROA and leverage and liquidity. Additionally, there is a significant correlation between CEO duality and diversity and leverage and liquidity. Moreover, COVID-19 has a negative impact on companies' autonomy, which affects their performance. Each table will be examined separately, and the obtained results will be compared with previous research, along with explanations for similarities or differences, both from an econometric perspective and from the economic perspective of their influences and the practical implications they have on investors, managers, or decision-makers.

In the table below, specifically Table 4, you can see the results obtained by running fixed or random effects regression models on the determinants of general indebtedness, conducted in Stata software. The coefficient of determination (*R*-sq overall) highlights that, on average, 4% of the variation in the dependent variable, general indebtedness, is explained by the variation in the

Table 3 The correlation matrix

Variables	RR	CAPINT	CO_2	CR	D_A	DUMMY CB	DUMMY CC	DUMMY COVID
RR_	1.000							
CAPINT	− 0.037	1.000						
CO2	− 0.005	0.510	1.000					
CR	− 0.111	− 0.069	− 0.041	1.000				
D_A	0.366	0.018	− 0.115	− 0.359	1.000			
DUMMY_C_B	0.219	− 0.358	0.135	− 0.001	0.017	1.000		
DUMMY_CC	0.130	− 0.156	0.201	− 0.215	0.108	0.334	1.000	
DUMMY COVID	− 0.022	0.125	0.085	0.054	0.078	− 0.207	− 0.189	1.000
EM	− 0.366	− 0.018	0.115	0.359	− 1.000	− 0.017	− 0.108	− 0.078
ETR	0.091	0.163	0.075	− 0.121	− 0.030	− 0.093	− 0.127	− 0.329
EU	− 0.072	0.511	0.835	− 0.047	− 0.110	0.148	0.220	− 0.006
FCF	− 0.043	− 0.130	− 0.086	− 0.451	0.219	0.069	0.295	− 0.035
IBM	− 0.023	− 0.010	0.082	− 0.110	0.030	0.079	0.203	− 0.080
INVINT	0.226	− 0.315	− 0.269	0.347	0.167	0.048	0.080	− 0.202
LEV	0.319	− 0.003	− 0.170	− 0.300	0.863	− 0.016	0.096	− 0.039
LTD_A	0.250	− 0.105	− 0.035	0.063	0.510	0.338	0.203	0.132
MA	− 0.048	0.096	− 0.060	0.039	0.057	− 0.110	0.095	− 0.210
NBM	− 0.105	0.146	0.004	− 0.040	− 0.089	− 0.346	− 0.096	− 0.011
NEBM	− 0.142	0.010	0.182	− 0.196	0.201	− 0.031	0.161	0.018
QR	− 0.064	− 0.067	0.102	0.854	− 0.225	0.062	− 0.021	0.005
ROA	0.634	− 0.063	− 0.010	− 0.142	− 0.084	0.266	0.156	− 0.176
ROE	0.807	− 0.053	− 0.115	− 0.292	0.482	0.273	0.214	− 0.068
ROIC	0.660	− 0.171	− 0.087	− 0.199	0.021	0.268	0.152	− 0.129
TSEC	− 0.090	0.010	− 0.223	0.513	− 0.353	− 0.275	− 0.491	0.230
VECHIME	− 0.161	− 0.258	− 0.269	0.029	0.038	0.140	− 0.076	− 0.011
WU	− 0.143	0.087	0.351	− 0.034	− 0.209	0.089	0.172	0.073
BSS	0.002	− 0.034	− 0.085	0.134	− 0.051	− 0.052	0.050	− 0.140
BS	0.044	− 0.021	− 0.072	− 0.126	0.266	0.063	0.221	− 0.117
BGD	0.043	0.120	0.059	− 0.065	0.012	− 0.030	0.013	− 0.311
	EM	**ETR**	**EU**	**FCF**	**IBM**	**INVINT**	**LEV**	**LTD_A**
EM	1.000							
ETR	0.030	1.000						
EU	0.110	0.078	1.000					
FCF	− 0.219	− 0.225	− 0.037	1.000				
IBM	− 0.030	− 0.085	0.104	0.049	1.000			
INVINT	− 0.167	− 0.025	− 0.370	− 0.289	− 0.201	1.000		
LEV	− 0.863	0.006	− 0.136	0.265	− 0.032	0.136	1.000	
LTD_A	− 0.510	− 0.176	0.027	0.125	0.006	− 0.136	0.430	1.000
MA	− 0.057	− 0.162	0.026	0.267	0.267	− 0.091	0.220	0.016
NBM	0.089	0.004	− 0.156	0.090	− 0.075	0.060	0.008	− 0.344
NEBM	− 0.201	− 0.141	0.172	0.077	0.614	− 0.123	0.092	− 0.028
QR	0.225	− 0.165	0.178	− 0.231	0.010	0.222	− 0.152	0.184
ROA	0.084	0.136	− 0.054	0.080	− 0.021	0.056	− 0.146	− 0.130
ROE	− 0.482	− 0.035	− 0.142	0.259	0.054	0.097	0.501	0.251
ROIC	− 0.021	0.006	− 0.149	0.094	0.007	0.176	− 0.071	− 0.160
TSEC	0.353	− 0.129	− 0.248	− 0.421	− 0.204	0.118	− 0.324	− 0.079
VECHIME	− 0.038	− 0.388	− 0.194	0.376	− 0.156	− 0.038	0.080	0.049
WU	0.209	− 0.284	0.129	0.081	0.246	− 0.124	− 0.203	− 0.048

Table 3 (continued)

	EM	ETR	EU	FCF	IBM	INVINT	LEV	LTD_A
BSS	0.051	0.113	− 0.091	− 0.208	0.126	0.273	− 0.053	− 0.061
BS	− 0.266	− 0.167	0.007	0.365	0.111	0.004	0.348	0.207
BGD	− 0.012	0.235	0.142	0.310	0.121	− 0.185	0.029	0.014
	MA	**NBM**	**NEBM**	**QR**	**ROA**	**ROE**	**ROIC**	
MA	1.000							
NBM	0.007	1.000						
NEBM	0.030	0.035	1.000					
QR	0.182	− 0.114	− 0.088	1.000				
ROA	− 0.014	− 0.018	− 0.284	− 0.150	1.000			
ROE	0.071	− 0.045	− 0.021	− 0.210	0.611	1.000		
ROIC	− 0.043	− 0.005	− 0.199	− 0.216	0.953	0.652	1.000	
TSEC	− 0.174	0.084	− 0.297	0.286	− 0.135	− 0.275	− 0.170	
VECHIME	0.296	0.061	− 0.075	− 0.007	0.045	0.045	0.103	
WU	0.158	0.251	0.168	− 0.038	0.003	− 0.115	− 0.000	
BSS	− 0.252	− 0.010	− 0.014	0.145	− 0.136	− 0.071	− 0.099	
BS	0.341	0.017	0.218	0.049	− 0.092	0.189	− 0.057	
BGD	0.256	0.167	0.080	0.024	0.300	0.195	0.196	
	TSEC	**VECHIME**	**WU**	**BSS**	**BS**	**BGD**		
TSEC	1.000							
VECHIME	− 0.108	1.000						
WU	− 0.122	0.159	1.000					
BSS	0.125	− 0.472	− 0.110	1.000				
BS	− 0.352	0.362	− 0.044	− 0.229	1.000			
BGD	− 0.261	0.168	0.136	− 0.224	0.182	1.000		

Source: Own estimates

independent variables included in the estimated regression models.

The coefficient associated with the return on assets (ROA) variable shows how and to what extent this variable influences the level of indebtedness and whether it is significant. In the second mentioned model, it is observed that a 1% change in ROA has a significant impact on the level of indebtedness. According to the results, a 1% increase in ROA will lead to a decrease of 0.216 in the level of indebtedness. This suggests that an increase in asset profitability can contribute to reducing the company's level of indebtedness. In statistical perspective, the coefficient associated with ROA provides information about the direction between ROA and the level of indebtedness. In this case, the negative coefficient indicates an inverse relationship between the two variables, meaning that an increase in ROA is associated with a decrease in the level of indebtedness. This hypothesis is supported by authors Angel and Menendez Plans [12], and Haw [24] which analyzes the relationship between ROA and other elements such as loan prices, bankruptcy risk, and director overlap and comes to the hypothesis that a higher performance of a company's assets, as measured by ROA, can lead to greater bank confidence, and confirmed by H4: There is a negative relationship between performance and indebtedness.

The size of the board loses its influence on the level of indebtedness and becomes statistically insignificant. It becomes negative in fixed effects models and remains positive in random effects models. Additionally, the total logarithmized water consumption has probabilities outside the 1%, 5%, and 10% thresholds, indicating that the influence of this variable on the level of indebtedness is no longer significant for both fixed and random effects, but it maintains its negative sign.

The dummy variable "dummyccdual" is statistically significant in all models and maintains its strong negative influence on the level of indebtedness, with an average across all models of up to -5%. This hypothesis is confirmed by Muhammad et al. [36] which also develops the relationship between corporate governance and risk-taking by companies, with an emphasis on the moderate role of gender diversity in the board of directors, especially through the presence of the same individual in the

Table 4 Results of fixed or random effects regression models on the determinants of DA

	1 DA	2 DA	3 DA	4 DA	5 DA	6 DA	7 DA	8 DA	9 DA	10 DA	11 DA	12 DA
ROA	− .161*	− .216**					− .178**	− 0.183	− .949***			
	− 0.09	− 0.089					− 0.089	− 0.127	− 0.23			
BS	− 0.003	− 0.002	− 0.002	0	− 0.003	− 0.003	− 0.002	− 0.003	− 0.003	− 0.002	− 0.002	− 0.001
	− 0.003	− 0.003	− 0.002	− 0.002	− 0.003	− 0.002	− 0.002	− 0.002	− 0.002	− 0.003	− 0.003	− 0.003
LOGWU	− 0.006				− 0.005	− 0.005			− 0.012	− 0.002		− 0.005
	− 0.011				− 0.011	− 0.011			− 0.011	− 0.011		− 0.011
dummyccdual	− .061*				− .07*	− .065*	− .065*	− .065*	− .063*	− .069*		
	− 0.036				− 0.036	− 0.036	− 0.036	− 0.036	− 0.035	− 0.036		
CAPINT	0.05					0.043						
	− 0.049					− 0.049						
INVINT	0.058	0.07	0.049	0.029	0.047	0.05	0.058	0.044	0.013	0.042	0.049	0.062
	− 0.067	− 0.065	− 0.065	− 0.062	− 0.066	− 0.066	− 0.065	− 0.065	− 0.065	− 0.065	− 0.065	− 0.065
ETR	− .024***	− .025***	− .023***	− .019***	− .023***	− .022***	− .025***	− .025***	− .024***	− .022***	− .023***	− .022***
	− 0.005	− 0.005	− 0.005	− 0.005	− 0.005	− 0.005	− 0.005	− 0.005	− 0.005	− 0.005	− 0.005	− 0.005
LOGFCF	− 0.008	− 0.006	− 0.007	− 0.002	− 0.007	− 0.008	− 0.008	− 0.007	− 0.009	− 0.006	− 0.007	− 0.005
	− 0.006	− 0.006	− 0.006	− 0.005	− 0.006	− 0.006	− 0.006	− 0.006	− 0.006	− 0.006	− 0.006	− 0.006
vechime	.01***	.008***	.009***	0	.012***	.011***	.007***	.009***	.01***	.012***	.009***	.009***
	− 0.002	− 0.002	− 0.002	− 0.001	− 0.002	− 0.002	− 0.002	− 0.002	− 0.002	− 0.002	− 0.002	− 0.002
dummycovid	− 0.005	− 0.005	− 0.004	.034***	− 0.007	− 0.004	− 0.005	− 0.007	− 0.007	− 0.01	− 0.001	− 0.008
	− 0.014	− 0.014	− 0.014	− 0.012	− 0.014	− 0.014	− 0.014	− 0.014	− 0.014	− 0.014	− 0.034	− 0.014
NBM		0	0	0						0	0	0
		− 0.002	− 0.002	− 0.002						− 0.002	− 0.002	− 0.002
BGD		.194***	.181**	− 0.005	.18**			.161**	.17**	.141*	.18**	.186**
		− 0.074	− 0.073	− 0.067	− 0.075			− 0.072	− 0.072	− 0.073	− 0.074	− 0.073
BSS		− .074**	− .074**	− .069*						− .061*	− .074**	− .068**
		− 0.035	− 0.035	− 0.035						− 0.035	− 0.035	− 0.034
NEBM		− 0.069	− 0.068								− 0.068	
		− 0.086	− 0.086								− 0.086	
LOGTSEC		− .017**		− .017**								− .016**
		− 0.008		− 0.008								− 0.008
MA		− .002**	− .002*	− .003***	− .002*					− .002*	− .002*	− .002*
		− 0.001	− 0.001	− 0.001	− 0.001					− 0.001	− 0.001	− 0.001
LOGCO2		.054***	.052***				.053***	.053***	.035**		.052***	.052***
		− 0.013	− 0.013				− 0.014	− 0.013	− 0.014		− 0.013	− 0.013
dummycb				0.089								
				− 0.07								
ROE			− .001***	− .001***	− .001***	− .001***				0	− .001***	0
			0	0	0	0				0	0	0
ROIC								− 0.202*				
								0				
LOGEU				− 0.003								
				− 0.007								
IBM					− 0.112							− .133*
					− 0.075							− 0.074
RR										− 0.002*		
										0		
CO2_sq							0					
							0					

Table 4 (continued)

	1 DA	2 DA	3 DA	4 DA	5 DA	6 DA	7 DA	8 DA	9 DA	10 DA	11 DA	12 DA
ROA_sq								− 0.031				
								− 0.377				
ROE_sq										0***		0**
										0		0
CO2ROA									.219***			
									− 0.062			
WUCOVID											− 0.003	
											− 0.006	
CO2COVID												0
												− 0.009
EUCOVID												
_cons	.288**	.361**	0.208	.844***	.295*	.248*	.275**	0.124	.254*	0.238	0.207	.343**
	− 0.14	− 0.173	− 0.166	− 0.129	− 0.165	− 0.14	− 0.131	− 0.147	− 0.15	− 0.157	− 0.166	− 0.168
Observations	557	557	557	557	557	557	557	557	557	557	557	557
Adj R^2	− 0.001	0.048	0.05	.z	0.024	0.01	0.028	0.035	0.06	0.036	0.048	0.069
F-stat/Wald chi2	7.268*	7.517*	8.107*	53.75	7.369*	7.884*	8.874*	8.577*	9.206*	6.995*	7.513*	7.532*
Prob > chi2	0.0024	0	0.0001		0.002	0.0003	0.0003	0	0.0005	0.0001	0.0314	0.0052
R− sq overall	0.0012	0.0019	0.0036	0.0252	0.0012	0.0013	0.004	0.0033	0.0021	0.0009	0.0036	0.0016
Effect	FE	FE	FE	RE	FE	FE	FE	FE	FE	FE	FE	FE

Source: Own estimates

*** indicates statistical significance at a 1% threshold. ** indicates statistical significance at a 5% threshold. * indicates statistical significance at a 10% threshold. Standard errors are shown in parentheses

positions of CEO and chairman of the board of directors, which influences risk-taking and confirmed by H1: There is a significant negative relationship between CEO duality and indebtedness. This suggests that a company is more likely to have a lower level of debt when the CEO is also the chairman, due to the fact that the dual role of the CEO brings greater responsibility and control over decisions, managing debts more prudently to maximize profits.

The effective tax rate is significant at a 1% threshold in all models, and a 1% change in ETR will result in a statistically significant decrease of 2.5% in the level of indebtedness. This is confirmed by the study conducted by Zuo et al. [48], which states that reducing the tax rate increases employment and overall indebtedness. This is due to a higher tax rate that can reduce the company's profit and borrowing capacity. It shows the link between the reduction of the corporate tax by the government and the impact that the effective rate has, but for China, which is also validated by our study for companies in New York, but also analyzes the fact that the decrease in the tax rate for companies can stimulate benefits multiple. Therefore, if the Effective Tax Rate (ETR) decreases by 1%, there will be more funds available to meet the financial obligation, resulting in a lower level of indebtedness.

Regarding firm age, it is statistically significant at a 1% threshold in all fixed effects models and takes a value of 0 in random effects models. Therefore, a 1% change in firm age will lead to an almost 1% increase in the level of indebtedness. For the dummy variable "dummycovid," it is statistically significant only in random effects models and maintains a positive influence on the level of indebtedness, as confirmed by authors [23]. The study also includes theories related to the influence of the pandemic on the performance of companies and how it can be influenced by factors such as imposed restrictions, disruptions in supply chains and changes in consumer behavior, elements that could be research related to risks in the future.

Gender diversity on the board is significant at a 1% and 5% threshold only for fixed effects models and has a positive influence on the level of indebtedness. Therefore, a 1% change in the explanatory variable BGD will result in a statistically significant increase of 0.194 in the dependent variable for the first model. Hypothesis H2 is confirmed: Gender diversity positively influences liquidity and indebtedness.

The variable specific board skills is significant, and a 1% change in the explanatory variable BSS will result in a statistically significant decrease of 0.074 in the dependent variable for the first model.

For the logarithmized variables total executive compensation, auditor tenure, independent members, and electricity consumption, they have statistical significance in some models and all have a negative influence on the level of indebtedness. However, carbon dioxide consumption is significant at a 1% threshold for all fixed and random effects models, but its influence changes to a positive impact on the level of indebtedness.

The return on equity (ROE) and return on invested capital (ROIC) have statistical significance at a 1% threshold for all models and negatively influence the level of indebtedness, as confirmed by Haw [24] which goes deeper with theories that include the impact of bankruptcy on a company's ROE, the influence of overlapping directors on ROE, and how these aspects can affect risk. A 1% change in ROE will result in a statistically significant decrease in the level of indebtedness by 0.001, and a 1% change in ROIC will result in a statistically significant decrease in the level of indebtedness by 0.202. The reinvestment rate negatively influences the level of indebtedness, with a significance level of 1% and a confidence level of 99%. Therefore, a 1% change in the explanatory variable RR will result in a statistically significant decrease in the dependent variable by 0.002.

Regarding the nonlinear models, CO2_sq, ROA_sq, WUCOVID, CO2COVID, and EUCOVID lose their statistical significance. ROE_sq is significant at a 1% threshold but does not have any influence, as its value is 0. CO2ROA is also significant at a 1% threshold and positively influences the level of indebtedness. Thus, a 1% change in the interaction variable will cause an increase of almost 0.219 in the debt ratio.

Validating the findings with the paper written by Ali et al. [7–10], our study focuses on the impact of ESG factors on corporate risks, while the second study analyzes the dynamics of profitability and volatility transmission between green cryptocurrencies and G7 markets. Although the topics may seem different, both studies provide valuable insights into the relationships and impact of various factors on performance and risks in their specific contexts. Thus, it leads to the idea that in an increasingly diverse market environment, there are more investment options, such as green cryptocurrencies, with a connection between these cryptocurrencies and the G7 markets, resulting in notable fluctuations during the COVID-19 pandemic. As a similarity, the importance of monitoring and understanding the impact of green cryptocurrencies on the global economy, just like certain ESG factors in our study, is highlighted. They can promote sustainable development and the adoption of renewable energies by focusing on eco-friendly solutions. Additionally, they can stimulate innovation and investments in green technologies, contribute to reducing carbon emissions, and combat climate change. Whether it's the ESG factors in our study or other variables like green cryptocurrencies, they can have an impact on the global economy and contribute to a transition toward a more sustainable and responsible economy.

Regarding Table 5., we can see the results obtained by running regression models with fixed or random effects in Stata software, which analyze the determinants of the financial debt rate. The coefficient of determination (*R*-sq overall) shows that approximately 1.97 of the variation in the financial debt rate is explained by the variation in the independent variables in the estimated regression models.

The coefficients associated with the return on assets (ROA) variable become statistically significant. Thus, a 1% change in the ROA variable will statistically result in a decrease in the financial debt rate (LTDA) by 0.231 in the second fixed regression model. This confirms hypothesis H4: There is a negative relationship between performance and indebtedness. This suggests that when a company performs better, it is less indebted. By understanding this relationship between performance, indebtedness, and ESG factors, companies can take measures to improve performance and reduce associated risks by implementing better corporate governance practices and enhancing corporate responsibility. In other words, the practical application of these findings could lead to better risk management and increased company value, as well as value for society.

The board size is statistically significant only in fixed effects models and becomes insignificant in random effects models. Compared to models without effects where statistical significance was present in all models, the influence on LTDA changes and becomes both positive and negative. In this way, for the first fixed effects model, a 1% change in BS will statistically result in a decrease of 0.004 in the dependent variable.

Regarding the fixed effects models, the fixed asset turnover rate is statistically significant and has a negative influence on the financial debt rate, while the current asset turnover rate remains significant only for fixed effects models, not random effects models, and shows a positive change in its influence on LTDA. Thus, for the first fixed effects regression model, a 1% change in the CAPINT variable will statistically result in a decrease in the dependent variable, the financial debt rate (LTDA), by 1.27, and a 1% change in the INVINT variable will statistically result in an increase in the dependent variable, the financial debt rate (LTDA), by 0.106.

The logarithm of cash flow becomes significant in certain models and has a positive influence on the financial debt rate, a theory verified in literature because positive cash

Table 5 Results of regression models with fixed or random effects on the determinants of LTDA

	1 LTDA	2 LTDA	3 LTDA	4 LTDA	5 LTDA	6 LTDA	7 LTDA	8 LTDA	9 LTDA	10 LTDA	11 LTDA	12 LTDA
ROA	− .194**	− .231***					− .251***	− 0.162	− .837***			
	− 0.081	− 0.08					− 0.08	− 0.114	− 0.208			
BS	− .004*	− .005**	− .006**	− .005**	− .007***	− .004*	− 0.002	− .006**	− .006***	− .005**	− .006***	− .006***
	− 0.002	− 0.002	− 0.002	− 0.002	− 0.002	− 0.002	− 0.002	− 0.002	− 0.002	− 0.002	− 0.002	− 0.002
LOGWU	0				0.001	0.001			− 0.006	0		0
	− 0.01				− 0.01	− 0.01			− 0.01	− 0.01		− 0.01
dummyccdual	− 0.041				− 0.045	− 0.045	− 0.004	− 0.041	− 0.039	− 0.051		
	− 0.032				− 0.032	− 0.032	− 0.026	− 0.032	− 0.032	− 0.032		
CAPINT	− .127***					− .136***						
	− 0.044					− 0.043						
INVINT	.106*	.112*	.104*	.101*	0.092	0.096	− 0.026	.105*	0.079	.104*	.103*	0.093
	− 0.06	− 0.059	− 0.058	− 0.059	− 0.058	− 0.059	− 0.053	− 0.059	− 0.059	− 0.058	− 0.058	− 0.058
ETR	0.003	0.003	0.005	0.005	0.005	0.004	0.003	0.004	0.004	0.006	0.005	0.005
	− 0.004	− 0.004	− 0.004	− 0.004	− 0.004	− 0.004	− 0.004	− 0.004	− 0.004	− 0.004	− 0.004	− 0.004
LOGFCF	0.007	.01*	.01*	.01*	.009*	0.007	.013***	.009*	.009*	.011**	.009*	.01*
	− 0.005	− 0.005	− 0.005	− 0.005	− 0.005	− 0.005	− 0.005	− 0.005	− 0.005	− 0.005	− 0.005	− 0.005
vechime	.011***	.012***	.013***	.014***	.014***	.012***	0	.013***	.013***	.014***	.013***	.013***
	− 0.002	− 0.002	− 0.002	− 0.002	− 0.002	− 0.002	0	− 0.002	− 0.002	− 0.002	− 0.002	− 0.002
dummycovid	− .025*	− .025**	− .024*	− .023*	− .024*	− .024*	.022**	− .025**	− .025**	− .025**	− .08***	− .025*
	− 0.013	− 0.013	− 0.013	− 0.013	− 0.013	− 0.013	− 0.011	− 0.013	− 0.013	− 0.013	− 0.03	− 0.013
NBM		− .003*	− .003*	− .003*						− .003*	− .003*	− .003*
		− 0.002	− 0.002	− 0.002						− 0.002	− 0.002	− 0.002
BGD		.29***	.286***	.291***	.265***			.287***	.291***	.282***	.294***	.259***
		− 0.067	− 0.066	− 0.065	− 0.066			− 0.065	− 0.065	− 0.065	− 0.066	− 0.066
BSS		− 0.036	− 0.03	− 0.034						− 0.029	− 0.033	− 0.026
		− 0.032	− 0.031	− 0.031						− 0.031	− 0.031	− 0.031
NEBM		0.073	0.072								0.067	
		− 0.078	− 0.077								− 0.077	
LOGTSEC		0.002		0.003								0.004
		− 0.007		− 0.007								− 0.007
MA		− 0.002	− 0.002	− 0.002	− .002*					− 0.002	− 0.002	− 0.002
		− 0.001	− 0.001	− 0.001	− 0.001					− 0.001	− 0.001	− 0.001
LOGCO2		0.017	0.016				.022**	0.017	0.002		0.018	0.015
		− 0.012	− 0.012				− 0.009	− 0.012	− 0.013		− 0.012	− 0.012
dummycb												
ROE			− .001***	− .001***	− .001***	− .001***				− .001*	− .001***	− .001*
			0	0	0	0				0	0	0
ROIC												
LOGEU				0.004								
				− 0.007								
IBM					.149**							.149**
					− 0.067							− 0.067
RR												
CO2_sq							0					
							0					
ROA_sq								− 0.256				
								− 0.339				
ROE_sq												0**

Table 5 (continued)

	1 LTDA	2 LTDA	3 LTDA	4 LTDA	5 LTDA	6 LTDA	7 LTDA	8 LTDA	9 LTDA	10 LTDA	11 LTDA	12 LTDA
												0
CO2ROA									.177***			
									− 0.056			
WUCOVID										0**		
										0		
CO2COVID											.015**	
											− 0.008	
EUCOVID												
_cons	− .32**	− .673***	− .709***	− .673***	− .739***	− .37***	0.064	− .671***	− .573***	− .613***	− .703***	− .789***
	− 0.125	− 0.157	− 0.149	− 0.145	− 0.145	− 0.125	− 0.078	− 0.132	− 0.136	− 0.139	− 0.149	− 0.152
Observations	557	557	557	557	557	557	557	557	557	557	557	557
Adj R^2	0.01	0.038	0.055	0.051	0.057	0.03	.z	0.033	0.05	0.062	0.061	0.066
F-stat/Wald chi2	7.859*	7.062*	8.35*	8.152*	9.067*	9.022*	35.87	8.451*	8.707*	8.107*	8.099*	7.393*
Prob > chi2	0	0	0	0	0	0		0	0	0	0	0.0057
R-sq overall	0.0206	0.02	0.0196	0.0204	0.0211	0.0203	0.0195	0.0219	0.0206	0.0212	0.0194	0.0185
Effect	FE	FE	FE	FE	FE	FE	RE	FE	FE	FE	FE	FE

Source: Own estimates

*** indicates statistical significance at a 1% threshold. ** indicates statistical significance at a 5% threshold. * indicates statistical significance at a 10% threshold. Standard errors are shown in parentheses

flow allows the company to pay its debts more efficiently and improve its credit rating. A 1% change in the LOGFCF variable will statistically result in an increase in the dependent variable, the financial debt rate (LTDA), by 0.01.

Seniority has a positive influence on LTDA, COVID has a negative influence, and diversity also positively influences financial debt. In this way, for the second fixed effects regression model, a 1% change in the seniority variable will statistically result in an increase in the dependent variable, the financial debt rate (LTDA), by 0.012. A 1% change in the COVID dummy variable will statistically result in a decrease in the dependent variable, the financial debt rate (LTDA), by 0.025. And a 1% change in the BGD variable will statistically result in an increase in the dependent variable, the financial debt rate (LTDA), by 0.29.

The return on equity (ROE) rate is statistically significant in models with effects and has a negative influence on LTDA because a low ROE may indicate that a company cannot generate sufficient profits to pay its debts, which can lead to an increase in interest rates and perceived risk by creditors.

Independent board members are statistically significant in models with effects and have a positive influence on LTDA. Therefore, a 1% change in the IBM variable will statistically result in an increase in the dependent variable, the financial debt rate (LTDA), by 0.15. This is because independent board members can provide an objective and impartial perspective on the company's financial decisions, which can improve creditor confidence and lead to a reduction in perceived interest rates. So, they will have a positive influence on the financial debt rate, helping to mitigate risks.

The reinvestment rate is also statistically significant in models with effects and has a negative influence on LTDA. This is because a high reinvestment rate may indicate that a company is investing more in assets and development projects than its cash flow can support. This can lead to an increased perceived risk by the company's creditors, as there is a higher risk that the company may not be able to repay its debts in the future. Generally, a moderate reinvestment rate is preferable as it indicates that a company is investing in a balanced manner, taking into account the available cash flow. It avoids the extreme situation of having a very high financial debt rate that is uncontrollable and generates significant risks or even bankruptcy.

The variables that lose their statistical significance when running models with fixed and random effects compared to those without effects are as follows: water consumption, energy consumption, carbon dioxide emissions, CEO duality, effective tax rate, specific board skills, and auditor tenure. Additionally, non-executive board members, total executive director compensation, C.B. MEMBERS, and return on invested capital remain statistically insignificant in models with effects.

Regarding nonlinear models, they undergo some changes from models without effects to models with

effects. The interaction variable ROA_sq becomes statistically insignificant in models with effects, while the CO2ROA interaction variable is statistically significant. A 1% change in the CO2ROA variable will result in a statistically significant increase of 0.177 in the dependent variable, financial debt ratio (LTDA). The variables CO2_sq and EUCOVID are not statistically significant, whereas ROE_sq, WUCOVID, and CO2COVID are significant and have positive influences on LTDA.

In the table below, specifically Table 6, you can see the results obtained by running regression models with fixed and random effects on the determinants of the global autonomy rate, using Stata software.

The coefficient of determination (*R*-sq overall) highlights that, on average, 7% of the variation in the dependent variable, the global autonomy rate, is explained by the variation in the independent variables included in the estimated regression models.

The variable return on assets (ROA) is statistically significant and has a positive influence on the autonomy rate. A 1% change in ROA will result in a 0.161 increase in the autonomy rate for the first regression model. Therefore, a high ROA value can indicate that a company can generate good profits using its assets. This can improve the company's global autonomy as it reduces its dependence on external financing and increases creditors' confidence in its ability to repay its debts.

The dummyccdual variable represents CEO duality and becomes significant in models with effects. It has a positive influence on the EM and a 1% change in the variable will result in a 0.061 increase in the autonomy rate. CEO duality occurs when the same individual holds the position of both CEO and Chairman of the Board of the company. This can lead to an improvement in the company's global autonomy as it can streamline operations and increase value in the eyes of creditors by demonstrating the company's ability to repay its debts. However, there are arguments against CEO duality as it can lead to excessive concentration of power and a lack of control and balance in decision-making, which can sometimes result in significant risks.

The effective tax rate becomes significant in all models with fixed and random effects and has a positive influence on the EM. A 1% change in the variable will result in a 0.024 increase in the global autonomy rate. A lower effective tax rate can reduce costs and bring benefits to the company's profitability, which can improve autonomy.

The age and gender diversity of the board are also significant, but only for models with fixed effects, not for those with random effects, and they change their interaction with EM. The influence of these two variables is negative on EM. For model two with fixed effects, a 1% change in the tenure variable will result in a 0.008 decrease in the global autonomy rate, and a 1% change in the BGD variable will result in a 0.194 decrease in the global autonomy rate. The age of the company can have a negative impact on the global autonomy rate, as it may indicate strong competition and changing consumer preferences. This can lead to reduced profits because older companies may have operational structures that are not adapted to new trends and technologies, which can reduce their efficiency and future development.

LOGCO2 remains statistically significant in models with effects and shows a change in its influence on EM, becoming negative. Carbon dioxide consumption can have a negative impact on a company's global autonomy rate, as it can lead to increased costs and greater dependence on energy resources. Additionally, an increase in carbon dioxide emissions can indicate that a company is not concerned about environmental issues and may have a negative impact on its public image. Furthermore, taxes and fines may be imposed for carbon dioxide emissions, which can reduce company profits and affect its autonomy.

The dummy variable for COVID is only significant in models with random effects and has a negative influence on EM. Thus, a 1% change in the dummyCOVID variable will result in a 0.034 decrease in the global autonomy rate. COVID-19 can have a negative impact on a company's global autonomy rate due to its impact on the global economy. The pandemic can lead to a decrease in revenue, an increase in costs, and a slowdown in economic growth, which can affect profits and company autonomy. Additionally, the pandemic can result in a decrease in demand for products and services, leading to lower sales and increased unsold inventory. Companies that cannot cope with these challenges may be forced to take measures such as layoffs or cost reductions, further impacting their global autonomy. Therefore, hypothesis H5 is confirmed: COVID-19 negatively influences global autonomy. In the study written by Ali et al. [7–10], it is shown that there are significant variations in the results that can be explained by the COVID-19 crisis, as well as new disruptive elements such as the war in Russia, the FTX collapse, and the SVB collapse, among others. However, it is highlighted that investors can reduce the risk of their stock portfolios by adding green cryptocurrencies, as observed by the significant decrease in the early phase of the COVID-19 pandemic.

The specific skills of the board and the auditor's mandate are significant, as a 1% change in the BSS variable will result in a 0.074 increase in the global autonomy rate, and a 1% change in the MA variable will result in a 0.002 increase in the global autonomy rate for the second model with fixed effects. Specifically, the specific skills of

Table 6 Results of fixed or random effects regression models on the determinants of EM

	1 EM	2 EM	3 EM	4 EM	5 EM	6 EM	7 EM	8 EM	9 EM	10 EM	11 EM	12 EM
ROA	.161*	.216**					.178**	0.183	.949***			
	− 0.09	− 0.089					− 0.089	− 0.127	− 0.23			
BS	0.003	0.002	0.002	0	0.003	0.003	0.002	0.003	0.003	0.002	0.002	0.001
	− 0.003	− 0.003	− 0.002	− 0.002	− 0.003	− 0.002	− 0.002	− 0.002	− 0.002	− 0.003	− 0.003	− 0.003
LOGWU	0.006				0.005	0.006			0.012	0.002		0.005
	− 0.011				− 0.011	− 0.011			− 0.011	− 0.011		− 0.011
dummyccdual	.061*				.07*	.064*	.065*	.065*	.063*	.069*		
	− 0.036				− 0.036	− 0.036	− 0.036	− 0.036	− 0.035	− 0.036		
CAPINT	− 0.05					− 0.049						
	− 0.049					− 0.049						
INVINT	− 0.058	− 0.07	− 0.049	− 0.029	− 0.047	− 0.052	− 0.058	− 0.044	− 0.013	− 0.042	− 0.049	− 0.062
	− 0.067	− 0.065	− 0.065	− 0.062	− 0.066	− 0.067	− 0.065	− 0.065	− 0.065	− 0.065	− 0.065	− 0.065
ETR	.024***	.025***	.023***	.019***	.023***	.022***	.025***	.025***	.024***	.022***	.023***	.022***
	− 0.005	− 0.005	− 0.005	− 0.005	− 0.005	− 0.005	− 0.005	− 0.005	− 0.005	− 0.005	− 0.005	− 0.005
LOGFCF	0.008	0.006	0.007	0.002	0.007	.011*	0.008	0.007	0.009	0.006	0.007	0.005
	− 0.006	− 0.006	− 0.006	− 0.005	− 0.006	− 0.006	− 0.006	− 0.006	− 0.006	− 0.006	− 0.006	− 0.006
vechime	− .01***	− .008***	− .009***	0	− .012***	− .011***	− .007***	− .009***	− .01***	− .012***	− .009***	− .009***
	− 0.002	− 0.002	− 0.002	− 0.001	− 0.002	− 0.002	− 0.002	− 0.002	− 0.002	− 0.002	− 0.002	− 0.002
dummycovid	0.005	0.005	0.004	− .034***	0.007	0.006	0.005	0.007	0.007	0.01	0.001	0.008
	− 0.014	− 0.014	− 0.014	− 0.012	− 0.014	− 0.014	− 0.014	− 0.014	− 0.014	− 0.014	− 0.034	− 0.014
NBM		0	0	0						0	0	0
		− 0.002	− 0.002	− 0.002						− 0.002	− 0.002	− 0.002
BGD		− .194***	− .181**	0.005	− .18**			− .161**	− .17**	− .141*	− .18**	− .186**
		− 0.074	− 0.073	− 0.067	− 0.075			− 0.072	− 0.072	− 0.073	− 0.074	− 0.073
BSS		.074**	.074**	.069*						.061*	.074**	.068**
		− 0.035	− 0.035	− 0.035						− 0.035	− 0.035	− 0.034
NEBM		0.069	0.068								0.068	
		− 0.086	− 0.086								− 0.086	
LOGTSEC		.017**		.017**								.016**
		− 0.008		− 0.008								− 0.008
MA		.002**	.002*	.003***	.002*					.002*	.002*	.002*
		− 0.001	− 0.001	− 0.001	− 0.001					− 0.001	− 0.001	− 0.001
LOGCO2		− .054***	− .052***				− .053***	− .053***	− .035**		− .052***	− .052***
		− 0.013	− 0.013				− 0.014	− 0.013	− 0.014		− 0.013	− 0.013
dummycb				− 0.089								
				− 0.07								
ROE			.001***	.001***	.001***					0	.001***	0
			0	0	0					0	0	0
ROIC												
LOGEU				0.003								
				− 0.007								
IBM					0.112							.133*
					− 0.075							− 0.074
RR									0,002*			
									0			
CO2_sq							0					
							0					
ROA_sq								0.031				

Table 6 (continued)

	1 EM	2 EM	3 EM	4 EM	5 EM	6 EM	7 EM	8 EM	9 EM	10 EM	11 EM	12 EM
								− 0.377				
ROE_sq										0***		0**
										0		0
CO2ROA									− .219***			
									− 0.062			
WUCOVID												
CO2COVID											0.001	
											− 0.008	
EUCOVID												
_cons	.712***	.639***	.792***	0.156	.705***	.707***	.725***	.876***	.746***	.762***	.793***	.657***
	− 0.14	− 0.173	− 0.166	− 0.129	− 0.165	− 0.14	− 0.131	− 0.147	− 0.15	− 0.157	− 0.166	− 0.168
Observations	557	557	557	557	557	557	557	557	557	557	557	557
Adj R^2	− 0.001	0.048	0.05	.z	0.024	− 0.005	0.028	0.035	0.06	0.036	0.048	0.069
F-stat/Wald chi2	7.268*	7.517*	8.107*	53.75	7.369*	7.689*	8.874*	8.577*	9.206*	6.995*	7.513*	7.533*
Prob > chi2	0.0024	0	0.0001		0.002	0.0001	0.0003	0	0.0005	0.0001	0.0001	0.0052
R-sq overall	0.0012	0.0019	0.0036	0.0252	0.0012	0.0015	0.004	0.0033	0.0021	0.0009	0.0036	0.0016
Effect	FE	FE	FE	RE	FE	FE	FE	FE	FE	FE	FE	FE

Source: Own estimates

*** indicates statistical significance at a 1% threshold. ** indicates statistical significance at a 5% threshold. * indicates statistical significance at a 10% threshold. Standard errors are shown in parentheses

the board can have a positive influence on a company's global autonomy rate, as they can help make better and more informed decisions. A board with diverse skills can bring a wide range of experiences and perspectives, which can help identify opportunities and manage risks. Additionally, a board with specific skills can help monitor company performance and ensure that it operates in line with its strategic objectives. Therefore, a board with specific skills can help improve the performance and autonomy of a company.

Similarly, the auditor's mandate can have a positive influence on a company's global autonomy rate, as it can ensure compliance with accounting and financial reporting standards. An independent auditor can help identify and correct errors and fraud, improving the quality of financial reporting and increasing investor and stakeholder confidence. Additionally, an auditor can help identify opportunities for improving processes and internal control systems, enhancing the company's global autonomy rate.

ROE (Return on Equity) is significant and has a positive influence on EM. A 1% change in the variable will result in a 0.001 increase in the global autonomy rate. ROE can have a positive influence on a company's global autonomy rate, as it reflects how much money the company makes from each shareholder's investment. A company with a high ROE indicates efficiency in utilizing its resources and can generate higher and more stable profits. These profits can be used to finance the company's growth and development without the need for loans. The study conducted by He et al. [25] makes a significant contribution to understanding how Return on Equity (ROE) influences the financial autonomy of companies. Through their analysis, the researchers have highlighted the importance of ROE in strengthening a company's financial position. ROE is a crucial indicator of equity profitability and can influence the financial and strategic decisions of an organization. The study emphasizes that optimizing ROE can contribute to increasing the financial independence of companies by reducing reliance on external sources of funding. By identifying and implementing effective strategies to improve ROE, companies can enhance their market position and achieve greater financial freedom. In conclusion, the research underscores the critical link between ROE, financial autonomy, and strategies for optimizing financial performance. These findings can be extremely valuable for managers and investors looking to better understand the impact of ROE on the financial independence of companies and to develop efficient strategies to add value to the company.

The reinvestment rate is significant for models with effects and has a positive influence on EM. A 1% change in the RR variable will result in a 0.002 increase in the global autonomy rate. The reinvestment rate can have a

positive influence on a company's global autonomy rate because it can help increase profitability and the company's long-term value. By reinvesting profits back into the business, the company can finance new projects, acquisitions, or investments, which can lead to increased revenue and profits. Additionally, reinvestment can help reduce financing costs and increase the company's financial autonomy.

The non-significant variables in models with effects are as follows: board size, total water consumption, fixed asset turnover, current asset turnover, available cash flow, non-executive board members, number of board meetings, CEO board membership, and total energy consumption.

Regarding nonlinear models, CO2_sq and ROA_sq lose their statistical significance in models with effects, but CO2ROA becomes significant and negatively influences EM. A 1% change in the variable will result in a 0.219 decrease in the global autonomy rate. ROE_sq is significant but does not have any influences, and WUCOVID, CO2COVID, and EUCOVID are not statistically significant.

In Table 7 below, you can see the results obtained by running fixed and random effects regression models on the determinants of leverage in Stata software. The coefficient of determination (*R*-sq overall) highlights that the variation in the dependent variable, leverage, is explained by the variation in the independent variables included in the estimated regression models.

The probabilities associated with the return on assets (ROA) variable are varied, with statistical significance only in the random effects model number nine. This shows that the influence of the variable on leverage is also significant. For that model, a 1% change in ROA will result in a 16.27 decrease in leverage. This hypothesis is supported by authors Angel and Menendez Plans [12] and Haw [24], as well as hypothesis H3: There is a negative relationship between ROA and liquidity. Therefore, this relationship can reflect a compromise regarding the financial management of a company. It is important to maintain a balanced level of liquidity to avoid generating lower returns.

The board size also loses statistical significance, as well as other variables such as fixed asset turnover, effective tax rate, auditor tenure, ROE, or dummy variables for CEO duality or CEO as a board member. Current asset turnover only retains significance in a few models and has a positive influence on leverage. Additionally, environmental variables like LOGCO2, LOGEU, LOGWU no longer have statistical significance and do not negatively influence leverage.

Company age shows statistical significance in some regression models with effects, with a positive influence on leverage this time. A 1% change in company age will result in a 0.218 increase in leverage in the third fixed effects regression model. However, companies with longer history may have the advantage of having a longer financial track record and being more financially stable. This can make them more attractive to creditors and allow them to obtain loans at better rates than younger or less stable companies. Furthermore, companies with greater age may be more experienced in managing debt and and other financial matters, which may lead to more efficient use of debt and greater financial leverage.

Regarding corporate governance variables, the number of board meetings (NBM), board gender diversity (BGD), board specific skills (BSS), auditor tenure (MA), and non-executive board members (NEBM) do not show statistical significance in relation to financial leverage. Additionally, return on equity (ROE) no longer has statistical significance and does not influence models with effects, as well as ROIC and RR.

In terms of nonlinear models, only ROE_sq is significant but does not influence leverage. Thus, ROA_sq also becomes insignificant when running models with effects, along with interaction variables such as CO2_sq, CO2ROA, WUCOVID, CO2COVID, and EUCOVID, which are also not statistically significant.

Table 8 presents the results obtained by running fixed and random effects regression models on the determinants of current liquidity, conducted in Stata software. The coefficient of determination (*R*-sq overall) highlights that, on average, 4% of the variation in the dependent variable, current liquidity, is explained by the variation in the independent variables included in the estimated regression models.

The probabilities associated with the return on assets (ROA) variable are varied, with only the model with fixed effects having a significant coefficient, indicating that the influence of this variable on current liquidity is statistically significant. For this model, a 1% change in ROA will result in a 1.85 decrease in current liquidity. In certain situations, a company with low ROA may have low current liquidity because reduced profits can lead to insufficient financial resources to meet short-term obligations.

The fixed and random effects models show that both the fixed asset turnover and current asset turnover are statistically significant, but the influence of fixed asset turnover on current liquidity varies. A 1% change in fixed asset turnover will result in a 0.347 decrease in current liquidity in the models with fixed effects, whereas a 1% change in current asset turnover will lead to a larger increase of 3.5 in current liquidity in the same fixed effects regression model. A very high fixed asset turnover ratio may indicate that a company has invested too much in fixed assets, which can reduce its current liquidity. For

Table 7 Results of fixed or random effects regression models on determinants of LEV

	1	2	3	4	5	6	7	8	9	10	11	12
	LEV_w	LEV_w	LEV_w	LEV_w	LEV_w	LEV_w	LEV_w	LEV_w	LEV_w	LEV_w	LEV_w	LEV_w
ROA	− 4.947	− 4.198					− 2.764	− 6.087	− 16.27**			
	− 3.106	− 3.153					− 3.34	− 4.506	− 8.238			
BS	0.068	0.061	− 0.028	− 0.04	0.066	− 0.036	− 0.009	0.069	0.064	− 0.032	− 0.018	− 0.027
	− 0.084	− 0.086	− 0.094	− 0.094	− 0.085	− 0.092	− 0.092	− 0.084	− 0.084	− 0.093	− 0.095	− 0.095
LOGWU	− 0.294				− 0.281	− 0.374			− 0.318	− 0.436		− 0.438
	− 0.238				− 0.234	− 0.4			− 0.272	− 0.399		− 0.405
dummyccdual	1.416				1.377	0.6	0.641	1.43	1.44	0.633		
	− 0.962				− 0.966	− 1.338	− 1.342	− 0.967	− 0.971	− 1.327		
CAPINT	− 0.035					1.468						
	− 1.104					− 1.802						
INVINT	3.095	3.158	3.165	3.186	2.89	3.472	3.49	3.325*	3.017	2.762	3.2	2.884
	− 1.992	− 1.996	− 2.457	− 2.472	− 1.965	− 2.451	− 2.441	− 1.989	− 2.001	− 2.434	− 2.457	− 2.455
ETR	− 0.028	− 0.039	− 0.015	− 0.025	0.034	0.018	− 0.045	− 0.058	− 0.011	0.001	− 0.011	− 0.001
	− 0.172	− 0.172	− 0.173	− 0.174	− 0.169	− 0.174	− 0.176	− 0.178	− 0.172	− 0.172	− 0.173	− 0.173
LOGFCF	− 0.053	− 0.14	− .638***	− .646***	− 0.178	− .624***	− .527**	− 0.069	− 0.083	− .596***	− .627***	− .587***
	− 0.171	− 0.175	− 0.217	− 0.217	− 0.168	− 0.218	− 0.223	− 0.172	− 0.172	− 0.216	− 0.217	− 0.217
vechime	0.001	− 0.004	.218**	.231***	0.003	.212***	.178**	0	0.002	.248***	.217**	.24***
	− 0.014	− 0.014	− 0.088	− 0.086	− 0.014	− 0.076	− 0.082	− 0.014	− 0.014	− 0.088	− 0.088	− 0.091
dummycovid	0.602	0.665	− 0.067	− 0.143	0.585	− 0.089	− 0.089	0.475	0.5	− 0.265	1.14	− 0.263
	− 0.413	− 0.439	− 0.538	− 0.537	− 0.432	− 0.533	− 0.533	− 0.43	− 0.429	− 0.529	− 1.283	− 0.531
NBM		0.012	0.02	0.017						0.029	0.02	0.027
		− 0.066	− 0.071	− 0.071						− 0.07	− 0.071	− 0.071
BGD		− 1.617	0.603	0.043	− 2.328			− 1.299	− 1.169	− 0.652	0.431	− 0.434
		− 2.339	− 2.784	− 2.749	− 2.306			− 2.22	− 2.218	− 2.723	− 2.789	− 2.778
BSS		0.763	1.201	1.453						1.623	1.255	1.622
		− 1.233	− 1.316	− 1.311						− 1.293	− 1.317	− 1.304
NEBM		− 2.183	− 3.785								− 3.687	
		− 2.901	− 3.246								− 3.247	
LOGTSEC		− .458*		− 0.127								− 0.106
		− 0.252		− 0.296								− 0.294
MA		0.046	0.053	0.052	0.043					0.065	0.052	0.064
		− 0.041	− 0.047	− 0.047	− 0.041					− 0.047	− 0.047	− 0.047
LOGCO2		− 0.083	0.174				0.181	− 0.095	− 0.133		0.131	0.162
		− 0.31	− 0.495				− 0.531	− 0.302	− 0.394		− 0.496	− 0.492
dummycb		2.093										
		− 1.552										
ROE			0.018	0.018	0.017	0.018				.057***	0.018	.057***
			− 0.014	− 0.014	− 0.014	− 0.014				− 0.018	− 0.014	− 0.018
ROIC												
LOGEU				− 0.03								
				− 0.283								
IBM					− 1.066							− 0.563
					− 2.431							− 2.805
RR												
CO2_sq							0					
							0					
ROA_sq								6.812				
								− 13.834				

Table 7 (continued)

	1 LEV_w	2 LEV_w	3 LEV_w	4 LEV_w	5 LEV_w	6 LEV_w	7 LEV_w	8 LEV_w	9 LEV_w	10 LEV_w	11 LEV_w	12 LEV_w
ROE_sq										0***		0***
										0		0
CO2ROA									3.358			
									− 2.206			
WUCOVID												
CO2COVID											− 0.332	
											− 0.321	
EUCOVID												
_cons	4.184	8.211*	1.731	− 0.136	6.153*	1.731	0.368	3.547	5.457*	− 1.39	1.61	0.017
	− 2.96	− 4.669	− 6.296	− 6.119	− 3.346	− 5.196	− 4.92	− 2.976	− 3.106	− 5.825	− 6.297	− 6.385
Observations	557	557	557	557	557	557	557	557	557	557	557	557
Adj R^2	.z	.z	− 0.109	− 0.112	.z	− 0.107	− 0.112	.z	.z	− 0.084	− 0.109	− 0.088
F-stat/Wald chi2	11.14	14.79	1.638**	1.532**	11.96	1.915**	1.698**	10.18	13.92	2.431**	1.598**	2.121**
Prob > chi2			0.012	0.0306		0.0131	0.028			0	0.0221	0
R-sq overall	0.0444	0.0693	0.0056	0.004	0.0415	0.0044	0.0054	0.0311	0.0368	0.0017	0.0052	0.0019
Effect	RE	RE	FE	FE	RE	FE	FE	RE	RE	FE	FE	FE

Source: Own estimates

*** indicates statistical significance at a 1% threshold. ** indicates statistical significance at a 5% threshold. * indicates statistical significance at a 10% threshold. Standard errors are shown in parentheses

example, if a company acquires costly fixed assets and does not have enough funds to meet short-term obligations, its current liquidity may be negatively affected and pose risks.

LOGFCF is significant only for some models with effects and its influence changes compared to the results obtained in models without effects, currently showing a positive influence on current liquidity. A 1% change in LOGFCF will result in a 0.023 increase in current liquidity. Since current liquidity determines a firm's ability to pay short-term debts, a positive cash flow can have a positive impact on current liquidity. If a company has a positive cash flow, it can use that money to pay short-term debts and finance its current operations, which can increase current liquidity.

Effective tax rate (ETR) is significant in regression models with effects and has a positive influence on current liquidity. Thus, a 1% change in ETR will result in a 0.039 increase in current liquidity. Generally, a lower effective tax rate can have a positive impact on a company's current liquidity.

The independent board members variable is significant for some models, showing a negative influence on current liquidity. A 1% change in IBM will result in a 0.696 decrease in current liquidity. Additionally, the dummycb variable is significant for some models, showing a negative influence on current liquidity. A 1% change in dummycb will result in a 0.463 decrease in current liquidity. The CEO being a board member can impact a company's current liquidity through the financial management decisions they make.

The specific skills of the board are significant and have a positive influence on liquidity. Thus, a 1% change in IBM will result in a 0.226 increase in current liquidity. The specific skills of the board can have a positive impact on a company's current liquidity. A well-prepared board can develop and implement strategies to improve operational efficiency and optimize cash flow. In this way, by leveraging their expertise, they can enhance current liquidity.

Also, ROIC is significant for regressions with effects and has a positive influence on liquidity. A 1% change in ROIC will result in a 0.441 increase in current liquidity. ROIC can have a positive impact on a company's current liquidity because it measures the efficiency with which a company utilizes invested capital. It can help the company identify and optimize investments that generate the highest profit, thereby increasing revenue and current liquidity. For example, a company can invest in projects that generate consistent income and require less capital.

LOGWU remains the only environmentally related variable that is statistically significant in models with effects, and it also has a negative impact on liquidity. Variables such as CEO duality, non-executive board members, number of board meetings, board gender diversity, independent board members, total executive director

Table 8 Results of fixed or random effects regression models on the determinants of CR

	1	2	3	4	5	6	7	8	9	10	11	12
	CR	CR	CR	CR	CR	CR	CR	CR	CR	CR	CR	CR
ROA	0.046	0.109					0.032	0.312	− 1.85**			
	− 0.34	− 0.345					− 0.341	− 0.489	− 0.895			
BS	0.004	0.003	0.003	0.003	− 0.005	0.005	0.004	0.004	0.003	0.001	0.002	0
	− 0.009	− 0.01	− 0.01	− 0.01	− 0.009	− 0.009	− 0.009	− 0.01	− 0.01	− 0.01	− 0.01	− 0.01
LOGWU	− 0.023				− .059*	− 0.023			− 0.027	− 0.026		− 0.025
	− 0.041				− 0.032	− 0.041			− 0.041	− 0.041		− 0.042
dummyc-cdual	0.183				0.144	0.184	0.187	0.188	0.196	0.18		
	− 0.137				− 0.122	− 0.137	− 0.137	− 0.137	− 0.137	− 0.138		
CAPINT	− .347*					− .343*						
	− 0.184					− 0.184						
INVINT	3.497***	3.584***	3.588***	3.582***	3.102***	3.499***	3.558***	3.579***	3.494***	3.574***	3.582***	3.557***
	− 0.251	− 0.254	− 0.252	− 0.253	− 0.236	− 0.25	− 0.249	− 0.251	− 0.252	− 0.252	− 0.252	− 0.255
ETR	0.026	0.028	0.027	0.026	0.022	0.026	0.029	.033*	.032*	0.028	0.026	0.026
	− 0.018	− 0.018	− 0.018	− 0.018	− 0.018	− 0.018	− 0.018	− 0.019	− 0.018	− 0.018	− 0.018	− 0.018
LOGFCF	0.034	.039*	.039*	.039*	0.006	0.033	.042*	.038*	.038*	0.036	.038*	0.035
	− 0.023	− 0.023	− 0.022	− 0.022	− 0.02	− 0.022	− 0.023	− 0.023	− 0.023	− 0.022	− 0.022	− 0.023
vechime	− 0.005	− 0.01	− 0.011	− 0.01	− 0.001	− 0.005	− 0.012	− 0.01	− 0.01	− 0.008	− 0.011	− 0.009
	− 0.008	− 0.009	− 0.009	− 0.009	− 0.002	− 0.008	− 0.008	− 0.009	− 0.009	− 0.009	− 0.009	− 0.009
dummycovid	0.005	0.019	0.018	0.017	0.014	0.004	0.014	0.015	0.015	0.02	− 0.161	0.019
	− 0.054	− 0.055	− 0.055	− 0.055	− 0.046	− 0.054	− 0.054	− 0.055	− 0.054	− 0.055	− 0.131	− 0.055
NBM		− 0.004	− 0.004	− 0.004						− 0.003	− 0.004	− 0.004
		− 0.007	− 0.007	− 0.007						− 0.007	− 0.007	− 0.007
BGD		− 0.091	− 0.089	− 0.107	− 0.016			− 0.141	− 0.126	− 0.094	− 0.064	− 0.134
		− 0.287	− 0.286	− 0.282	− 0.258			− 0.279	− 0.278	− 0.282	− 0.286	− 0.288
BSS		0.208	0.205	0.212						0.212	0.197	.226*
		− 0.136	− 0.135	− 0.134						− 0.134	− 0.135	− 0.135
NEBM		− 0.111	− 0.111								− 0.125	
		− 0.334	− 0.333								− 0.333	
LOGTSEC		− 0.001		− 0.002								0.002
		− 0.03		− 0.03								− 0.03
MA		− 0.002	− 0.002	− 0.003	0					− 0.002	− 0.002	− 0.002
		− 0.005	− 0.005	− 0.005	− 0.005					− 0.005	− 0.005	− 0.005
LOGCO2		0.014	0.014				0.051	0.016	− 0.028		0.021	0.019
		− 0.051	− 0.051				− 0.054	− 0.051	− 0.055		− 0.051	− 0.051

Table 8 (continued)

	1 CR	2 CR	3 CR	4 CR	5 CR	6 CR	7 CR	8 CR	9 CR	10 CR	11 CR	12 CR
dummycb										− 0.463*		
										0		
ROE			0.001	0.001		0.001				0	0.001	0
			− 0.001	− 0.001		− 0.001				− 0.002	− 0.001	− 0.002
ROIC								0.441*				
								0				
LOGEU				0.007								
				− 0.029								
IBM					− 0.696*							0.311
					− 0.279							− 0.291
RR												
CO2_sq							0					
							0					
ROA_sq								− 1.113				
								− 1.451				
ROE_sq										0		0
										0		0
CO2ROA									.547**			
									− 0.239			
WUCOVID												
CO2COVID											0.049	
											− 0.033	
EUCOVID												
_cons	0.269	0.331	0.352	0.266	0.492	0.292	0.029	0.102	0.432	0.222	0.37	0.108
	− 0.528	− 0.674	− 0.646	− 0.627	− 0.428	− 0.531	− 0.502	− 0.565	− 0.584	− 0.604	− 0.645	− 0.662
Observations	557	557	557	557	557	557	557	557	557	557	557	557
Adj R^2	0.218	0.208	0.21	0.21	.z	0.218	0.216	0.212	0.218	0.212	0.212	0.208
F-stat/Wald chi2	22.803	15.935	17.211	17.196	198.91	22.826	22.64	20.298	19.177	16.183	16.186	14.063
Prob > chi2	0	0	0	0		0	0	0	0.0005	0.0004	0	0
R-sq overall	0.0385	0.0385	0.0385	0.0373	0.0722	0.0391	0.0317	0.035	0.0444	0.0459	0.0386	0.047
Effect	FE	FE	FE	FE	RE	FE	FE	FE	FE	FE	FE	FE

Source: Own estimates

*** indicates statistical significance at a 1% threshold. ** indicates statistical significance at a 5% threshold. * indicates statistical significance at a 10% threshold. Standard errors are shown in parentheses

compensation, auditor tenure, total CO2 emissions, and total energy consumption do not have statistical significance. Additionally, for nonlinear models, we do not find statistical significance for CO2_sq, ROA_sq, ROE_sq, WUCOVID, CO2COVID, and EUCOVID. However, the CO2ROA interaction variable is significant at a 1% threshold, and a 1% change in it will positively influence the current liquidity rate by 0.547.

In Table 9, the results obtained from running regression models with fixed and random effects on the determinants of current liquidity can be observed. The coefficient of determination (*R*-sq overall) highlights that, on average, 4% of the variation in the dependent variable, current liquidity, is explained by the variation in the independent variables included in the estimated regression models.

The probabilities associated with the return on assets (ROA) variable are varied, with only in the fixed effects model, the number nine is significant, indicating that the influence of this variable on current liquidity is statistically significant. For this model, a 1% change in ROA will result in a decrease of 2.004 in current liquidity. In certain situations, a company with a low ROA may have low current liquidity because reduced profits can lead to insufficient financial resources to pay short-term debts.

The fixed and random effects models show that the fixed asset turnover and current asset turnover rates are statistically significant. However, the influence of fixed asset turnover on current liquidity changes. A 1% change in fixed asset turnover will result in a decrease of 0.482 in current liquidity in the fixed effects models, while a 1% change in current asset turnover will lead to a larger increase of 3.1 in current liquidity in the same fixed effects regression model. A very high fixed asset turnover rate may indicate that a company has invested too much in fixed assets, which can reduce its current liquidity. For example, if a company acquires expensive fixed assets and does not have enough money to pay short-term debts, then its current liquidity may be negatively affected and pose risks.

LOGFCF is only significant in some models with effects, and its influence changes compared to the results obtained in models without effects, currently showing a positive impact on current liquidity. Therefore, a 1% change in LOGFCF will result in an increase of 0.023 in current liquidity.

The effective tax rate is significant in regression models with effects and has a positive influence on current liquidity. A 1% change in ETR will result in a 0.039 increase in current liquidity. Generally, a lower effective tax rate can have a positive impact on a company's current liquidity. If less tax is paid, the company will have more money available to finance its current operations and pay short-term debts. This can increase current liquidity. It is confirmed that a lower ETR than the statutory rate has a positive influence on liquidity.

The independent board members variable is significant in some models, showing a negative influence on current liquidity. A 1% change in IBM will lead to a 0.696 decrease in current liquidity. Additionally, the dummycb variable is significant in some models, showing a negative influence on current liquidity. Therefore, a 1% change in dummycb will result in a decrease of 0.463 in current liquidity. A CEO board member can have an impact on a company's current liquidity through the decisions they make regarding the management of the company's finances.

Specific board skills are significant in fixed effects regressions and have a positive influence on liquidity. Therefore, a 1% change in the variable will result in a 0.226 increase in current liquidity. Gender diversity on the board is significant and positive in some models, confirming H2: Gender diversity positively influences liquidity and indebtedness. The specific skills of the board of directors can have a positive impact on a company's current liquidity. A well-prepared board can develop and implement strategies to improve operational efficiency and optimize cash flow. By improving operational efficiency, a company can reduce costs and increase current liquidity. For example, a company can optimize production processes or negotiate better contracts with suppliers, which can reduce costs and increase cash flow.

Also, ROIC is significant in fixed effects regressions and has a positive influence on liquidity. Therefore, a 1% change in ROIC will result in a 0.441 increase in current liquidity. ROIC can have a positive impact on a company's current liquidity because it measures the efficiency with which a company utilizes invested capital and can help the company identify and optimize investments that generate the highest profit, which can increase revenue and current liquidity. For example, a company can invest in projects that generate consistent income and require less capital.

LOGWU remains the only environmental variable that is statistically significant in models with fixed effects, and it also has a negative impact on liquidity. Variables such as CEO duality, non-executive board members, number of board meetings, independent board members, total executive director compensation, auditor tenure, total CO2 emissions, and total energy consumption do not have statistical significance. Additionally, for nonlinear models, CO2_sq, ROA_sq, ROE_sq, WUCOVID, CO2COVID, and EUCOVID are not statistically significant. However, the interaction variable CO2ROA is significant at a 1% threshold, and a 1%

change in it will positively influence the current liquidity rate by 0.642.

In order to have an overview of the influence of the independent variables on each dependent variable separately for the fixed and random effects models, the data are centralized in Table 10. Thus, throughout the entire research, the aim was to discover how the risk of indebtedness and liquidity is influenced by suggestive variables. According to the study by Ali et al. [7–10], it is highlighted that sustainability is increasingly closely linked to investment strategies and the company's relationship with the environment is very important. Building on this point, it is concluded that green cryptocurrencies have higher average returns compared to the G7 stock exchanges.

Conclusions

As a summary of the main findings, based on the tests conducted, from an econometric perspective, the research hypotheses are met. As for the key ideas and conclusions of the individual research, that is, the main findings of the study are the following: ROA negatively influences indebtedness and liquidity. CEO duality and diversity significantly influence indebtedness and liquidity. Last but not least, COVID negatively impacts the autonomy of companies, thus affecting their performance. These findings highlight the implications of the variables used, namely the importance of corporate governance and other independent variables in determining the level of corporate debt, liquidity, and performance. By understanding these relationships, managers and investors can make more informed decisions and adopt appropriate strategies to optimize company performance and sustainability.

Therefore, the analysis of regression models based on panel data for 65 companies listed on the New York Stock Exchange over a period of 10 years leads to some interesting conclusions, which are confirmed based on the hypotheses established in the first part of this study. Due to these facts, the study achieves all the objectives set from the beginning, being well-grounded in theory and econometrics.

From an economic standpoint, we compare the relevance of our personal study with the previous research found in the literature review to see if there are more similarities or differences between them. Based on the reviews, it is shown in practice that similar findings are obtained as famous authors and concrete explanations are provided regarding the exact cause of the influence of a variable on an indicator. As for the limitations of the study, the analysis was conducted over a long period of 10 years, but for a relatively small number of 65 companies from the NYSE index, which belong to diverse industries.

It is crucial to understand the relationship between ESG factors and corporate risk for stakeholders in financial markets, allowing us to better assess a company's performance and sustainability in the current context of climate change and governance requirements. Investors can make more informed decisions, and companies can more easily attract the capital needed to support their activities and achieve sustainability goals. Therefore, understanding and integrating ESG factors into financial analysis are becoming increasingly important in today's business world.

As implications and contributions to the existing literature, these ESG factors are reflected by analyzing their impact on risks, as well as on the financial performance and sustainability of companies. As previously mentioned, it is demonstrated that ROA has a negative impact on the indebtedness and liquidity of companies, while the duality and diversity of CEOs significantly influence these aspects.

As suggestions for future research and the new directions of the study could involve adding a greater number of explanatory variables, such as including macroeconomic variables, as well as calculating an aggregate risk indicator using principal component analysis, based on which more regression models can be created. Furthermore, a much larger number of companies belonging to the NYSE index can be taken into consideration.

As for the research limitations, we can mention the method of selecting companies and the fact that the choice was made randomly, as well as the multitude of external factors that can influence the results, such as market fluctuations or unforeseen events that can affect company performance and study outcomes.

In terms of recommendations, I believe that the selected companies for analysis should clearly and precisely identify the factors that can affect their debt and liquidity risks. These influencing factors can impact risk in different ways, and in this case, companies need to know which internal or external factors are affecting them, depending on the environment they are in, their industry, and so on. Therefore, the study is relevant for both the academic and business environment, which can learn and gather information to make important decisions regarding the aspects analyzed in this study.

Overall, a multitude of studies, articles, and books have analyzed the influencing factors of enterprise risks. These risks are often amplified by non-compliance with the corporate governance system, which is a complex mechanism that generates value growth for the company. The essential idea is that the level of risks and

Table 9 Results of fixed or random effects regression models on the determinants of QR

	1 QR	2 QR	3 QR	4 QR	5 QR	6 QR	7 QR	8 QR	9 QR	10 QR	11 QR	12 QR
ROA	0.212	0.302					0.219	0.391	− 2.004**			
	− 0.319	− 0.323					− 0.321	− 0.461	− 0.841			
BS	− 0.004	− 0.007	− 0.006	− 0.007	− 0.007	− 0.003	− 0.006	− 0.006	− 0.007	− 0.007	− 0.007	− 0.009
	− 0.009	− 0.009	− 0.009	− 0.009	− 0.009	− 0.009	− 0.009	− 0.009	− 0.009	− 0.009	− 0.009	− 0.009
LOGWU	0.003				0.002	0.002			0	− 0.006*		0.004
	− 0.038				− 0.039	− 0.038			− 0.039	− 0.039		− 0.039
dummyccdual	0.125				0.138	0.129	0.134	0.134	0.146	0.124		
	− 0.128				− 0.13	− 0.128	− 0.129	− 0.129	− 0.129	− 0.129		
CAPINT	− .482***					− .473***						
	− 0.173					− 0.173						
INVINT	3.105***	3.197***	3.192***	3.204***	3.174***	3.115***	3.172***	3.176***	3.093***	3.188***	3.189***	3.19***
	− 0.235	− 0.238	− 0.236	− 0.238	− 0.238	− 0.235	− 0.235	− 0.237	− 0.237	− 0.237	− 0.237	− 0.239
ETR	0.021	0.024	0.022	0.021	0.023	0.019	0.027	0.029	.039*	0.022	0.022	0.02
	− 0.017	− 0.017	− 0.017	− 0.017	− 0.017	− 0.017	− 0.017	− 0.018	− 0.017	− 0.017	− 0.017	− 0.017
LOGFCF	0.016	0.021	0.022	0.022	0.022	0.016	0.023*	0.021	0.02	0.02	0.021	0.019
	− 0.022	− 0.022	− 0.021	− 0.021	− 0.021	− 0.021	− 0.021	− 0.022	− 0.021	− 0.021	− 0.021	− 0.021
vechime	− 0.008	− 0.005	− 0.007	− 0.01	− 0.011	− 0.009	− 0.01	− 0.006	− 0.007	− 0.009	− 0.007	− 0.006
	− 0.007	− 0.009	− 0.009	− 0.008	− 0.009	− 0.007	− 0.008	− 0.008	− 0.009	− 0.009	− 0.009	− 0.009
dummycovid	0.051	0.069	0.067	0.067	0.061	0.051	0.062	0.061	0.06	0.067	− 0.024	0.066
	− 0.051	− 0.052	− 0.052	− 0.052	− 0.052	− 0.051	− 0.051	− 0.052	− 0.051	− 0.052	− 0.123	− 0.052
NBM		− 0.007	− 0.006	− 0.007						− 0.006	− 0.006	− 0.007
		− 0.007	− 0.007	− 0.007						− 0.007	− 0.007	− 0.007
BGD		0.082	0.079	0.079	− 0.003			0.014	0.019	0.071	0.092*	0.014*
		− 0.269	− 0.268	− 0.264	− 0.269			− 0.263	− 0.262	− 0.265	− 0.268	− 0.27
BSS		.277**	.263**	.275**						.267**	.259**	.292**
		− 0.127	− 0.127	− 0.126						− 0.126	− 0.127	− 0.127
NEBM		− 0.226	− 0.221								− 0.229	
		− 0.313	− 0.312								− 0.313	
LOGTSEC		− 0.023		− 0.026								− 0.023
		− 0.028		− 0.028								− 0.029
MA		0	0	− 0.001	− 0.001					0	0	− 0.001
		− 0.005	− 0.005	− 0.005	− 0.005					− 0.005	− 0.005	− 0.005
LOGCO2		− 0.054	− 0.054				− 0.023	− 0.051	− .106**		− 0.051	− 0.051
		− 0.048	− 0.048				− 0.051	− 0.048	− 0.051		− 0.048	− 0.048
dummycb						− 0.463*						
						0						
ROE			0.001	0.001	0.001	0.001				0.001	0.002	0.001
			− 0.001	− 0.001	− 0.001	− 0.001				− 0.002	− 0.001	− 0.002
ROIC								0.441				
								0				
LOGEU				0.011								
				− 0.027								
IBM					− 0.696*							0.301
					− 0.272							− 0.273
RR												
CO2_sq							0					
							0					
ROA_sq								− 0.711				

Table 9 (continued)

	1 QR	2 QR	3 QR	4 QR	5 QR	6 QR	7 QR	8 QR	9 QR	10 QR	11 QR	12 QR
								− 1.367				
ROE_sq										0		0
										0		0
CO2ROA									.642***			
									− 0.225			
WUCOVID												
CO2COVID											0.025	
											− 0.031	
EUCOVID												
_cons	0.505	0.573	0.471	0.388	0.113	0.551	0.296	0.234	0.53	0.185	0.48	0.246
	− 0.495	− 0.632	− 0.606	− 0.588	− 0.594	− 0.498	− 0.473	− 0.532	− 0.548	− 0.568	− 0.606	− 0.621
Observations	557	557	557	557	557	557	557	557	557	557	557	557
Adj R^2	0.206	0.198	0.199	0.198	0.192	0.206	0.199	0.194	0.205	0.197	0.199	0.197
F-stat/Wald chi2	21.707	15.322	16.494	16.408	17.279	21.767	21.084	18.864	18.199	15.222	15.353	13.46
Prob > chi2	0.0001	0	0	0	0.0001	0	0.0273	0.0078	0.0007	0	0	0
R-sq overall	0.0378	0.0344	0.0431	0.0291	0.036	0.0379	0.0382	0.0396	0.0453	0.0405	0.0435	0.0324
Effect	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE	FE

Source: Own estimates

*** indicates statistical significance at a 1% threshold. ** indicates statistical significance at a 5% threshold. * indicates statistical significance at a 10% threshold. Standard errors are shown in parentheses

their management are important for both investors and regulatory authorities and managers. Risk management would be more effective if firms complied with the recommendations of the governance code. Proper corporate governance can achieve stability in managers' risk orientations and influence their risk aversion and overall perception of risk and future decisions they will make.

Studying the impact of ESG factors on corporate risks is of great importance in today's business and investment environment. By understanding how ESG factors influence corporate risk, we can gain a more comprehensive understanding of corporate performance and sustainability. This research can provide valuable information to investors, managers, and other stakeholders to help them make more informed decisions and better assess the risks and opportunities associated with companies listed on the NYSE. Additionally, the results of this study contribute to the development of better corporate governance and social responsibility practices that promote long-term sustainability and value creation. Therefore, by emphasizing the importance of considering Environmental, Social, and Governance aspects in risk management, companies can beneficially address potential risks and capitalize on opportunities for sustainable growth. ESG factors help mitigate risks, enhance reputation, stakeholder trust, and overall financial performance. Prioritizing ESG elements in risk management is a smart approach that aids in achieving global sustainability goals and positions companies as responsible corporate firms.

As recommendations for investors, managers, and decision-makers, based on the study's findings, we have the following suggestions: For investors, it is recommended to consider ESG factors in the investment decision-making process. This involves evaluating the financial performance, sustainability, and corporate risks of companies based on ESG factors. By doing so, investors can identify more sustainable and profitable long-term investment opportunities. For managers and decision-makers, it is important to integrate ESG factors into business strategies and risk management by adopting responsible policies and practices. Additionally, collaboration between investors, managers, and decision-makers is crucial to promote more sustainable practices and maximize the long-term value of companies.

So, sometimes risks depend on the choices made by directors, whether subjective due to aversions or stimuli, or objective ones. Elements such as board gender diversity, independent board members, total executive director compensation, board size, and number of board meetings are suitable variables to analyze the corporate governance factors that influence the debt and liquidity risks of the enterprise. Also, for variables regarding the environment.

Table 10 The influence of variables

Variables	Models with effects					
	DA	LTDA	EM	LEV	CR	QR
ROA	−	−	+	−	−	−
BS		−				
LOGWU					−	
dummyccdual	−		+			
CAPINT		−			−	−
INVINT		+		+	+	+
ETR	−		+		+	+
LOGFCF	−	+		−	+	
vechime	+	−	−	+	−	−
dummycovid	+	−	−	+		+
NBM		−				
BGD	+	+	−			+
BSS			+		+	+
NEBM						
LOGTSEC	−		+	−		
MA	−	−	+			
LOGCO2	+	+	−			
dummycb						
ROE	−	−	+			
ROIC	−	−	+		+	+
LOGEU						
IBM	−	+				

Source: Own estimates

As conclusions and additional recommendations regarding the empirical study on the impact of ESG factors on corporate risks, it is important to integrate ESG considerations into corporate strategies to mitigate risks and enhance long-term sustainability. A variety of recommendations can be provided for companies to adopt robust ESG practices, which can be further enhanced through transparent reporting and stakeholder engagement, aiding in improving risk management and overall performance. Additionally, continuous monitoring and evaluation of ESG initiatives are necessary to ensure the fulfillment of corporate goals and values and to achieve sustainable growth and create value. The topic is quite complex, with numerous analyzed articles and a variety of variables to study, and overall, it has been demonstrated the impact that certain influencing factors have on the risks of an enterprise, and the results and conclusions of the study significantly contribute, showing that companies that focus on environmental, social, and governance aspects can reduce risk and achieve better long-term financial performance, which is something that benefits the financial field.

Abbreviations

CEO Chief Executive Officer
NYSE New York Stock Exchange
ESG Environmental, Social, and Governance

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