Sustainability and financial risks of the best-in-class: A comprehensive analysis

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ABSTRACT

This study offers a comprehensive analysis of the relationship between corporate sustainability performance and financial risk. Drawing on a panel of 490 leading 'best-in-class' ESG firms from the United States and Europe over the 2000–2021 period, the study examines the impact of ESG scores on seven distinct dimensions of risk, including default risk, market volatility, information risk, and risk-adjusted performance (Jensen's Alpha). The findings consistently show that stronger ESG performance is associated with significantly lower financial risk, with the Environmental pillar emerging as the most influential driver of risk mitigation. The analysis also uncovers notable heterogeneity between U.S. and European firms, reflecting differences in regulatory environments and cultural norms. These results remain robust across a range of sensitivity tests, including checks for non-linear effects, firms' GHG emissions, and potential endogeneity, the latter addressed through instrumental variable techniques. Overall, the study provides compelling evidence that ESG integration is a critical component of modern corporate risk management and offers empirical support for regulatory initiatives that promote sustainability as a means to enhance systemic financial stability and market resilience.

Keywords: Sustainability, Environmental Social Governance (ESG), Financial Risk, Systematic Risk, Idiosyncratic Risk, Total Risk, Z-score, Returns Asynchronicity.

JEL Classification: C33, G12, G32, M14.

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1. Introduction

Corporate social responsibility (CSR) is a key issue for companies nowadays. Firms prioritise CSR by considering ESG (Environmental, Social, and Governance) criteria in their investments, aligning with international accords such as the *Paris Agreement* and *the United Nations' Agenda 2030*. ESG practices are gaining traction in terms of investments and financial risk management due to stricter regulations, such as the *Corporate Sustainability Reporting Directive* by the European Union in 2021 and the *Inflation Reduction Act* by the US administration in 2022, which seek to achieve greener economies.

The existing literature has extensively explored the impact of CSR, often proxied by ESG profile, on their financial performance and risk. A recurrent finding is that a better ESG profile generally contributes to mitigating financial risks. Specifically, studies indicate a reduction in systematic risk (e.g., Monti et al., 2022; Albuquerque et al., 2019), which reflects a firm's sensitivity to broader market fluctuations. Furthermore, a positive ESG profile has been linked to lower idiosyncratic risk (e.g., Bannier et al., 2019; Benlemlih et al., 2018), representing the inherent, firm-specific uncertainty not explained by market movements. Consequently, a strong ESG commitment often leads to a decrease in total risk (e.g., Maxfield & Wang, 2021; Benlemlih et al., 2018), which encompasses both systematic and idiosyncratic components. This literature often examines the ESG profile-risk relationship through a narrow lens, focusing on one or two risk measures in isolation, such as stock volatility or systematic risk. However, this limited approach is problematic because risk is not directly observable, so empirical analysis must rely on indirect proxies that individually fail to capture the complex and multifaceted dimensions of firms' risk. Therefore, a more complete assessment of a firm's risk profile requires a combination of measures that can identify different sources of risk and their various characteristics.

Motivated by the need for a more comprehensive understanding of the ESG-risk nexus, this study provides a multi-dimensional assessment of risk that extends beyond the metrics traditionally employed in the literature. While the impact of ESG on market volatility risk—typically decomposed into systematic risk (Beta), idiosyncratic risk (IDS), and total risk (SD)—has been a central focus of prior research (e.g., Albuquerque et al., 2019; Jo & Na, 2012), this analysis argues that a fuller picture requires incorporating additional risk dimensions. To this end, the study includes two complementary measures of default risk: the Merton's Distance-to-Default (DD), a forward-looking, market-based measure that gauges credit risk estimating the probability of default by considering both the firm's leverage and the volatility of its assets relative to its debt obligations, and the Z-score, which provides an internal, accounting-based perspective on insolvency risk, gauging the firm's financial health and susceptibility to bankruptcy based on its historical financial performance and structural solvency. Finally, the analysis also examines information risk through stock return asynchronicity (Async). This metric captures the degree to which a firm's stock price moves independently of the market, offering a crucial perspective on the information environment and idiosyncratic risk, as well as the extent to which firm-specific news, such as that related to unique ESG strategies, is impounded into stock prices.

To fully understand the financial implications of the ESG commitment, the analysis extends to include the risk-adjusted return, proxied by Jensen’s Alpha (Alpha). This analysis can help to determine whether ESG is merely a risk-mitigation tool or a genuine source of competitive advantage and value creation for shareholders. By integrating a set of specific risk metrics—focusing on internal financial stability and the likelihood of default, on market sensitivity risk (total, systematic, idiosyncratic risk) and information risk (asynchronicity)—along with Jensen’s Alpha, analysts and investors could gain a comprehensive understanding of a firm's multifaceted risk landscape, enabling more robust decision-making.

Besides that, a key methodological contribution of this study is its deliberate focus on a homogeneous sample of 'best-in-class' ESG firms from the United States and Europe. This rigorous sample selection directly confronts pervasive challenges in ESG research. The primary challenge faced is the selection of a reliable measure of corporate sustainability performance. The difficulty stems from two main issues. First is the rating divergence among major data providers, where firms often receive different ESG scores from sources like LSEG, MSCI, and Sustainalytics (Abhayawansa & Tyagi, 2021; Cort & Esty, 2020). The influential work by Berg et al. (2022) shows that differences in the scope, measurement, and weighting of ESG attributes drive the divergence. Secondly, there is the pervasive risk of greenwashing, where companies may report positive ESG activities that are merely symbolic rather than substantive, thereby obscuring their true performance (Uyar et al., 2020). To address these challenges, this study employs a targeted approach designed to ensure a high-fidelity dataset by selecting leading firms from the United States and Europe that are constituents of the FTSE/S-Network ESG Best Practices Indices. Focusing on this group of pre-screened ESG leaders inherently allows for mitigation of the two core problems outlined above. First, the risk of greenwashing is substantially reduced. Inclusion in these best-in-class indices requires passing rigorous screening and demonstrating tangible ESG performance, which disincentivizes superficial claims. Second, the rating divergence becomes less relevant. The homogeneity of this sample -comprising firms that adhere to similar high-quality reporting standards, partly due to regulations like the EU's

Corporate Sustainability Reporting Directive (CSRD)- directly minimizes the measurement and scope issues that Berg et al. (2022) identify as the largest drivers of divergence. Within this framework, the LSEG Refinitiv ESG scores are selected to measure sustainability performance, based on their reputation as a premier, transparent, and highly granular data source widely recognised as a reliable measure of corporate sustainability in both academic and professional circles (Gallucci et al., 2022).

Much of the existing research draws from broad, heterogeneous samples where the effects can be obscured by data noise and greenwashing, making it challenging to pinpoint the true impact of genuine sustainability efforts. Therefore, the strategy of combining a top-tier data provider with a curated sample of verified ESG leaders ensures a reliable foundation for the analysis, minimizing those distortions and allowing for a more precise and reliable analysis of how advanced and consistent sustainability performance impacts a firm's multi-faceted risk profile.

The paper estimates panel data models for a sample of 490 best-in-class firms (246 from the USA and 244 from Europe) from 2000 to 2021 to examine how a firm's ESG profile influences its risks. The models also include covariates related to the firm's characteristics, to control for confounding effects associated with growth opportunities, profitability, and capital structure. The most suitable panel model is chosen after systematic specification tests joint to unobserved firm-specific and time-specific heterogeneity, as addressed by two-way fixed effects.

Results point out that ESG commitment is relevant in mitigating firms' risks, consistent with the predictions of the Stakeholder theory and ESG-enhanced asset pricing models. Firms with higher ESG scores are less financially risky and present higher Z-scores, distance-to-default, and higher market-adjusted excess returns. Moreover, the ESG commitment leads to a decrease in total, systematic, and idiosyncratic risks in line with previous literature (Monti et al., 2022; Reber et al., 2022; Maxfield & Wang, 2021; Albuquerque et al., 2019). In the case of price informativeness, high-ESG-engaged firms exhibit less firm-specific information relative to market information embedded in prices, in line with the findings of Utz (2017). The lower asynchronicity for firms more engaged in ESG policies means that market information has more weight in determining their prices than for firms with low ESG engagement.

The comparison between the US and European corporate landscapes reveals significant divergences. Contrary to expectations, the aggregate ESG score does not explain Async in US firms, nor does it serve as an important predictor of systematic risk within European firms. This nuanced understanding underscores the limitations of aggregated ESG metrics in fully capturing the diverse channels through which sustainability practices influence financial risk across distinct regulatory and cultural environments. Further disaggregation of ESG performance into its constituent pillars reveals differences in their explanatory power regarding various risk measures. Environmental practices are the predominant driver of default and insolvency risk mitigation, a finding consistent with the empirical observations of Bannier et al. (2019) and Sassen et al. (2016) that reinforces the growing consensus regarding the tangible financial benefits associated with sound environmental management.

Crucially, the intensity of the effects of the Social and Governance pillars shows significant regional differences, reflecting the underlying institutional and cultural framework. Both generally help reduce financial risks—manifesting as increased DD, Z-scores, and Alpha, along with decreased total, systematic, and idiosyncratic risks—their relative importance varies. The governance profile has considerably greater explanatory power over various risk dimensions for US firms compared to their European counterparts. Conversely, the social pillar appears more critically relevant for European firms. This divergence is attributable to fundamental differences in underlying cultural and economic models. European countries often prioritize social welfare and operate within a credit-based financial system, which in turn influences corporate priorities and stakeholder engagement (López-Arceiz et al., 2018). In contrast, the US Anglo-Saxon model emphasizes pure governance principles, individual ethics, robust capital markets, and stringent protection of minority shareholders (López-Arceiz et al., 2018; Duuren et al., 2016; Danko et al., 2008). These deeply embedded systemic differences play a crucial role in how ESG pillars translate into concrete financial risk mitigation across these two major economic regions, thereby emphasising the necessity for regionally adapted ESG assessments and investment strategies.

The work includes an in-depth analysis and a set of robustness checks confirming the crucial role of ESG performance in mitigating firm risk. The first addresses the endogeneity concerns by estimating the model for the ESG score and each pillar via instrumental variables (IV), utilizing the sector-averaged ESG score (excluding the firm's own score) as an instrument. The results confirm that the observed risk-reducing effects of ESG profile are not driven by reverse causality or omitted variable bias. Second, the analysis explores the role of varying degrees of ESG commitment by categorizing firms into low, medium, and high ESG performers, revealing that higher ESG engagement is consistently associated with stronger risk mitigation. Third, the moderating effect of greenhouse gas (GHG) emissions is examined, showing that the risk-reducing benefits of ESG are significantly attenuated in high-emitting firms, particularly for the E and S pillars. Fourth, a sectoral analysis investigates whether the ESG–risk relationship varies across industries, finding that ESG practices remain effective in reducing risk but with sector-specific nuances, especially in high-polluting sectors. Finally, the study assesses the impact of the COVID-19 pandemic, proving that ESG profiles continued to mitigate risk during the crisis, albeit with some limitations, and that firms with stronger ESG profiles exhibited greater resilience. Together, these robustness checks reinforce the consistency of the main results and highlight the importance of contextual factors—such as emissions intensity, sectoral affiliation, and macroeconomic shocks—in shaping the ESG–risk nexus.

This paper makes four key contributions to the literature. First, it provides a novel and holistic risk analysis, moving beyond single-metric studies to simultaneously evaluate multiple dimensions of risk. This comprehensive view offers a completer and more nuanced picture of ESG's role in risk management. Second, this work provides a robust test of the risk-mitigation view by focusing exclusively on a curated sample of top-performing ESG companies. This deliberately homogeneous sample minimizes the distorting effects of inconsistent ESG measurement and greenwashing, allowing for a cleaner validation of findings from prior literature (e.g., Montie et al., 2022; Bannier et al., 2019; Jo & Na, 2012) on a more reliable dataset. Third, the study offers a crucial comparative analysis between leading firms in the USA and Europe. This issue is particularly relevant given their divergent approaches to sustainability, where a robust, regulation-driven framework defines the European context and the US has traditionally followed a more market-driven and shareholder-centric approach. By examining the ESG-risk nexus in these two distinct institutional and cultural settings, this work provides insights into the context-specific aspects of how sustainability performance translates into financial resilience. Fourth, a stress test of ESG resilience is offered by analyzing the stability of its impact on firms' risks during the COVID-19 crisis, moving beyond studies that focus solely on stock performance (e.g., Albuquerque et al., 2020; Broadstock et al., 2021). The finding that ESG's protective benefits persisted through this systemic shock provides evidence for the resilience channel, aligning with recent literature (Ameur & Boussetta, 2023; Cardillo et al., 2023) and supporting current European policy priorities focused on building a resilient financial system.

In summary, this paper investigates whether better ESG performance—both aggregate and disaggregated across its pillars—is associated with reduced financial risk exposure. While existing research suggests ESG can mitigate risk through operational resilience, stakeholder confidence, and regulatory compliance, empirical findings remain inconsistent and often context dependent. Addressing these ambiguities, the present study empirically tests ESG's risk-reducing potential across multiple dimensions of financial risk, grounded in the theoretical premise that firms with robust ESG engagement are better equipped to withstand adverse shocks, potentially leading to more stable financial outcomes and contributing to a clearer understanding of this complex relationship.

The rest of the paper is structured as follows. Section 2 presents the Theoretical Framework and Literature Review. Section 3 describes the research design, including the methodology, variables, and data used in the analysis. Section 4 reports the main results on the ESG profile's impact on financial risk, considering the different pillars and examining the differences between the USA and Europe. Section 5 conducts several robustness checks. Finally, Section 6 concludes.

2. Theoretical Framework and Literature Review

Investors consider the impact of ESG practices on operational improvement, productivity, efficiency, and long-term risk when deciding which companies to include in their investment portfolios. The main body of ESG literature primarily examines its effects on firm performance and value, financial costs, and stock returns. In this context, a stronger ESG profile is associated with better performance metrics such as return on equity, return on assets, or Tobin's Q (Huang, 2021), higher firm value indicated by capital expenditure, leverage, and earnings before interest and taxes (Albuquerque et al., 2019; Fatemi et al., 2018; Ferrel et al., 2016), cash holdings (Chang et al., 2019), lower financial costs measured through debt and equity costs (Breuer et al., 2018; Chava, 2014), and increased stock returns (Albuquerque et al., 2020; Henke, 2016; Auer & Schuhmacher, 2016).

2.1. Theoretical framework

Fewer theoretical and empirical studies examine the relationship between ESG engagement and financial risk because establishing a strong connection is challenging. Risk is defined as uncertainty about future performance, and firm risk measures the potential fluctuations in financial performance, such as stock prices (market risk) or internal accounting returns. Firm risk significantly influences forecasting and planning activities because it not only indicates higher variability in company returns but also increases the likelihood of firm defaults. Therefore, understanding the factors that explain firm risk across its various dimensions is crucial for investors, managers, and researchers alike.

To address this complexity, the literature has proposed three main theoretical explanations for the relationship between ESG performance and financial risk (see Bouslah et al., 2018). The first is a risk management argument based on stakeholder theory. The second links sustainable performance and returns, giving similar predictions as equilibrium models with incomplete information. The third is the overinvestment theory, which stems from managerial opportunism within the framework of agency theory.[1] The first two perspectives predict a negative relationship, where higher ESG commitment results in lower firm risk, while the last predicts the opposite.

The stakeholder theory advocates for a socially responsible approach to business management. It states that firms must consider the interests of multiple stakeholders, including employees, suppliers, customers, and communities, not just shareholders (Lee & Kohn, 2023; Hill & Jones, 1992). Under this view, a firm can reduce risk exposure by building moral capital— the economic value of morality that reflects how ethical principles and behavior influence financial outcomes— and goodwill— the value that exceeds the net fair value of assets and liabilities—including factors like brand reputation and customer loyalty among stakeholders.

The ESG scores can reflect a firm's commitment to stakeholder interests and boost moral capital. Firms with strong ESG profiles can be seen as more responsible and transparent in their stakeholder relations, with fewer external information asymmetries and better reputations (He et al., 2023; Viviani et al., 2019). They also face a lower risk of punishment for irresponsible behavior (Viviani et al., 2019), as well as reduced risks of regulatory and operational damages (Karwowski & Raulinajtys-Grzybek, 2021; Mishra & Modi, 2013). All of this will make these firms more attractive to investors through stable financial performance, higher profitability, a favorable risk profile (Utz, 2017; Stellner et al., 2015; Godfrey, 2005), and easier, faster access to capital (Seltzer et al., 2022; Chava, 2014).

The second theory is grounded on ESG-augmented Fama-French models that consider an ESG risk factor *a la* Fama-French, predicting a negative relationship between ESG scores and financial risk (Mackey et al., 2007; Fama & French, 2007). These models assume a segmented capital market made up of traditional investors and socially responsible investors. The latter prefer to hold stocks that match their sustainability values. This creates different pricing for a firm's sustainable performance, with sustainable stocks being overvalued compared to conventional ones due to lower risk and expected returns, driven by excess demand. This prediction aligns with equilibrium models with incomplete information developed by Merton (1987) and with models of imperfect markets caused by market or regulatory frictions developed by Kryzanowski and To

[1] The agency theory, first formalized by Ross (1973), establishes the inherent potential for misaligned interests between a principal and their agent, who represents the principal in day-by-day transactions.

(1982), among others.

Unlike the previous two theories, the overinvestment view, based on agency theory, indicates a positive link between ESG performance and financial risk. Managers might pursue ESG initiatives mainly to boost their reputation, which can lead to inefficient use of firm resources (Barnea & Rubin, 2010). This increased inefficiency, caused by higher agency costs, could create a positive correlation between ESG scores and financial risk. Surroca and Tribó (2008) provide evidence that managers sometimes use sustainability performance as a strategy to secure their positions. Generally, when managers combine entrenchment tactics with higher ESG performance, it adversely affects the company's financial outcomes.

In summary, although the relationship between ESG engagement and financial risk remains theoretically complex and empirically difficult to establish, these three primary frameworks explain the expected relation. Stakeholder theory and ESG-enhanced asset pricing models suggest a risk mitigation effect with a negative relationship, indicating that ESG practices improve stakeholder trust, reduce information asymmetry, and attract socially responsible investors, thereby lowering firms' risk. Conversely, the overinvestment theory suggests a risk-increasing effect, where ESG initiatives may reflect managerial entrenchment and resource misallocation, which could increase financial risk. These competing theories highlight the need for rigorous empirical analysis to understand how ESG performance influences firm-level risk across its various dimensions.

2.2. Empirical evidence

A growing body of literature on the ESG-risk nexus has established that a firm's sustainability profile is a critical component of modern corporate risk management, compelling a re-evaluation of how financial stability is assessed. While a large volume of empirical research has examined the relationship between firms' ESG performance and various dimensions of financial risk, the focus has often been on traditional measures of market volatility.

Regarding systematic risk, numerous studies report a consistent negative association with ESG engagement. For instance, Monti et al. (2022) and Viviani et al. (2019) find that firms from a broad international sample (52 and 49 countries, respectively) with stronger ESG profiles exhibit lower exposure to market-wide risk factors. Similar findings are reported for U.S. firms by Luo and Bhattacharya (2009), Jo and Na (2012), and, more recently, by Lee and Koh (2024), who focus on financial firms during the 2014–2020 period. Albuquerque et al. (2019) further demonstrate that U.S. firms with high ESG performance show reduced correlation with business cycles, suggesting that sustainable investments may serve as a form of insurance against macroeconomic fluctuations. These firms also experience a more pronounced reduction in systematic risk compared to their lower-performing counterparts.

In terms of idiosyncratic risk, which remains relevant for derivative pricing and retail investors with under-diversified portfolios (Goetzmann & Kumar, 2008), the literature similarly documents a negative relationship with ESG performance. Studies by Lee and Koh (2024), Monti et al. (2022), Reber et al. (2022), Bannier et al. (2019), Viviani et al. (2019), Sassen et al. (2016), and Luo and Bhattacharya (2009) consistently find that firms with stronger ESG practices exhibit lower firm-specific return volatility. One proposed mechanism is that ESG disclosure reduces information asymmetry and noise trading by providing investors with relevant non-financial information, thereby aligning expectations and reducing belief dispersion (He et al., 2023).

Regarding total risk, which encompasses both systematic and idiosyncratic components, it has also been shown to decline with higher ESG engagement. Evidence from Lee and Koh (2024), Maxfield and Wang (2021), Benlemlih et al. (2018), and Jo and Na (2012) supports the view that ESG-oriented firms are generally less risky overall. Taken together, these findings suggest that firms with robust ESG practices tend to experience lower levels of systematic, idiosyncratic, and total risk, reinforcing the notion that ESG engagement contributes to financial stability and resilience.

While the relationship between ESG practices and traditional financial risk measures has been widely explored, research on the impact of ESG engagement on less conventional dimensions of firm risk—such as default risk and information risk—remains relatively limited. Default risk, defined as the probability that a firm will be unable to meet its debt obligations, is a key concern for investors and debtholders when assessing a firm’s financial health (Campbell et al., 2008; Dichev, 1998). ESG strategies may mitigate this risk by enhancing customer satisfaction and stakeholder loyalty, which in turn support more stable cash flows and reduce the likelihood of financial distress (Luo & Bhattacharya, 2006; Brown & Dacin, 1997). Empirical evidence supports this view: Hsu and Chen (2015) find that US firms with strong ESG performance exhibit a greater DD, while Rizwan et al. (2017), using the Merton (1974) structural credit risk model, show that ESG engagement is associated with a lower probability of default among U.S. firms during the 2000–2012 period.

In addition to credit risk, information risk—the uncertainty arising from asymmetric or incomplete information available to investors—has emerged as another important but underexplored channel through which ESG practices may influence firm risk. One widely used proxy for information risk is return asynchronicity, which captures the extent to which firm-specific returns deviate from market-wide movements. ESG engagement is expected to significantly affect return asynchronicity by serving as an informational supplement (Kim et al., 2014), enhancing both the quantity and quality of firm-specific disclosures. This increased transparency, along with the accumulation of moral capital and goodwill among stakeholders (El Ghoul et al., 2019, 2017), can mitigate internal agency problems associated with information asymmetry, such as insider trading (Gao et al., 2014) and tax avoidance (Lanis & Richardson, 2015).

However, the direction of ESG's effect on return asynchronicity is theoretically unambiguous. According to Dávila and Parlatore (2023), the impact of additional firm-specific information on return synchronicity depends on the prevailing level of market informativeness. In highly informative markets, ESG disclosures may amplify idiosyncratic variation by enriching the information set available to investors, thereby increasing asynchronicity. Conversely, in less informative environments, ESG engagement may reduce noise and uncertainty, leading to more synchronized returns. Thus, the sign of the ESG effect on return asynchronicity remains an empirical question, contingent on the informational context in which firms operate.

Regarding the relationship between ESG and Alpha, the literature analysis is, at times, inconsistent, reporting positive, neutral, or even negative impact that varies significantly with methodology, geographical region, and timeframe (Revelli & Viviani, 2015). For instance, Molina and Clemente (2010) found higher Alpha for firms with strong ESG performance, a finding echoed by Liu and Deng (2023) and Bekaert et al. (2023), who reported higher Alpha for portfolios with high ESG values. Conversely, Ur Rehman et al. (2016) and Belghitar et al. (2014) found no significant difference in Alpha between firms listed in ESG indices and those listed in general indices.

Summarizing, while prior research has predominantly focused on the relationship between ESG performance and traditional risk dimensions—such as systematic, idiosyncratic, and total risk—more research is needed to integrate a broader and more nuanced set of risk indicators. By examining seven distinct measures simultaneously, including forward-looking credit risk metrics (Distance-to-Default and Altman Z-score), information risk (return asynchronicity), and risk-adjusted performance (Jensen's Alpha), along with traditional market-based risk dimensions (systematic, idiosyncratic, and total risk), this analysis captures the complex ways in which ESG engagement can influence firm-level financial stability. It provides a more comprehensive assessment of the ESG-risk relationship by considering both market-based and informational risk dimensions that are often overlooked in narrower empirical frameworks.

2.3. Expected impact of ESG on firms' risks

The reviewed theoretical and empirical literature allows for the establishment of the expected relationship between corporate sustainability practices and the seven financial risk metrics analyzed. This study hypothesizes a predominantly risk-mitigating effect of ESG performance, consistent with stakeholder theory and segmented market models, which suggest that ESG-oriented firms benefit from enhanced stability and reduced exposure to volatility. However, the analysis also considers the potential for managerial overinvestment, where ESG initiatives driven by reputational motives may lead to inefficiencies and increased risk exposure, which could explain instances of positive or non-significant associations between ESG performance and certain risk indicators.

Specifically, the mechanism through which the risk-mitigation effect operates on each risk dimension is as follows. The first two—Distance-to-Default (DD) and the Altman Z-score—are indicators of credit and insolvency risk. The forward-looking metric DD is derived from the structural model proposed by Merton (1974) and reflects the buffer between a firm's asset value and its debt obligations, while the backward-looking Z-score provides an accounting-based assessment of bankruptcy risk (see section 3.2 for more details on risk measures). Under the risk-mitigation view, ESG engagement is expected to positively influence both metrics, as sustainable firms are more likely to maintain stable earnings, lower leverage, and stronger stakeholder relationships, thereby reducing the likelihood of financial distress (Rizwan et al., 2017; Hsu & Chen, 2015).

The return asynchronicity serves as a proxy for information risk. It is calculated as the ratio of idiosyncratic to systematic risk and reflects the degree to which firm-specific information is incorporated into stock prices. ESG engagement is theorized to enhance transparency and reduce information asymmetry (El Ghoul et al., 2019; Kim et al., 2014). However, the expected effect on asynchronicity is context-dependent (Dávila & Parlatore, 2023), Thus, the sign of the ESG effect on asynchronicity is empirically indeterminate.

The traditional market-based measures are derived from the CAPM pricing model. Systematic risk is proxied by the CAPM beta, reflecting a firm's sensitivity to market-wide fluctuations. Idiosyncratic risk is measured by the standard deviation of the CAPM residuals, capturing firm-specific volatility unexplained by market movements. Total risk is computed as the standard deviation of daily excess stock returns, encompassing both systematic and idiosyncratic components. Theoretical and empirical literature consistently suggests a negative relationship between ESG performance and these three risk dimensions. Stakeholder theory and ESG-augmented asset pricing models posit that firms with strong ESG profiles benefit from enhanced stakeholder trust, reduced exposure to reputational and regulatory risks, and more stable cash flows, all of which contribute to lower volatility (Monti et al., 2022; Viviani et al., 2019; Albuquerque et al., 2019). Empirical studies confirm that ESG engagement is associated with lower beta, reduced firm-specific volatility, and overall risk mitigation (Lee & Koh, 2024; Jo & Na, 2012).

The last metric, Jensen's Alpha, represents risk-adjusted performance and is captured by the constant term in the CAPM regression. The literature on ESG and Alpha is mixed, with some studies reporting positive effects (Liu & Deng, 2023; Molina & Clemente, 2010), while others find neutral or even negative associations depending on region, methodology, and time period (Revelli & Viviani, 2015; Belghitar et al., 2014). Therefore, the expected relationship between ESG and Alpha remains ambiguous, warranting empirical investigation.

3. Research Design

3.1. Methodology

Panel data models are estimated to study the impact of firms' ESG performance on their financial risks according to this specification:

$$Y_{i,T} = \alpha_i + \beta_T + \mu\, ESG_{i,T-1} + \gamma\, Controls_{i,T-1} + \varepsilon_{i,T}, \quad (1)$$

where $Y_{i,T}$ represents one risk dimension of firm i in year T, $ESG_{i,T-1}$ is the ESG score of firm i in the year T-1, $Controls_{i,T-1}$ is a vector of control variables including relevant firms' characteristics that are described below, γ is the vector of corresponding coefficients, and is $\varepsilon_{i,T}$ the error term.

Independent variables are lagged one period to mitigate potential endogeneity concerns arising from simultaneity and reverse causality that could produce spurious relationships. According to the slack resource theory, simultaneity can emerge due to firms with greater financial stability and lower risk being better positioned to dedicate resources to ESG initiatives; hence, a firm's ESG performance and risk could be jointly determined. Firm-fixed effects to control for time-invariant unobserved firm characteristics, and time-fixed effects accounting for yearly variations in financial risk are also included. Although the strategy combining lagged explanatory variables and firms' FE is common practice to mitigate the effects of reverse causality (see, for instance, Maxfield & Wang, 2021), Equation (1) is also estimated using instrumental variables to check the robustness of our results.

In this model, μ is the key parameter capturing the direct impact of the ESG profile on financial risk. Based on the risk-mitigation view, μ is expected to be negative for total, systematic, and idiosyncratic risk (where lower values mean less financial risk). Conversely, μ is hypothesized to be positive for metrics where higher values indicate less financial risk, such as the Z-score, DD, and asynchronicity. However, considering managerial overinvestment theory, μ could also present the opposite sign or be non-significant, reflecting a detrimental or ambiguous ESG impact.

3.2. Financial risk measures

This work analyses how ESG practices relate to different dimensions of firms' financial risks. The first set of metrics is related to the firms' default risk, represented by DD and the Z-score. The former is a well-known market-based risk measure that considers liquidity and credit risk (Nguyen et al., 2023; Kabir et al., 2021), providing a forward-looking assessment of default risk relevant to regulators, investors, and depositors for early prediction. It considers the market value of firms' assets alongside the book value of liabilities (Harada et al., 2010). The larger the DD, the greater the distance from the default point, as it reflects that the assets' value increases more than the liabilities, and the lower the probability of default. The Z-score assesses insolvency risk by evaluating how much the firm's asset return must decline below its average, considering volatility, to exhaust the equity (Fuertes & Robles, 2020). In this context, a higher Z-score signifies a safer firm position. Consequently, higher values of these variables suggest lower default risk.

The second set of risk metrics is associated with information risk and stock price informativeness, which refers to how the stock price moves depending on the flow of firm-specific and market-wide information (Wang & Jiang, 2023; Durnev et al., 2003; Roll, 1988).[2] Ferreira and Laux (2007) and Durnev et al. (2004), among many others, propose to measure it by the returns *Asynchronicity* (Asyn ahead), which measures the relative weight of firm-specific (idiosyncratic) information over market information in determining the price. This relative weight

[2] The Efficient Market Hypothesis posits that pricing is better when prices reflect higher firm-specific information, making higher asynchronicity a signal of efficient markets (Wang & Jiang, 2023; Dang et al., 2015; Bae et al., 2013; Hutton et al., 2009; Ferreira & Laux, 2007; Jin & Mayers, 2006; Piotroski & Roulstone, 2004).

is usually computed as a function of the determination coefficient (R2) from a factor pricing model (Wang & Jiang, 2023; Wang et al., 2022; Durnev et al., 2004, 2003; Roll, 1988). In this case, the measure is computed from the CAPM. A low R^2 (that is, a high Asyn) indicates weaker co-movement between stock returns and the market, suggesting a stronger contribution of these firms to portfolio risk diversification.

ESG engagement is expected to significantly impact the asynchronicity of returns, as it will serve as an informational supplement (Kim et al., 2014), enhancing the quantity and quality of firm-specific information available to investors. This increased transparency, alongside enhanced moral capital and goodwill among stakeholders (El Ghoul et al., 2017, 2019), is posited to mitigate internal agency problems stemming from information asymmetry, such as insider trading (Gao et al., 2014) and tax avoidance (Lanis & Richardson, 2015). Hence, Asyn is expected to be affected by the firms' ESG engagement, leading to a significant value of μ in Equation (1). However, according to Dávila and Parlatore (2023), who analyse the conditional relationship between price informativeness and idiosyncratic price variation, the ultimate effect on Asyn—whether it increases or decreases—will depend on the extant level of informativeness within the market. If the initial informativeness is sufficiently high, greater ESG-driven information is expected to amplify idiosyncratic variation, leading to higher Asyn; conversely, in less informative environments, ESG practices may reduce noise, resulting in lower price variation and thus lower Asyn. Hence, the sign (positive or negative) of the ESG effect on Asyn remains an empirical question.

The third set of risk metrics is related to returns variability. Specifically, the total volatility of returns, as captured by their standard deviation (SD), and its two components, the systematic or market risk (Beta), and the idiosyncratic risk (IDS).

The analysis is enhanced with risk-adjusted excess returns, measured by Jensen's Alpha (Jensen, 1968), which provides information about the firm's performance after accounting for its systematic risk. Changes in Alpha across different ESG profiles capture the value investors demand to outperform the market by investing in sustainable firms.

Table 1 provides the definition, and a brief description of the seven financial risk measures outlined above, along with some papers that analyse them in similar contexts. All risk measures are calculated from excess daily returns for each firm on an annual basis. Appendix II offers a more detailed explanation of their definitions and calculations.

[Insert table 1 about here]

3.3. Sustainability measures

Equation (1) is estimated for the ESG profile of firms and each pillar (environmental, social, and governance) separately. The ESG combined profile and each pillar are proxied using the LSEG (formerly Thomson Reuters) Refinitiv ESG scores (TR-ESG, TR-E, TR-S, and TR-G codes).[3] These scores range from 0 to 100, with higher values indicating stronger ESG performance. The combined ESG score integrates firm-reported data across ten thematic categories and incorporates an ESG controversy overlay derived from global media sources, enhancing its comprehensiveness and reliability. The environmental pillar assesses resource use, emissions, and innovation; the social pillar evaluates workforce practices, human rights, community engagement, and product responsibility; and the governance pillar examines management structure, CSR strategy, and shareholder rights (Fandella et al., 2023). Refinitiv ESG scores are widely adopted in academic research due to their broad coverage, methodological transparency, and historical depth, with data available for over 16,000 companies globally and dating back to 2002 (LSEG, 2025).[4]

3.4. Control variables

A set of control variables is used to account for firms' characteristics that may covary with their risk profile, selected based on the main literature (see Fandella et al., 2023; Maxfield & Wang, 2021; Eliwa et al., 2021; Benlemlih & Gired-Potin, 2017, among others). The set includes Size ($Size_{i,T-1}$), measured as the log of total assets. Larger firms are generally associated with lower risk, as they tend to benefit from greater operational diversification, more predictable cash flows, and better access to capital markets, making them more resilient to shocks (Fama & French, 1992); Market-to-book ratio ($MTB_{i,T-1}$), defined as the market capitalisation of the firm over its total equity, as a proxy for growth opportunities and intangible assets. A higher ratio signals

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[3] These scores are enhanced versions of the Thomson Reuters ASSET4 ESG scores, which are already a widely accepted measure of firm sustainability in the literature (see Maxfield & Wang, 2021; Dyck et al., 2019; Ioannou & Serafeim, 2012). See the LSEG Refinitiv Thomson Reuters ESG scores report for all the details about calculating TR-ESG (Thomson Reuters ESG scores, May 2018. Available online).

[4] The analysis relies on LSEG ESG scores due to their broad coverage, methodological transparency, and alignment with widely adopted ESG reporting standards such as the Global Reporting Initiative, the Sustainability Accounting Standards Board, and the Task Force on Climate-related Financial Disclosures. Despite differences in scoring models across providers, prior research has shown that ESG assessments tend to converge (Berg et al., 2022), and Kimbrough et al. (2024) find lower ESG rating disagreement for firms with high disclosure quality and ESG maturity—such as those included in the FTSE/S-Network ESG Best Practices Index under analysis.

strong investor expectations about future growth and profitability, which is associated with lower perceived distress risk; ROA (return on assets ratio), as more profitable firms can generate more capital to reduce their reliance on external financing and provide a cushion against financial risks distress; Liquidity ($Liq_{i,T-1}$) proxied by the stock turnover ratio (total number of shares traded during the year over the total number of shares outstanding), as high stock liquidity is generally associated with lower risk due to reduced transaction costs for investors, a more efficient incorporation of information into the stock price, and lower the cost of capital, thereby reducing perceived risk (Amihud & Mendelson, 1986); and leverage ($Lev_{i,T-1}$), measured by the debt-to-assets ratio, positively related to risk as higher leverage increases a firm's fixed financial obligations, increasing earnings volatility and the probability of default (Rajan & Zingales, 1995).

Table 2 summarises all the explanatory variables and their definitions. Panel A shows the sustainability measures, and Panel B the covariates—the table includes a brief description and references that use these variables in similar contexts.

[Insert table 2 about here]

3.5. Data and preliminary analysis

As part of our identification strategy, firms selected are listed in the FTSE / S-Network ESG Best Practices Index, which includes firms that lead in ESG performance within their respective sectors.[5] This selection ensures a relatively homogeneous sample in terms of ESG maturity, disclosure quality, and adherence to international sustainability standards, reducing noise from inconsistent reporting and measurement error, thereby enhancing the reliability of ESG assessments across firms. This approach also strengthens the internal validity of our analysis by limiting confounding variation in ESG implementation. The sample includes 490, 246 from the USA, and 244 from Europe (including Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and the United Kingdom).

[5] S-Network is a leading socially responsible investment agency that publishes the best-practice ESG benchmark indexes in collaboration with LSEG. The S-Network rating system offers comprehensive benchmarks for investors by evaluating the environmental, social, and corporate governance practices of over 5,000 companies worldwide. It follows the best-in-class methodology to select the companies exhibiting the best CSR practices ensuring that only those demonstrating consistent ESG leadership are selected. This approach emphasizes relative ESG excellence within sectors and regions, rather than absolute performance or national benchmarks.

Daily stock closing prices for each firm in the sample, along with the European and US total market indexes from LSEG DataStream, are collected. It also included the 3-month US Treasury bill rate for the US and the 3-month BD Fibor for Europe as proxies for the risk-free rate. The sample period spans from January 3, 2000, to December 31, 2021, comprising a total of 5,740 daily observations for each firm.

Firms' daily excess returns are computed as $R_{it} = r_{it} - r_{ft}$, where r_{it} are the log returns defined as r_{it}=ln (P_{it}/P_{it-1}), and r_{ft} is the daily risk-free rate for each region. Similarly, the market excess returns are calculated.

Table 3 presents the descriptive statistics of risk measures for the full sample (Panel 1) and by region (USA in Panel 2 and Europe in Panel 3), respectively. US firms display slightly lower average DD and higher average Z-scores than their European counterparts, indicating marginally stronger solvency. US firms also show higher average Alpha, suggesting better risk-adjusted returns, and slightly higher systematic risk. In contrast, European firms exhibit lower dispersion in risk measures, particularly in total risk, and slightly lower idiosyncratic risk. These results highlight that, even within a high-ESG-performing sample, regional differences exist in risk profiles, with US firms showing marginally higher returns and risk exposure. In contrast, European firms appear more stable in terms of volatility and default risk.

[Insert table 3 about here]

The descriptive statistics of the explanatory variables (ESG, E, S, and G scores and covariates) in Table 4 reveal important patterns in financial and sustainability characteristics across regions. As expected, ESG scores are relatively high across the sample, with a mean of above 50 for the ESG score and averages above 60 for its components. Notably, European firms outperform their US counterparts in all ESG dimensions, suggesting a stronger firm commitment to sustainability. In contrast, US firms exhibit higher profitability and valuation ratios, reflecting different strategic priorities. Both regions show extreme kurtosis in variables such as MTB and liquidity, indicating the presence of outliers. These findings highlight the regional heterogeneity even within a high-ESG-performing sample.

[Insert Table 4 about here]

Table A1 in Appendix I presents the correlation matrix of risk measures, sustainability scores, and control variables. As expected, systematic risk (Beta), idiosyncratic risk (IDS), and total risk (SD) are positively correlated, with particularly strong associations between IDS and SD (0.95), indicating that more risky firms tend to exhibit greater overall volatility. Insolvency risk (Z-score) is negatively correlated with Beta, IDS, and SD, especially with IDS (-0.77), suggesting that firms with higher idiosyncratic risk are more financially vulnerable. ESG scores show consistently negative correlations with Beta, IDS, and SD (ranging from -0.06 to -0.17), implying that better ESG performance is associated with lower risk.

The ESG components are interrelated, particularly E and S (0.66) and S and G (0.39), reflecting the integrated nature of ESG assessments. Firm size is positively correlated with ESG scores and negatively with DD, indicating that larger firms tend to have better ESG ratings but also lower default risk. Profitability (ROA) is negatively associated with all risk measures and with firm size, while leverage (Lev) and liquidity (Liq) show weak and inconsistent correlations across variables. Overall, the matrix supports the hypothesis that stronger ESG performance is associated with lower financial risk, although the relationships vary across risk dimensions.

4. ESG Impact on Financial Risks

The final panel data model specification was rigorously selected based on the Breusch-Pagan and Hausman tests. For enhanced interpretability of coefficients, all variables are standardized by subtracting their mean and dividing by their standard deviation. Furthermore, multicollinearity is not a concern, as evidenced by all Variance Inflation Factor (VIF) values remaining below 1.5 (see Table A2 in Appendix I).[6]

Table 5 displays the estimation results of Equation (1) considering the combined ESG score. The findings provide strong empirical support for the risk-mitigation view, indicating that higher ESG performance is associated with improved financial stability across multiple dimensions of firm risk.

[Insert Table 5 here]

Consistent with stakeholder theory and ESG-augmented asset pricing models, the results show that a higher ESG score is significantly linked to increased DD and Z-score, indicating improved creditworthiness and reduced insolvency risk for high ESG committed firms. An increase of the ESG combined score by one standard deviation results in a corresponding rise in DD and Z-score by 0.048 and 0.023, respectively. These findings are consistent with Chiaramonte et al. (2016), supporting the idea that ESG policies can help firms reduce their risk of financial

[6] To assess the robustness of results to the presence of outliers, Equation (1) is also estimated after winsorizing all continuous variables at the 5th and 95th percentiles. The results remain qualitatively unchanged, with only minor variations in statistical significance, suggesting that extreme values do not drive the main findings.

distress. Atif and Ali (2021) further endorse this view, arguing that ESG engagement increases market confidence and lowers the cost of capital, thereby improving a firm's leverage profile and pushing it further from default.

The results also indicate a negative and significant effect of ESG performance on Asyn, suggesting that firms with higher ESG scores exhibit greater return comovement with the market. An increase in ESG score by one standard deviation reduces Asyn by 0.027. This implies that market-wide information plays a more dominant role in price formation for these firms, likely due to standardized ESG disclosures aligning with market ESG factors. This finding contrasts with studies such as Barth et al. (2024) and Grewal et al. (2021), which find that high-quality, voluntary ESG disclosures can increase firm-specific informativeness and reduce synchronicity. These contrasting results reflect the context-dependent nature of ESG's effect on information risk, as emphasized by Dávila and Parlatore (2023), who remark on the relevance of the prevailing level of market informativeness.

Turning to market-based risk measures, the ESG score is negatively associated with Beta, IDS, and SD. These results are in line with a broad body of literature (e.g., Lee & Koh, 2024; Maxfield & Wang, 2021; Benlemlih et al., 2018; Lins et al., 2017; Verheyden et al., 2016; Mishra & Modi, 2013), which finds that ESG engagement reduces firms' exposure to both market-wide and firm-specific volatility. The economic significance of these effects is notable: a one standard deviation increases in the ESG score results in a reduction of 0.086 and 0.067 standard deviations in IDS and SD, respectively, and lowers Beta by 0.033 standard deviations, with IDS being the more responsive risk. These reductions imply lower exposure to extreme negative returns and reduced vulnerability to market shocks—key considerations for institutional investors seeking to construct resilient, low-volatility portfolios.

In addition, the ESG score is positively associated with Alpha, indicating that firms with stronger ESG performance tend to achieve superior risk-adjusted returns. A one standard deviation increases in the ESG score results in a rise in Alpha by 0.045. This finding is consistent with Liu and Deng (2023), Bekaert et al. (2023), and Molina and Clemente (2010), who argue that ESG-driven outperformance may stem from firm-specific advantages such as reputational capital, operational efficiency, and stakeholder alignment. As Nagy et al. (2016) suggest, a significant portion of firms' Alpha may be attributable to ESG-related factors that are not fully priced by the market.

Finally, regarding the control variables, most exhibit expected signs and statistical significance. Leverage and market turnover are positively associated with total, systematic, and idiosyncratic risks, with leverage exerting approximately twice the impact of turnover. Leverage also reduces DD and Z-score while increasing Asyn, further confirming its destabilizing effect on firm risk profiles.

Taken together, these results reinforce the view that ESG factors are not merely ethical or reputational considerations but serve as quantifiable inputs in financial risk management. The consistent and significant associations across all seven-risk metrics—spanning credit, market, and information risk—highlight the strategic value of ESG integration for investors, credit analysts, and corporate decision-makers. These findings support the inclusion of ESG metrics in capital allocation, credit risk assessment, and portfolio construction frameworks, particularly for stakeholders seeking long-term value and resilience. Moreover, improved corporate financial risk profiles through enhanced ESG performance have additional implications. Firms demonstrating stronger ESG practices often experience better access to credit markets, face lower borrowing costs, and exhibit increased resilience during economic downturns. These dynamics suggest that encouraging sustainability practices may not only promote long-term environmental and social goals but also contribute to financial system stability and efficient capital allocation

4.1. Impact of E, S, and G on firms' risks

To analyse the impact of each pillar separately, Equation (1) is estimated for the Environmental, Social, and Governance pillars individually. Results are in Tables 6, 7, and 8, respectively. The main conclusions about risk mitigation are maintained, as are the signs and significance of the control variables. The environmental pillar is the most relevant in explaining firms' risk in terms of statistical significance and the estimated impact size. The Social and Governance pillars significantly impact DD, Z-score, Beta, IDS, and SD, but do not affect Asyn risk and Alpha.

[Insert tables 6, 7, and 8 about here]

Specifically, firms that rank higher in the E score tend to have lower default risk (higher DD and Z-score) and a better performance measured by Alpha. They also present lower Asyn with an increase in the co-movements of their stock returns and the market. An increase of one standard deviation in the E score leads to a rise in DD and Z-score by 0.029 and 0.019 standard deviations, respectively, and a decrease by 0.046, 0.103, and 0.072 standard deviations of Beta, IDS, and SD risks, respectively. This result aligns with the view that firms that commit to environmental responsibility generally experience reduced financial risks (see Breitenstein et al., 2021). Viviani et al. (2019) relate this effect to changes in environmental laws and regulations that incentivise firms to enhance green practices to diminish their exposure to transition risk. Lee and Koh (2024) and Bolton and Kacperczyk (2020) relate it to the influence of environmental news, which has become more relevant, affecting firms across countries and industries.

Regarding S and G, a higher social score leads to a higher DD and Z-score and lower Beta, IDS, and SD (Table 7), confirming the finding by Lee and Koh (2024) that shows that social commitments can explain lower systematic, idiosyncratic, and total risks. At the same time, a higher governance score leads to higher DD and Z-score and lower IDS and SD (Table 8). This result differs from Lee and Koh (2024), who find that governance commitments lead to a lower IDS and SD and a lower Beta. This difference may stem from the differences in sample size, as they only analyze US financial firms, whereas this work considers US and European firms across a more comprehensive range of sectors. Although companies have generally prioritized the environmental pillar, results emphasize the significance of the social pillar, which—based on the size of its coefficient—plays a relevant role in mitigating default risk compared to the environmental and governance pillars. Thus, these results point to the need to consider the specific impact of each pillar in business decision-making and risk management.

4.2. Differences in the ESG-risk nexus in the US and Europe

To analyse the extent to which the results vary across regions, Equation (1) is estimated now for both European and US firms separately. In the latter case, the model is extended to control for the heterogeneity within the European countries by including a dummy variable (*Main Economy*) equal to 1 for firms based in larger European countries based on GDP criteria (namely, Germany, France, Italy, the United Kingdom, and Spain) and zero otherwise.

[Insert table 9 about here]

Results for the ESG score in Table 9 reveal that, overall, the main conclusions about the role of firms' ESG commitment in enhancing their risk profile are similar across both regions, but with slight variations in the effects of ESG and the covariates (for example, liquidity does not play a role for European firms but is relevant for US ones). US firms with a stronger ESG profile exhibit higher DD and Z-score and lower Beta, IDS, and SD. This aligns with Karoui and Nguyen (2022), who find that low-scoring stocks display high Betas and SD in their analysis of US stocks from 1991 to 2019. However, ESG does not explain Asyn and Alpha. The ESG score explains all risk measures except Beta in European firms. When comparing the impact sizes, the strongest effect of the ESG score is seen in European firms. This finding contradicts Bannier et al. (2019), who report that the risk-reducing effect is more pronounced for US firms than for European ones.

The difference may be due to (i) the longer sample period used in this study compared to Bannier et al. (2019), and (ii) the basis of the sample, which in this case includes best-in-class firms, whereas Bannier et al. (2019) use a broad set of listed firms.

Interestingly, results indicate a significant difference in firms' risk within European economies. The coefficient of the *Main Economy* variable is significant and negative for DD, Beta, IDS, and SD, while it is significant and positive for Z-score, Asyn, and Alpha. Firms from major countries tend to have lower Beta, IDS, and SD than other European firms. The results on default risk are less clear, as these firms have lower DD and higher Z-score. Asyn and Alpha are also higher for firms in the largest European economies.

The analysis by region and pillar (Tables 10, 11, and 12) reveals notable differences in how firms' sustainability profiles impact risk between American and European companies. For US firms, the E pillar explains all risk measures except Asyn and Alpha (Table 11). This supports Bannier et al. (2019), who find that the E pillar reduces risk for US firms. However, our findings contradict Bannier et al. (2019) in the case of European firms by demonstrating that higher E scores do lower financial risks, with the Z-score being the only exception.

[Insert tables 10, 11, and 12 about here]

Tables 11 and 12 present empirical evidence on how the S and G pillars impact financial risk, revealing cultural differences between the two regions. These findings offer a different perspective compared to Bannier et al. (2019) for US firms. The findings in Table 11 indicate that US firms with a more socially responsible profile exhibit a better default risk profile, characterized by higher DD. Thus, as the distance to the default increases (higher DD), the market value of assets moves further away from the default point, and the odds that a company faces bankruptcy also increase. The social pillar also relates to lower SD for US firms. For European firms, the social profile of firms also plays a role in explaining all the risk dimensions, except Asyn. It helps to have lower systematic, total, and idiosyncratic risk, confirming the results in Sassen et al. (2016). Results point out more significant concerns for social criteria in Europe than in the United States, in line with Duuren et al. (2016) and Danko et al. (2008), which analyse how asset managers and business leaders account for the ESG factors in their investment process. Again, belonging to a prominent European country plays a role in explaining risks, indicating a significant difference in the risk of firms belonging to the European countries with larger GDP. These firms will have lower DD, Beta, IDS, and SD while having higher Z-score, Asyn, and Alpha.

Salient differences emerge in firms' governance profiles between the USA and Europe. For US firms, the governance pillar accounts for all risk measures except Asyn and Beta. Higher G scores increase Z-score, DD, and Alpha, and reduce systematic and idiosyncratic errors. For European firms, the G pillar also helps explain DD, Z-score, systematic, and idiosyncratic risk, but its impact appears weaker.

In summary, the analysis of the S and G pillars points out that the governance profile of firms is more helpful in explaining their different risk dimensions in the US. In contrast, the S pillar is more important for the European case, as shown in Table 11, where the value of the coefficient estimates is larger. The rationale is that while European countries tend to be more influenced by social principles associated with a general concept of ethics (social innovation, employment, and environmental protection) and, by extension, a financial system based on a credit system (governments and financial institutions), the Anglo-Saxon model followed in the US is based on pure governance principles, presenting more autonomy in the decision-making process based on individuals' ethics, is based on capital markets and the protection of minority shareholders (see López-Arceiz et al., 2018; Duuren et al., 2016; Danko et al., 2008).

5. Robustness Analysis

5.1. Endogeneity analysis

The study employs panel data models with firm-fixed effects and incorporates lagged ESG and control variables. This methodology is commonly used to address persistent endogeneity issues related to simultaneity and reverse causality (Maxfield & Wang, 2021). However, some unavoidable endogeneity concerns may still remain, potentially biasing the results (Bouslah et al., 2013). To analyse the extent to which this issue affects our study, the Instrumental Variables (IV) approach is adopted, which requires selecting a valid instrument that must be relevant, that is, highly correlated with firms' ESG score, and exogenous, that is, independent of the error term. Following the literature, we use the leave-one-out sector-average ESG score, calculated excluding the i-th firm (El Ghoul et al., 2019; Martielli et al., 2024) as the instrumental variable. Firms operating in the same sector face similar challenges and regulations, and common sustainability patterns and standards are likely to develop, forcing ESG profiles within sectors to converge. Excluding the i-th firm to compute the average removes the direct contamination from the specific firm's own ESG, while capturing the relevant influence of the sector peer group.

[Insert table 13 about here]

Table 13 shows the results for the IV analysis, including two specification tests. The first assesses instrument relevance through the weak instrument test that evaluates the predictive power of the instrument—the leave-one-out sector average—on the endogenous ESG variable. The null hypothesis is that the instrument is weak. As reported, according to the p-value of the The first-stage statistic, the null hypothesis is strongly rejected in all models, for the ESG score (Panel 1) and for each pillar (panels 2, 3 and 4 for E, S and G, respectively), confirming that the selected instrument is relevant predictor of a firm's ESG (E, S and G) performance. The second diagnostic examines the presence of endogeneity using the Wu-Hausman (WH) test. This test compares the coefficients from the baseline FE model with those from the IV model. The null hypothesis is that the variable of interest is exogenous, which would imply that the more efficient FE estimator is consistent and appropriate. The test results indicate that for most of the models estimated, the null hypothesis of exogeneity cannot be rejected at conventional significance levels, being rejected in 7 out of 32 cases at 10% significance level and only two at 5%. In the case of ESG score, the WH test rejects the null hypothesis for Asyn, Alpha, and Beta; Asyn and IDS for the S score; and DD and SD for the G score. Significantly, the direction and stability of the key ESG coefficients were maintained across both FE and IV models in all cases, despite the WH results.

The IV coefficients confirm the risk-reducing role of ESG, particularly in the aggregate model, where higher ESG scores are associated with increased distance-to-default and Z-score, and reduced idiosyncratic and total risk. For asynchronicity, where endogeneity is present, the significant negative coefficient confirms that stronger ESG performance reduces firm-specific return variation. The E pillar shows the strongest negative effect on idiosyncratic risk, while the S pillar has the strongest effect on default risk, highlighting its role in financial stability, with the effect of the G pillar being less significant.

Taken together, the diagnostics provide a robust validation of the methodological approach. The confirmed strength of the instrument lends credibility to the results of the WH test. The general failure to reject the null of exogeneity suggests that while endogeneity is a critical theoretical concern, it does not appear to introduce a significant bias in the estimates for this specific sample. Overall, the IV analysis supports the main findings and confirms that ESG performance contributes to lower firm risk, with limited evidence of endogeneity bias.

5.2. Effect of the degree of ESG commitment on the ESG-risk nexus

This subsection explores the relationship between ESG commitment and risk reduction in more detail, focusing on potential nonlinear effects. Previous research, such as Yang et al. (2025), has identified nonlinear impacts of ESG risk factors on returns. Agarwala et al. (2024) and Pu (2023) find nonlinearities in the relationship between ESG practices and firm performance, while Bagh et al. (2024) specifically document that this link is U-shaped. Given these findings, we examine whether our initial results hold under a more flexible specification that accounts for varying degrees of ESG commitment.

To achieve this, firms are grouped based on the distribution of their ESG scores, defining three distinct levels of commitment: low (P1 group), medium (P2), and high (P3). These categories are operationalized through dummy variables. Specifically, P2 identifies the medium-committed firms by taking the value of 1 for firms with ESG scores falling between the 20th and 80th percentiles, and P3 identifies the high-committed firms by taking a value of 1 for firms whose ESG score exceeds the 80th percentile. These two dummies replace the ESG score in Equation (1), with low-committed firms (P1 group) serving as the reference.

[Insert table 14 about here]

The results in Table 14 indicate that different thresholds of ESG engagement influence firms' risk profiles. Highly committed firms in the P3 group have higher DD, Z-scores, and Alpha, and lower Beta, IDS, and SD than the lowest, indicating that a higher degree of ESG commitment leads to greater risk mitigation. The result is the same for medium-committed firms (P2). Additionally, medium-commitment firms in P2 have higher DD, Z-scores, and Asyn, and lower IDS and SD, compared to firms with the lowest ESG profile. Furthermore, comparing the significant coefficient firms in P3 and P2, in general, the high-committed firms have larger sizes than the medium ones. Therefore, even considering these different degrees of commitment instead of the direct use of the ESG score, the qualitative essence of results does not change, that is, the mitigating effect of the ESG practices maintained.

5.3. Effect of GHG emissions on the ESG-risk nexus

The environmental profile of firms, which is the most effective in mitigating financial risk according to the results, mainly depends on GHG emissions and resource use of firms (Thomson Reuters, 2017). It also reflects firms' concern about climate change and their need to comply with environmental regulations to reduce GHG emissions. This subsection examines the extent to which the polluting profile of firms alters the role of sustainability policies in risk reduction. A firm-specific indicator is built from the intensity of effective emissions of each firm, which is computed as the sum of the Scope 1 and Scope 2 emissions (in tons of CO_2) over the market capitalization as in Garcia-Jorcano, et al. (2025).[7] The GHG emissions indicator-*EE* variable-is defined as equal to 1 for firms with the intensity of effective emissions exceeding the 75th percentile of its distribution (high polluter firms), and zero otherwise. To analyse the moderating effect of the polluting profile of firms, Equation (1) is extended by including the interaction of the GHG emissions proxy with the ESG score.

[Insert table 15 about here]

Results, presented in Table 15, indicate that the ESG score continues to play a role in mitigating financial risk measures, consistent with results in previous sections. ESG is positively associated with DD and Z-score, and negatively with Beta, IDS, and SD, all statistically significant (see Panel 1, Table 15). The positive effect on Alpha further supports the notion that social responsibility contributes to superior risk-adjusted performance. The interaction terms capture how the risk-reducing impact of ESG scores varies for high-polluting firms. This interaction is negative for DD (-0.055) and Z-score (-0.031), and positive for IDS (0.100) and SD (0.110), indicating a dampening of the risk-reducing effect of ESG performance in high-emitting firms. The interaction with Asyn, Alpha, and Beta is not significant, suggesting a more nuanced or limited moderating role of the polluting profile.

Panels 2, 3, and 4 of Table 15 report the results by pillars, which confirms the previously documented relationships between ESG pillars and firm risks. Higher E and S scores remain significantly associated with lower financial risk, as evidenced by their positive relationship with DD and Z-score, and negative association with idiosyncratic and total risk. Moreover, the positive effect on Alpha reinforces the notion that strong environmental and social performances contribute to superior risk-adjusted returns. In contrast, the G score shows weaker but still significant associations with dd and Z-score, and a negative relationship with IDS and total risk, while its effects on Alpha and Beta are insignificant.

The interaction effects with EE indicate that firms' emissions intensity significantly moderates the risk-reducing influence of ESG pillars. For firms in the top quartile of the emissions distribution, the interaction between environmental score and EE is negative and significant for DD and Z-score, and positive and significant for IDS and total risk, suggesting that the beneficial effects of environmental performance are weakened or even reversed in high-emitting firms.

[7] Scope 1 accounts for direct GHG emissions from sources owned or controlled by firms, while Scope 2 includes indirect emissions resulting from the purchase of energy, steam, heating, or cooling for their own use. Data is collected from the LSGE Datastream database.

Similarly, the interaction between S score and EE is negative for DD and Z-score, and positive for total risk, indicating a dampening of the risk-reducing effect of social performance under high emissions conditions. However, the interaction with idiosyncratic risk is not statistically significant. In contrast, the interaction effects involving Governance score are generally weaker, with only marginal influence on total risk, implying that governance practices may be less sensitive to emissions intensity in their relationship with firm-level risk.

These findings have several implications. First, they reinforce the role of ESG, particularly the environmental and social dimensions, as effective tools for risk mitigation and for enhancing risk-adjusted returns. Second, they highlight the limitations of ESG in high-emission firms, where the risk-reducing benefits are significantly attenuated, suggesting that ESG scores alone may not fully capture the risks associated with environmental externalities. Finally, the results underscore the importance of integrating emissions data into ESG assessments and point to the need for targeted regulatory or market-based incentives to promote genuine environmental improvements in high-emitting sectors.

5.4. Sectoral analysis

The previous results encourage a more in-depth look at how carbon intensity impacts the ESG–risk relationship from a sector-by-sector perspective. To do this, four dummy variables are added to the model to identify firms in the most polluting sectors: Materials, Industry, Energy, and Utilities. Table A3 in Appendix I presents the distribution of firms by sector. In summary, the mitigation power of the ESG score remains after accounting for sectors, supporting the risk-mitigation perspective emphasized in this study, although the effectiveness of ESG practices differs across sectors.

[Insert table 16 about here]

Table 16 shows the results, indicating that the risk-mitigating effect of the ESG score is consistent across risk measures, except for Asyn, which further reinforces the robustness of the current findings. Although sector dummies do not help explain risk measures, their interactions with the ESG score do, suggesting that the impact of the ESG profile varies depending on whether the firms belong to one of the four high-polluting sectors. The impact of sustainability is generally more evident in these cases, with some nuances. The ESG level of firms in the more polluter sectors leads to higher DD, Beta, IDS, and SD, and a lower Z-score than those in low-polluting sectors. Lastly, the effect of ESG on Asyn risk is mixed, depending on the specific polluting sector.

Going into detail, for firms in the energy sector, ESG impact is linked to a lower Z-score and Alpha, and higher Beta, IDS, and SD compared to firms in other sectors. For firms in the utility sector, ESG performance increases Asyn, indicating greater return asynchronicity with the market. This suggests that a higher ESG profile emphasizes firm-specific information in pricing more than in other sectors. The effect of ESG on firms in the industry sector is unclear, but it is expected to lead to an increase in DD and Beta and a decrease in Asyn and Alpha. Finally, the ESG score of firms in the materials sector has a stronger impact on DD and Z-score and a lesser effect on SD compared to firms in other sectors. In this case, ESG enhances the risk mitigation capacity of materials firms, as shown by increases in DD, Z-score, and SD.

5.5. COVID-19 impact on the ESG-risk nexus

Finally, given the most recent and unprecedented scenario of COVID-19, an extra analysis is included to determine to what extent the pandemic disruption altered the ESG profile-risk relationship. The sample period extends until 2021, encompassing the COVID-19 crisis. Therefore, this analysis aims to assess the moderating effects of the pandemic on the link between ESG and firms' risks. This effect can be particularly relevant as certain studies suggest that investors' perceptions of sustainability may change during turbulent times (Broadstock et al., 2021). Albuquerque et al. (2020) find that US firms with high E score exhibit greater stock price resilience during the early COVID-19 market crash. Yahya (2023) further supports this by showing that Nordic firms with better environmental and social performance experienced enhanced revenue, profitability, and valuation amidst the pandemic. Gianfrate et al. (2024) observe that although this ESG-driven resilience is not a globally consistent phenomenon, there is stronger evidence for the US. Conversely, Petitjean (2019) finds a weak relationship between ESG policies and financial performance in turbulent markets, where the only factor that seems to matter to investors is the firm's survival.

[Insert table 17 about here]

The effect of the COVID-19 crisis is examined by extending the baseline model to include a COVID-19 indicator variable—set to 1 for 2020 and 2021, and 0 otherwise—along with its interaction term with the ESG score. Results regarding the impact of ESG scores on risks (Table 17) are consistent with previous findings in this study. The ESG combined score remains relevant in explaining all risk measures except Asyn during the crisis period. The influence of ESG practices during the pandemic is higher for Beta, IDS, and SD, but lower for Z-score and Asyn compared to the previous period.

The overall impact of ESG during the crisis (calculated by adding the ESG parameter to that of the interaction) is higher for Z-score and lower for Asyn, indicating that increased ESG commitment during the pandemic enhances co-movement with the market, and raises Beta risk. The mitigating effect on IDS and SD remains but is more limited. This result aligns with the growing body of literature demonstrating that firms with strong ESG practices are better positioned to weather crises and maintain performance during periods of heightened uncertainty (see Albuquerque et al., 2020; Gianfrate et al., 2024; Yahya, 2023). A strong ESG profile is found to be related to greater resilience through reduced financial risk (Broadstock et al., 2021), higher returns and lower return volatility (Yoo et al., 2021; Albuquerque et al., 2020), as well as superior stock performance (Cardillo et al., 2023; Engelhardt et al., 2021), and faster recoveries (Ameur & Boussetta, 2023).

The COVID-19 variable is relevant for explaining all risks, except for Asyn and Alpha, indicating that the unprecedented pandemic was a source of risk for firms. This led to increases in DD, IDS, and SD, as well as decreases in Z-score and Beta. This means that during the COVID-19 years, the DD was higher, as were IDS and SD, due to increased variability in returns. Additionally, during these years, the distance to insolvency decreased (a negative effect for firms) while Beta decreased, which can be seen as positive since market risk cannot be diversified. This impact on Beta could reflect the reversed behavior of securities, as Horstmeyer and Vij (2020) explain. They find that sectors that traditionally amplify market movements (technology and biotech) showed lower volatility than the market during the pandemic crisis. In contrast, sectors that usually dampen market movements experienced sharper declines.

6. Concluding Remarks

This study provides robust empirical evidence that, for a sample of US and European best-in-class ESG firms, a stronger commitment to sustainability is systematically associated with a lower and more stable multi-dimensional risk profile. By extending the analysis beyond traditional market-based risk metrics to include default, solvency, and information-based risk measures, the findings confirm that superior ESG performance translates into enhanced financial resilience. Notably, the Environmental pillar emerges as the most potent driver of risk mitigation, while the benefits of ESG engagement are attenuated in high-polluting sectors. Furthermore, ESG-driven resilience is most pronounced during periods of systemic stress, such as the COVID-19 pandemic, underscoring the strategic value of sustainability in crisis contexts. The primary contribution of this research lies in offering a granular and empirically validated perspective on the ESG-risk nexus, helping to reconcile the mixed results found in prior literature.

The implications for corporate risk management are substantial. The evidence compels firms to treat ESG not as a peripheral compliance obligation but as a core strategic lever for value preservation and long-term competitiveness. The results provide a clear mandate for embedding ESG considerations into Enterprise Risk Management (ERM) frameworks, where environmental and social metrics should be actively monitored as material financial risks. Strong ESG performance is shown to function as a strategic buffer, enhancing firms' ability to withstand both idiosyncratic shocks and broader market downturns.

This research also offers timely insights for policymakers and regulators. The demonstrated link between ESG performance and reduced financial risk provides a compelling economic rationale for regulatory initiatives that promote sustainable business practices. In the European context, the findings lend empirical support to the EU's Sustainable Finance Action Plan and its key instruments, such as the Corporate Sustainability Reporting Directive (CSRD), by validating the principle that sustainability risks are financial risks. In the U.S., the results contribute to the ongoing debate surrounding the SEC's climate disclosure rules, suggesting that ESG integration is not merely ethical but essential for prudent risk oversight. The observed attenuation of ESG's benefits in high-emission sectors further implies that broad disclosure mandates may need to be complemented by targeted, sector-specific interventions—such as carbon pricing or emissions caps—to address externalities not fully captured by market-based ESG ratings.

Furthermore, policymakers should consider mandating or promoting ESG reporting with consistent standards to enhance market transparency. Additionally, establishing ESG capital requirements would strengthen sustainability as a key element of economic growth, supporting the stability of the financial system through these ESG measures.

Finally, some directions for future research could examine long-term feedback loops between ESG and risk by using dynamic panel data models and also explore country-specific differences through multilevel modelling frameworks that consider the nested structure of firms within countries. These methods would enhance our understanding of how ESG engagement interacts with institutional, regulatory, and cultural factors over time.

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Appendix I

Table A1: Correlation Matrix

	Beta	*IDS*	*SD*	*DD*	*Z-score*	*Asyn*	*Alpha*	*ESG*	*E*	*S*	*G*	*Size*	*MTB*	*ROA*	*Lev*	*Liq*
Beta	1.00															
IDS	0.37	1.00														
SD	0.50	0.95	1.00													
DD	-0.10	-0.02	-0.08	1.00												
Z-score	-0.45	-0.77	-0.28	0.05	1.00											
Asyn	-0.51	0.18	-0.06	0.15	0.10	1.00										
Alpha	0.14	-0.03	-0.02	0.22	0.00	-0.09	1.00									
ESG	-0.06	-0.17	-0.13	-0.03	0.12	-0.05	-0.03	1.00								
E	-0.01	-0.11	-0.05	-0.18	0.07	-0.10	-0.07	0.66	1.00							
S	-0.05	-0.15	-0.10	-0.07	0.11	-0.07	-0.07	0.75	0.66	1.00						
G	-0.02	-0.09	-0.07	-0.11	0.10	-0.04	-0.07	0.58	0.34	0.39	1.00					
Size	0.11	-0.21	-0.11	-0.52	0.16	-0.28	-0.16	0.17	0.37	0.33	0.28	1.00				
MTB	0.01	0.01	0.01	0.06	0.00	-0.01	0.03	-0.01	0.00	0.00	-0.02	-0.02	1.00			
ROA	-0.17	-0.22	-0.23	0.34	0.16	0.04	0.13	0.01	-0.09	0.00	-0.04	-0.22	0.03	1.00		
Lev	-0.11	-0.02	-0.03	-0.09	0.07	0.07	-0.09	0.09	0.09	0.09	0.04	0.03	-0.04	-0.06	1.00	
Liq	0.08	0.08	0.08	-0.10	-0.04	-0.03	-0.05	-0.02	0.01	0.01	0.03	0.08	0.00	-0.10	0.03	1.00

This table reports the correlation coefficients of the risk measures and independent variables at firm level. DD is the Merton's distance-to-default, Z-score the insolvency risk, Asyn is the asynchronicity risk. Alpha is the risk- adjusted excess return. Beta and IDS are the systematic and the idiosyncratic risk estimated from the CAPM; SD is the total risk. The independent variables are the Thomson Reuters ESG combined score. E, S, and G are the environmental, social, and governance scores, respectively. Size is the size of the firm. MTB is the Market-to-book ratio. ROA is the return on assets ratio. Lev is the leverage ratio. Liq is the turnover ratio. Variables are annual.

Table A2: VIF

	Panel A						*Panel B*					
	ESG	*Size*	*MTB*	*ROA*	*Lev*	*Liq*	*E score*	*Size*	*MTB*	*ROA*	*Lev*	*Liq*
DD	1.050	1.181	1.003	1.137	1.012	1.015	1.175	1.343	1.004	1.158	1.012	1.015
Z-score	1.050	1.181	1.003	1.137	1.012	1.015	1.175	1.343	1.004	1.158	1.012	1.015
Asyn	1.050	1.181	1.003	1.137	1.012	1.015	1.175	1.343	1.004	1.158	1.012	1.015
Alpha	1.050	1.181	1.003	1.137	1.012	1.015	1.175	1.343	1.004	1.158	1.012	1.015
Beta	1.050	1.181	1.003	1.137	1.012	1.015	1.175	1.343	1.004	1.158	1.012	1.015
IDS	1.050	1.181	1.003	1.137	1.012	1.015	1.175	1.343	1.004	1.158	1.012	1.015
SD	1.050	1.181	1.003	1.137	1.012	1.015	1.175	1.343	1.004	1.158	1.012	1.015
	Panel C						*Panel D*					
	S score	*Size*	*MTB*	*ROA*	*Lev*	*Liq*	*G score*	*Size*	*MTB*	*ROA*	*Lev1*	*Liq*
DD	1.151	1.294	1.003	1.149	1.013	1.015	1.092	1.235	1.004	1.134	1.005	1.014
Z-score	1.151	1.294	1.003	1.149	1.013	1.015	1.092	1.235	1.004	1.134	1.005	1.014
Asyn	1.151	1.294	1.003	1.149	1.013	1.015	1.092	1.235	1.004	1.134	1.005	1.014
Alpha	1.151	1.294	1.003	1.149	1.013	1.015	1.092	1.235	1.004	1.134	1.005	1.014
Beta	1.151	1.294	1.003	1.149	1.013	1.015	1.092	1.235	1.004	1.134	1.005	1.014
IDS	1.151	1.294	1.003	1.149	1.013	1.015	1.092	1.235	1.004	1.134	1.005	1.014
SD	1.151	1.294	1.003	1.149	1.013	1.015	1.092	1.235	1.004	1.134	1.005	1.014

This table reports the variance inflation factor for all the risk measures and independent variables for the ESG score (Panel A), and for each of the pillars separately. E, S, G (Panel B, C, and D respectively). With an unbalanced panel of 490 firms and 21 years (2000-2021). All variables have been standardized using annual data. DD is Merton's distance-to-default, Z-score is the insolvency risk. Asyn is the asynchronicity of returns with the market Alpha is the risk-adjusted return. Beta is systematic risk; IDS is idiosyncratic risk; SD total risk. Lev is the leverage ratio. Liq is the turnover ratio. ESG is the annual Thomson Reuters Combined ESG score and by pillars (E, S, G). Size is the size of the firm. Market-to-book ratio (MTB). ROA is the return on assets ratio.

Table A3: Number of firms by industry

C. discretionary	57
C. staples	39
Energy	14
Financials	72
Health Care	59
Industrials	81
I. tech	73
Materials	34
Real Estate	6
Telco	25
Utilities	30
Total	*490*

The table displays the distribution of firms across industries within the sample

Appendix II: Risk Measures

Merton's Distance-to-Default (DD) is calculated by a structural model of credit risk assessment pioneered by the option pricing theory of Merton (1974) and Black and Scholes (1973). As Harada et al. (2010) explain, the model defines a default when the market value of assets falls below the book value of liabilities, the default point. DD is defined as the number of standard deviations of the market value of assets away from the default point. For instance, a DD of 1.0 means that a default within a year is a one-standard deviation event, presuming the fluctuation of the market value of assets and using the current market value of assets as a starting point. A zero DD does not mean that the firm fails at that point. A negative or zero DD means the firm will likely fail unless the asset value improves. If short-term debts are rolled out, the firm survives on a cash-flow basis, technically insolvent. If short-term debts are not rolled over and are called, the firm may fail due to a shortage of liquidity and will need to exhaust its assets to repay them within a year.

Option pricing theory determines the value of assets and the volatility of a company based on the observed stock prices. Concretely, the value and the volatility of assets are calculated using the Black and Scholes (1973) model to appraise the value and volatility of stock prices. Once the asset's market value and its volatility are known, it is possible to calculate the probability with which the asset value declines to the default point. Such probability is the probability of default (PD), and it corresponds one-to-one with the DD (that is, there is one PD to each DD). Such a probability of default provides an estimate of the likelihood of a firm being unable to meet its debt obligations (Dar & Qadir, 2019). The higher the probability of default, the higher the firm's default risk (Hafeez et al., 2022). In this way, the larger the DD, the greater the distance of a company from the default point and the lower the probability of default (that is an inverse relationship exists between the DD and the probability of default). Moreover, it contains expectations of market participants, and it is forward-looking since the DD is a market-based measure of distress (Harada et al., 2010).

$$DD_{iT} = \frac{log\left(\frac{V_{it}}{L_{it}}\right) + \left(\mu_V - \frac{1}{2}{\sigma^2}_V\right)T}{\sigma_V\sqrt{T}} \qquad (A.1)$$

where V_{it} is the market value of the *i-th* firm's assets at time t (calculated by multiplying the number of shares and the security price); L_{it} is the *i-th* firm's liability (representing all short -and long-term obligations of the firm) at time *t* (the default point). The model assumes that V_{it} follows a geometric Brownian motion with mean μ_V and standard deviation σ_V. T is the time horizon (which is set to one year), consistent with Nguyen et al. (2023) and Capasso et al. (2020). Finally, the accounting variables used to calculate the DD (that is, V_t and L_t) are directly sourced from Thomson Reuters.

Total risk (SD): This measure is the combination of all risk factors (systematic and specific) associated with making an investment decision. It is calculated as the standard deviation (sd) of daily excess stock returns, R_{it}.

$$SD_{iT} = sd(R_{it}) \qquad (A.2)$$

CAPM is represented in Sharpe's (1964) equation by Ordinary Least Squares (OLS):

$$R_{it} = \alpha_t + \beta_{iT} R_{Mt} + \varepsilon_{it} \qquad (A.3)$$

where R_{it} is the excess return of the asset *i* on day *t*, and R_{Mt} is the excess market return on day *t*, and ε_{it} is an uncorrelated error term. This model is used to compute the beta, the alpha, and the error term as follows:

Systematic risk (Beta): is the slope, β_{iT}, in Model (A.3) for each firm and year. It measures the volatility of a security or portfolio compared to the market.

$$\beta_{iT} = \frac{Cov(R_{it} R_{Mt})}{Var(R_{Mt})} \qquad (A.4)$$

Idiosyncratic risk (IDS) is the standard deviation of the residuals from the model (A.3). It represents a security's specific or endemic risk. So, as for the beta, it was obtained one value per year for each of the 490 firms of the sample:

$$IDS_{iT} = sd(\varepsilon_{it}) \qquad (A.5)$$

Alpha: As Grinold (1994) states, Alpha is the key to investment success. As Molina and Clemente (2010) explain, Alpha is the excess return on the risk associated with a particular security due to its own characteristics in relation to the market as a whole (benchmark stock index). It allows us to evaluate a security or portfolio performance relative to a benchmark stock index.

$$\alpha_t = R_{it} - \beta_{iT} R_{Mt} \qquad (A.6)$$

Asynchronicity (Asyn) or lack of synchronicity of returns with the market (Ferreira & Laux, 2007; Durnev et al., 2004): running (A.3) for each firm every year, R2 is obtained for each estimation. As Durnev et al. (2004) explain, one minus R2 represents the firm-specific return variation, and R2 represents the market variation. However, to avoid the econometric problems due to the bounded and highly skewed nature of R2, the standard practice in the literature is followed (Utz, 2017; Hutton et al., 2009; Ferreria & Laux, 2007; Durnev et al., 2004; Morck et al., 2000), and the logistic transformation that is close to being normally distributed is applied. Thus, Asyn is the natural logarithm of the ratio firm-specific to market variation information:

$$Asyn_{iT} = ln\left(\frac{1-R_{it}^2}{R_{it}^2}\right) \qquad (A.7)$$

A higher value of Asyn indicates greater asynchronicity of returns with the market and greater importance of the firm-specific variation relative to the market variation in explaining stock price movements (Durnev et al., 2004).

Z-score: This is a well-established indicator of insolvency risk. It relates the capital level of firms to the variability of returns, informing on how much variability in returns can be absorbed by capital without the firm becoming insolvent (Li et al., 2017; Hafeez et al., 2022). Thus, the lower the Z-score, the higher the odds that a company faces bankruptcy. The Z-score is a more comprehensive measure of predicting a firm's state of financial distress. It predicts 76% of firms' failures (Chiaramonte et al., 2016). The Z-score gives information about the probability of insolvency, considering capital levels and return variation (Hafeez et al., 2022). So, a lower Z-score implies higher odds of facing bankruptcy due to insolvency. Z-score is an accounting-based measure (Chiaramonte et al., 2016), and it can be calculated as the sum of the return on assets and the capital–asset ratio (equity over total assets) divided by the standard deviation of the return on assets. Also, it can be calculated from market data (Laeven & Levine, 2009; Barth & Schnabel, 2013), that is the standard practice in the recent literature (see Atif and Ali, 2021; Fuertes & Robles, 2021), as the ratio of the mean of daily stock returns $(\underline{R_{it}})$ plus one over the standard deviation (sd) of daily stock returns:

$$Z_{iT} = \frac{\underline{R_{it}} + 1}{sd(R_{it})} \qquad (A.8)$$

Tables

Table 1: Risk measures

Variable	*Formula*	*Description*	*References*
DD	$DD_{iT} = \frac{log\left(\frac{V_{it}}{L_{it}}\right) + \left(\mu_A - \frac{1}{2}\sigma^2{}_A\right)T}{\sigma_A\sqrt{T}}$	Merton's distance to Default is defined by the number of the standard deviations that the value of the firm is from the default point.	Hsu and Chen (2015); Rizwan et al. (2017); Kabir et al. (2021)
Z-score	$Z_{iT} = \frac{\overline{R_{it}} + 1}{sd(R_{it})}$	It expresses the distance at which corporate values fall into debt levels.	
Asyn	$Asyn_{iT} = ln\left(\frac{1 - R_{it}^2}{R_{it}^2}\right)$	It measures the lack of synchronicity of stocks of a share market in a particular period of time	
Alpha	$\alpha_t = R_{it} - \beta_{iT}R_{Mt}$	It is the excess return on the risky security in relation to the market as a whole.	
Beta	$\beta_{iT} = \frac{Cov(R_{it}, R_{Mt})}{Var(R_{Mt})}$	It measures the expected change in the return of an individual risky asset following changes in the market return.	Albuquerque at al. (2019); Monti et al. (2022); Sassen at al (2016); Viviani et al. (2019); Jo & Na (2012)
IDS	$IDS_{iT} = sd(\varepsilon_{it})$	Idiosyncratic risk represents the factors that affect individually each stock or firm.	Sassen et al. (2016); Bannier et al. (2019); Viviani et al. (2019); Monti et al. (2022).
SD	$SD_{iT} = sd(R_{it})$	Total risk represents the whole set of risks factors that affect an organization, internal and external.	Sassen et al. (2016); Bannier et al. (2019); Jo & Na (2012); Monti et al. (2022).

Table 2: ESG variables and control variables

Variable	*Formula*	*Description*	*References*
Panel A: ESG			
ESG combined score	ESG Combined Score = (W_S * Social Pillar Score +W_G* Government Pillar Score + W_E *Environmental Pillar Score) * ESG Controversial Score Adjustment	It is the weighted average score of a company based on the reported information for the three categories that compounds the indicator.	Maxfield & Wang (2021); Bannier et al. (2019)
Environmental score	E = W*Resource use + W*Emissions + W*Innovation	It is the weighted average score of a company based on the reported information for three environmental categories.	Bannier et al. (2019)
Social score	S = W*Workforce + W*human rights + W*Community + W*Product Responsibility	It is the weighted average score of a company based on the reported social information for four social categories.	Bannier et al. (2019)
Governance score	G = W*Management + W*Shareholders + W*CSR strategy	It is the weighted average score of a company based on the reported information for three governance categories.	Bannier et al. (2019)
Panel B: Control			
Size	$\text{Size} = \log(Total\ Assets_{iT})$	The size of the firm	Maxfield & Wang (2021); Bannier et al. (2019)
MTB	$\text{MTB} = \frac{Market\ capitalization_{iT}}{Total\ equity_{iT}}$	Market to book ratio compares the firm's book value to its market value.	Maxfield & Wang (2021)
ROA	$\text{ROA} = \log\left(\frac{Net\ Income_{iT}}{Total\ Assets_{iT}}\right)$	Return on assets ratio measures the profitability of a business in relation to its total assets.	Maxfield & Wang (2021)
Lev	$\text{Lev} = \frac{Total\ Debt_{iT}}{Total\ Assets_{iT}}$	Leverage ratio indicates how the company's assets and business operations are financed (using debt or equity).	Maxfield & Wang (2021); Bannier et al. (2019)
Liq	$\text{Liq} = \frac{Total\ shares\ traded_{iT}}{Total\ shares\ outstanding_{iT}}$	Stock market liquidity represents the percentage of a stock that has been replaced in a given year.	Maxfield & Wang (2021)

Table 3: Descriptive statistics of the risk measures

	N obs.	*Mean*	*St.D.*	*Min*	*Max*	*Skew*	*Kurt*
Panel 1. Total Sample (490 firms)							
DD	10,780	-6.218	2.396	-12.458	0.725	0.940	1.113
Z-score	9,879	58.917	23.430	6.182	232.670	0.580	0.505
Asyn	9,751	0.881	1.166	-1.793	13.829	2.317	12.479
Alpha	9,751	0.007	0.110	-0.870	0.922	0.367	6.750
Beta	9,751	1.034	0.429	-0.500	3.479	0.721	1.840
IDS	9,751	1.633	0.863	0.032	9.982	2.676	12.316
SD	9,880	0.020	0.011	0.000	0.163	2.452	13.568
Panel 2. US (246 US firms)							
DD	5,413	-5.960	2.150	-12.020	-0.350	1.126	1.679
Z-score	5,016	60.714	101.082	9.099	167.750	0.515	0.038
Asyn	4,959	0.905	1.144	-1.538	12.790	2.159	11.257
Alpha	4,959	0.010	0.120	-0.870	0.920	0.655	7.900
Beta	4,959	1.061	0.458	-0.500	3.479	0.825	1.937
IDS	4,959	1.643	0.967	0.479	9.854	2.688	11.101
SD	5,016	0.020	0.012	0.000	0.108	2.762	15.248
Panel 3. Europe (244 firms)							
DD	5,367	-6.483	2.590	-12.458	0.725	0.936	0.803
Z-score	4,863	57.060	21.014	6.182	232.668	0.570	1.057
Asyn	4,792	0.855	1.189	-1.793	13.829	2.466	15.584
Alpha	4,792	0.003	0.102	-0.810	0.690	-0.128	4.051
Beta	4,792	1.006	0.395	-0.304	3.216	0.477	1.181
IDS	4,792	1.622	0.742	0.032	9.982	2.403	11.971
SD	4,864	0.020	0.009	0.000	0.163	2.080	11.140

This table reports the descriptive statistics of risk measures at firm level for an unbalanced panel of 490 firms and a period of 21 years (2000-2021). It contains three different panels. The first one is for the total sample. The other two for each of the subsambles (US and Europe). DD is the Merton' s distance to default. Z-score is the insolvency risk. Asyn is the asynchronicity of returns with the market. Alpha is the risk-adjusted return. Beta is the systematic risk. IDS is the idiosyncratic risk. SD is the total risk. Variables are measured using yearly basis.

Table 4 Descriptive statistics of Returns, ESG scores and control variables

	N obs.	*Mean*	*St.D.*	*Min*	*Max*	*Skew*	*Kurt*
Panel 1. Total Sample (490 firms)							
R	9,879	-0.030	2.296	-127.567	81.793	-0.598	38.200
ESG	7,590	55.689	18.197	3.030	93.810	-0.300	-0.572
E	7,141	61.745	23.671	0.360	99.070	-0.647	-0.477
S	7,589	62.562	21.883	0.260	98.630	-0.518	-0.572
G	7,590	60.012	21.092	0.840	99.330	-0.422	-0.636
Size	9,829	16.630	1.854	9.382	22.043	0.186	0.163
MTB	9,776	3.080	37.888	-1376.620	1530.070	-8.703	808.475
ROA	9,630	6.922	8.092	-116.690	69.320	-0.819	17.414
Lev	9,729	25.878	18.273	0.000	269.790	1.849	14.282
Liq	9,209	1.036	1.634	0.004	63.407	16.900	401.982
Panel 2. US (246 US firms)							
R	5,016	-0.026	2.347	-93.688	81.793	-0.513	36.374
RM	5,016	-0.041	0.119	-0.324	0.097	-0.916	-0.203
ESG	3,837	51.631	18.152	4.180	92.520	-0.130	-0.695
E	3,479	56.447	24.033	0.360	98.550	-0.445	-0.800
S	3,837	58.757	21.592	0.260	98.000	-0.347	-0.678
G	3,837	58.297	21.322	0.840	99.100	-0.360	-0.707
Size	4,986	16.605	1.722	9.955	22.043	0.074	0.528
MTB	5,006	3.468	49.604	-1376.620	1530.070	-6.560	502.717
ROA	4,919	7.613	8.941	-116.690	63.050	-1.596	19.451
Lev	4,956	25.799	18.280	0.000	255.960	1.689	12.228
Liq	4,691	0.983	1.055	0.005	20.063	13.334	215.792
Panel 3. Europe (244 firms)							
R	4,863	-0.038	2.249	-127.567	78.059	-0.670	39.724
RM	4,863	-0.053	0.140	-0.476	0.093	-1.626	2.822
ESG	3,753	59.838	17.288	3.030	93.810	-0.482	-0.241
E	3,662	66.778	22.182	0.570	99.070	-0.876	0.088
S	3,752	66.454	21.493	2.430	98.630	-0.742	-0.249
G	3,753	61.765	20.711	4.170	99.330	-0.485	-0.544
Size	4,843	16.655	1.980	9.382	21.866	0.325	-0.156
MTB	4,770	2.673	18.968	-946.120	670.820	-19.434	1672.297
ROA	4,711	6.201	7.027	-54.440	69.320	0.682	10.452
Lev	4,773	25.961	18.268	0.000	269.790	2.020	16.430
Liq	4,518	1.092	2.070	0.004	63.407	15.075	301.474

This table reports the descriptive statistics of returns and control variables at the firm level for an unbalanced panel of 490 firms and a period of 21 years (2000-2021). It contains three different panels. The first is for the total sample. The other two are for US and Europe, respectively. The variables in the table are defined as follows: R is the risk premium of the assets, defined as returns of firms minus the risk-free rate. RM is the risk premium of the market (TOTMKUS and TOTMEU, respectively) defined as returns of the market minus the risk-free rate. 3 moth US daily Treasury bill rate and the 3-month BD Fibor are the risk-free rate for US and Europe, respectively. ESG is the annual Thomson Reuters Combined ESG score. E, S, and G are the environmental, social, and governance scores, respectively. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Liq is the turnover ratio calculated as the total number of shares during the year over the total number of shares outstanding. Variables are measured using yearly basis.

Table 5: Impact of ESG practices on Risks

	DD	*Z-score*	*Asyn*	*Alpha*	*Beta*	*IDS*	*SD*
ESG	0.048***	0.023***	-0.027*	0.045**	-0.033**	-0.086***	-0.067***
	(0.004)	(0.005)	(0.012)	(0.014)	(0.011)	(0.013)	(0.014)
Size	-0.099***	0.016	0.029	-0.535***	0.072+	-0.076+	-0.051
	(0.013)	(0.016)	(0.043)	(0.050)	(0.037)	(0.045)	(0.049)
MTB	0.004	0.004	0.002	0.018+	0.003	-0.006	-0.006
	(0.002)	(0.003)	(0.008)	(0.009)	(0.007)	(0.008)	(0.009)
ROA	0.048***	0.008+	-0.039**	-0.107***	-0.070***	-0.052***	-0.028+
	(0.004)	(0.005)	(0.013)	(0.015)	(0.011)	(0.013)	(0.015)
Lev	-0.085***	-0.017**	0.065***	0.046*	0.054***	0.127***	0.116***
	(0.005)	(0.007)	(0.018)	(0.021)	(0.015)	(0.018)	(0.020)
Liq	-0.001	-0.006	-0.003	-0.021	0.025*	0.060***	0.059***
	(0.004)	(0.005)	(0.013)	(0.015)	(0.011)	(0.013)	(0.014)
Model	FE	FE	FE	FE	FE	FE	FE
Num.Obs.	7147	7147	7143	7143	7143	7143	7147
R2	0.098	0.008	0.005	0.025	0.012	0.023	0.013
AIC	-2463.3	1067.3	15072.3	17264.5	12853.9	15625.1	16940.2

This table reports the panel regression results regarding the impact of the combined ESG score on risk measures at the firm level for an unbalanced panel of 490 firms and a period of 490 firms and a period of 21 years (2000-2021). All variables have been standardized using annual data, with independent variables lagged by one year. DD is the Merton's distance-to-default, Z-score the insolvency risk, Asyn the asyncronicity risk. Alpha is the risk-adjusted excess return. Beta and IDS are the systematic and idiosyncratic risks, estimated form the CAPM; SD is the total risk. ESG is the annual Thomson Reuters Combined ESG score. Size is the size of the firms. MTB is the Market-to-book ratio. ROA is the return on assets ratio. Lev is the leverage ratio. Liq is the turnover ratio. The model, Pooled (P), Fixed Effects (FE) or Random Efffects (RE), is selected according to the result of the Breusch-Pagan and the Hausman tests. Robust standard errors in paranthesis are computed by using the variance covariance matrix HC3, a hererocedasticity-consistent (HC) class estimator. +, *, **, *** denote significance at the 10, 5, 1 and 0.1%, respectively.

Table 6: Impact of Environmental practices on Risks

	DD	*Z-score*	*Asyn*	*Alpha*	*Beta*	*IDS*	*SD*
E	0.029***	0.019***	-0.042**	0.076***	-0.046***	-0.103***	-0.072***
	(0.004)	(0.005)	(0.014)	(0.016)	(0.012)	(0.014)	(0.016)
Size	-0.027+	0.009	0.208***	-0.584***	0.163***	0.025	-0.02
	(0.014)	(0.019)	(0.049)	(0.057)	(0.042)	(0.052)	(0.057)
MTB	0.003	0.004	0.003	0.017+	0.003	-0.007	-0.007
	(0.002)	(0.003)	(0.008)	(0.009)	(0.007)	(0.008)	(0.009)
ROA	0.053***	0.005	-0.040**	-0.108***	-0.071***	-0.038**	-0.014
	(0.004)	(0.005)	(0.014)	(0.016)	(0.012)	(0.015)	(0.016)
Lev	-0.075***	-0.018*	0.070***	0.037+	0.065***	0.136***	0.124***
	(0.005)	(0.007)	(0.019)	(0.022)	(0.016)	(0.020)	(0.022)
Liq	-0.003	-0.008+	-0.003	-0.018	0.026*	0.063***	0.064***
	(0.004)	(0.005)	(0.013)	(0.015)	(0.011)	(0.013)	(0.015)
Model	FE	FE	FE	FE	FE	FE	FE
Num.Obs.	6712	6712	6708	6708	6708	6708	6712
R2	0.071	0.005	0.008	0.022	0.016	0.023	0.013
AIC	-2455.7	1115.2	14035	15982.9	11863.9	14638.8	15973.2

This table reports the panel regression results regarding the impact of the E score on risk measures at the firm level for an unbalanced panel of 490 firms and a period of 21 years (2000-2021). All variables have been standardized using annual data, with independent variables lagged by one year. DD is the Merton's distance-to-default, Z-score is the insolvency risk, Asyn is the asyncronicity risk. Alpha is the risk-adjusted excess return. Beta and IDS are the systematic and the idiosyncratic risks respectively, estimated from the CAPM; SD is the total risk. E is the annual Thomson Reuters Environmental score. Size is the size of the firm. MTB is the Market-to-book ratio. ROA is the return on assets ratio. Lev is the leverage ratio. Liq is the turnover ratio. The model, Pooled (P), Fixed Effects (FE) or Random Effects (RE), is selected according to the results of the Breusch-Pagan and the Hausman tests. Robust standard errors in parenthesis are computed by using the variance covariance matrix HC3, a hererocedasticity-consistent (HC) class estimator. +, *, **, *** denote significance at the 10, 5, 1, and 0.1%, respectively.

Table 7: Impact of Social practices on Risks

	DD	*Z-score*	*Asyn*	*Alpha*	*Beta*	*IDS*	*SD*
S	0.045***	0.010+	-0.021	0.060***	-0.044***	-0.051***	-0.033*
	(0.004)	(0.005)	(0.014)	(0.016)	(0.012)	(0.014)	(0.015)
Size	-0.100***	0.037*	0.021	-0.570***	0.096*	-0.126**	-0.103*
	(0.013)	(0.017)	(0.045)	(0.053)	(0.039)	(0.047)	(0.052)
MTB	0.003	0.004	0.002	0.018+	0.003	-0.006	-0.006
	(0.002)	(0.003)	(0.008)	(0.009)	(0.007)	(0.008)	(0.009)
ROA	0.049***	0.010*	-0.040**	-0.108***	-0.069***	-0.057***	-0.033*
	(0.004)	(0.005)	(0.013)	(0.015)	(0.011)	(0.013)	(0.015)
Lev	-0.085***	-0.016*	0.064***	0.045*	0.055***	0.124***	0.113***
	(0.005)	(0.007)	(0.018)	(0.021)	(0.015)	(0.019)	(0.020)
Liq	-0.002	-0.007	-0.003	-0.02	0.025*	0.062***	0.062***
	(0.004)	(0.005)	(0.013)	(0.015)	(0.011)	(0.013)	(0.014)
Model	FE	FE	FE	FE	FE	FE	FE
Num.Obs.	7147	7147	7143	7143	7143	7143	7147
R2	0.091	0.005	0.004	0.025	0.013	0.019	0.011
AIC	-2410.7	1089	15074.9	17259.4	12849.1	15658.5	16959.5

This table reports the panel regression results regarding the impact of the S score on risk measures at the firm level for an unbalanced panel of 490 firms and a period of 21 years (2000-2021). All variables have been standardized using annual data, with independent variables lagged by one year. DD is Merton's distance-to-default, Z-score the insolvency risk, Asyn is the asynchronicity risk. Alpha is the risk- adjusted excess return. Beta and IDS are the systematic and the idiosyncratic risks estimated from the CAPM; SD is the total risk. S is the annual Thomson Reuters Social score. Size is the size of the firm. MTB is the Market-to-book ratio. ROA is the return on assets ratio. Lev is the leverage ratio. Liq is the turnover ratio. The model, Pooled (P), Fixed Effects (FE), or Random Effects (RE), is selected according to the resutls of the Breusch-Pagan and the Hausman tests. Robust standard errors in parenthesis are computed by using the variance covariance matrix HC3, a hererocedasticity-consistent (HC) class estimator. +, *, **, *** denote significance at the 10, 5, 1 and 0.1%, respectively.

Table 8: Impact of Governance practices on Risks

	DD	*Z-score*	*Asyn*	*Alpha*	*Beta*	*IDS*	*SD*
G	0.022***	0.018***	0.003	0.027+	-0.016	-0.061***	-0.060***
	(0.004)	(0.005)	(0.012)	(0.014)	(0.011)	(0.013)	(0.014)
Size	-0.039***	0.037*	-0.02	-0.486***	0.032	-0.161***	-0.105*
	(0.012)	(0.015)	(0.040)	(0.046)	(0.034)	(0.041)	(0.045)
MTB	0.004	0.004	0.002	0.018+	0.003	-0.006	-0.006
	(0.002)	(0.003)	(0.008)	(0.009)	(0.007)	(0.008)	(0.009)
ROA	0.054***	0.010*	-0.042***	-0.102***	-0.074***	-0.061***	-0.035*
	(0.004)	(0.005)	(0.013)	(0.015)	(0.011)	(0.013)	(0.014)
Lev	-0.083***	-0.017*	0.062***	0.048*	0.053***	0.124***	0.115***
	(0.005)	(0.007)	(0.018)	(0.021)	(0.015)	(0.019)	(0.020)
Liq	-0.003	-0.007	-0.001	-0.023	0.027*	0.063***	0.062***
	(0.004)	(0.005)	(0.013)	(0.015)	(0.011)	(0.013)	(0.014)
Model	FE	FE	FE	FE	FE	FE	FE
Num.Obs.	7147	7147	7143	7143	7143	7143	7147
R2	0.079	0.006	0.004	0.024	0.011	0.02	0.013
AIC	-2314.9	1076.1	15077.4	17271.3	12861.9	15648.4	16944.5

This table reports the panel regression results regarding the impact of the G score on risk measures at the firm level for an unbalanced panel of 490 firms and a period of 21 years (2000-2021). All variables have been standardized using annual data, with independent variables lagged by one year. DD is Merton's distance-to-default, Z-score the insolvency risk, Asyn is the asynchronicity risk. Alpha is the risk- adjusted excess return. Beta and IDS are the systematic and the idiosyncratic risks estimated from the CAPM; SD is the total risk. G is the annual Thomson Reuters Governance score. Size is the size of the firm. MTB is the Market-to-book ratio. ROA is the return on assets ratio. Lev is the leverage ratio. Liq is the turnover ratio. The model, Pooled (P), Fixed Effects (FE), or Random Effects (RE), is selected according to the resutls of the Breusch-Pagan and the Hausman tests. Robust standard errors in parenthesis are computed by using the variance covariance matrix HC3, a hererocedasticity-consistent (HC) class estimator. +, *, **, *** denote significance at the 10, 5, 1 and 0.1%, respectively.

Table 9: Impact of ESG practices on risks by subsample

	DD	*Z-score*	*Asyn*	*Alpha*	*Beta*	*IDS*	*SD*
				Panel 1. US			
ESG	0.037***	0.014*	0.014	0.024	-0.056***	-0.052**	-0.042*
	(0.005)	(0.007)	(0.018)	(0.020)	(0.015)	(0.019)	(0.020)
Size	-0.137***	0.040+	0.058	-0.490***	-0.091+	-0.208***	-0.165*
	(0.015)	(0.022)	(0.060)	(0.065)	(0.050)	(0.062)	(0.067)
MTB	0.004	0.004	0.004	0.022*	0.005	-0.007	-0.007
	(0.002)	(0.003)	(0.009)	(0.010)	(0.008)	(0.010)	(0.010)
ROA	0.056***	0.013*	-0.046**	-0.076***	-0.062***	-0.073***	-0.046*
	(0.004)	(0.006)	(0.017)	(0.019)	(0.014)	(0.018)	(0.020)
Lev	-0.065***	0.000	0.072**	0.066*	0.072***	0.080**	0.069**
	(0.006)	(0.009)	(0.024)	(0.026)	(0.020)	(0.024)	(0.026)
Liq	-0.002	-0.021*	0.004	-0.138***	0.063**	0.213***	0.197***
	(0.007)	(0.010)	(0.028)	(0.030)	(0.023)	(0.028)	(0.031)
Model	FE	FE	FE	FE	FE	FE	FE
Num.Obs.	3662	3662	3660	3660	3660	3660	3662
R2	0.122	0.007	0.007	0.032	0.019	0.032	0.019
AIC	-1955.2	850.3	8230.5	8830.7	6883.6	8438.3	9090.1
				Panel 2. Europe			
ESG	0.054***	0.030***	-0.076***	0.065**	-0.014	-0.118***	-0.089***
	(0.006)	(0.007)	(0.017)	(0.021)	(0.015)	(0.018)	(0.019)
Main Economy	-0.168***	0.138***	0.141*	0.229*	-0.218***	-0.327***	-0.429***
	(0.024)	(0.027)	(0.071)	(0.090)	(0.063)	(0.074)	(0.081)
Size	-0.064**	0.008	-0.003	-0.531***	0.278***	0.019	0.008
	(0.022)	(0.025)	(0.063)	(0.080)	(0.056)	(0.066)	(0.073)
MTB	0.007	0.006	-0.008	0.001	-0.005	-0.01	-0.01
	(0.007)	(0.008)	(0.020)	(0.025)	(0.018)	(0.021)	(0.023)
ROA	0.036***	-0.005	-0.044*	-0.159***	-0.070***	-0.006	0.015
	(0.007)	(0.007)	(0.019)	(0.024)	(0.017)	(0.020)	(0.022)
Lev	-0.122***	-0.050***	0.02	0.01	0.044+	0.214***	0.205***
	(0.010)	(0.011)	(0.029)	(0.037)	(0.025)	(0.030)	(0.033)
Liq	0.000	-0.002	-0.009	0.015	0.017	0.012	0.018
	(0.005)	(0.005)	(0.013)	(0.017)	(0.012)	(0.014)	(0.015)
Model	FE	FE	RE	FE	FE	FE	FE
Num.Obs.	3485	3485	3483	3483	3483	3483	3485
R2	0.107	0.023	0.012	0.027	0.027	0.041	0.03
AIC	-714.1	153.2	6737.5	8411.3	5877.8	7041.9	7728.1

This table reports the panel regression results regarding the impact of the ESG score on risk measures at the firm level for an unbalanced panel of 490 firms and a period of 21 years (2000-2021). Panel 1 corresponds to the US sample and Panel 2 corresponds to the European sample. All variables have been standardized using annual data, with independent variables lagged by one year. DD is Merton's distance-to-default, Z-score the insolvency risk, Asyn is the asynchronicity risk. Alpha is the risk-adjusted excess return. Beta and IDS are the systematic and the idiosyncratic risks estimated from the CAPM; SD is the total risk. ESG is the annual Thomson Reuters Combined ESG score. Main Economy is a dummy that takes value 1 for firms from the biggest economies of Europe, and 0 otherwise. Size is the size of the firm. MTB is the Market-to-book ratio. ROA is the return on assets ratio. Lev is the leverage ratio. Liq is the turnover ratio. The model, Pooled (P), Fixed Effects (FE) or Random Effects (RE), is selected according to the results of Breusch-Pagan and the Hausman tests. Robust standard errors in parenthesis are computed by using the variance covariance matrix HC3, a hererocedasticity-consistent (HC) class estimator. +, *,**, *** denote 10, 5, 1 and 0.1%, significance at the respectively.

Table 10: Impact of Environmental practices on risks by subsample

	DD	*Z-score*	*Asyn*	*Alpha*	*Beta*	*IDS*	*SD*
				Panel 1.US			
E	0.028***	0.028***	-0.015	0.034	-0.047**	-0.099***	-0.082***
	(0.005)	(0.008)	(0.021)	(0.022)	(0.017)	(0.021)	(0.024)
Size	-0.076***	-0.003	0.304***	-0.456***	-0.057	-0.031	-0.056
	(0.017)	(0.028)	(0.075)	(0.079)	(0.061)	(0.076)	(0.084)
MTB	0.003	0.004	0.003	0.022*	0.005	-0.008	-0.008
	(0.002)	(0.003)	(0.010)	(0.010)	(0.008)	(0.010)	(0.011)
ROA	0.061***	0.008	-0.052*	-0.069**	-0.073***	-0.054*	-0.023
	(0.005)	(0.008)	(0.021)	(0.021)	(0.017)	(0.021)	(0.023)
Lev	-0.051***	-0.001	0.101***	0.047+	0.075***	0.089***	0.072*
	(0.006)	(0.009)	(0.025)	(0.026)	(0.021)	(0.026)	(0.028)
Liq	-0.004	-0.020+	0.003	-0.130***	0.066**	0.212***	0.195***
	(0.007)	(0.010)	(0.028)	(0.029)	(0.023)	(0.029)	(0.032)
Model	FE	FE	FE	FE	FE	FE	FE
Num.Obs.	3314	3314	3312	3312	3312	3312	3314
R2	0.093	0.008	0.016	0.024	0.017	0.033	0.02
AIC	-2154.4	858.4	7531.4	7795.4	6128.6	7614.4	8276.5
				Panel 2.Europe			
E	0.026***	0.006	-0.079***	0.117***	-0.042**	-0.097***	-0.052*
	(0.006)	(0.007)	(0.018)	(0.023)	(0.016)	(0.019)	(0.021)
Main Economy	-0.168***	0.134***	0.158*	0.226*	-0.200**	-0.305***	-0.418***
	(0.025)	(0.028)	(0.069)	(0.090)	(0.062)	(0.075)	(0.082)
Size	0.006	0.053*	0.137*	-0.648***	0.360***	-0.021	-0.102
	(0.023)	(0.026)	(0.065)	(0.085)	(0.059)	(0.070)	(0.078)
MTB	0.006	0.007	0.000	-0.010	-0.006	-0.009	-0.012
	(0.007)	(0.008)	(0.020)	(0.026)	(0.018)	(0.021)	(0.024)
ROA	0.039***	-0.006	-0.042*	-0.153***	-0.064***	-0.003	0.017
	(0.007)	(0.008)	(0.019)	(0.025)	(0.017)	(0.021)	(0.023)
Lev	-0.126***	-0.054***	-0.004	0.027	0.053*	0.230***	0.228***
	(0.010)	(0.012)	(0.029)	(0.038)	(0.026)	(0.032)	(0.035)
Liq	-0.002	-0.006	-0.008	0.019	0.016	0.018	0.024
	(0.005)	(0.005)	(0.013)	(0.017)	(0.012)	(0.014)	(0.016)
Model	FE	FE	FE	FE	FE	FE	FE
Num.Obs.	3398	3398	3396	3396	3396	3396	3398
R2	0.084	0.016	0.01	0.033	0.031	0.035	0.027
AIC	-593.4	193.4	6345.7	8160.1	5668.2	6907	7585.3

This table reports the panel regression results regarding the impact of the E score on risk measures at the firm level for an unbalanced panel of 490 firms and a period of 21 years (2000-2021). Panel 1 corresponds to the US sample and Panel 2 corresponds to the European sample. All variables have been standardized using annual data, with independent variables lagged by one year. DD is Merton's distance-to-default, Z-score the insolvency risk, Asyn is the asynchronicity risk. Alpha is the risk-adjusted excess return. Beta and IDS are the systematic and the idiosyncratic risks estimated from the CAPM; SD is the total risk. E is the annual Thomson Reuters Environmental score. Main Economy is a dummy that takes value 1 for firms from the biggest economies of Europe, and 0 otherwise. Size is the size of the firm. MTB is the Market-to-book ratio. ROA is the return on assets ratio. Lev is the leverage ratio. Liq is the turnover ratio. The model, Pooled (P), Fixed Effects (FE) or Random Effects (RE), is selected according to the results of Breusch-Pagan and the Hausman tests. Robust standard errors in parenthesis are computed by using the variance covariance matrix HC3, a hererocedasticity-consistent (HC) class estimator. +, *, **,*** denote 10, 5, 1 and 0.1%, significance at the respectively.

Table 11: Impact of Social practices on risks by subsample

	DD	*Z-score*	*Asyn*	*Alpha*	*Beta*	*IDS*	*SD*
				Panel 1.US			
S	0.032***	-0.017*	-0.02	0.043+	-0.030+	0.03	0.056*
	(0.005)	(0.008)	(0.021)	(0.023)	(0.017)	(0.021)	(0.023)
Size	-0.134***	0.091***	0.114+	-0.526***	-0.128*	-0.339***	-0.326***
	(0.016)	(0.023)	(0.064)	(0.069)	(0.053)	(0.066)	(0.072)
MTB	0.003	0.004	0.004	0.022*	0.005	-0.007	-0.007
	(0.002)	(0.003)	(0.009)	(0.010)	(0.008)	(0.010)	(0.010)
ROA	0.058***	0.018**	-0.041*	-0.078***	-0.066***	-0.084***	-0.059**
	(0.004)	(0.006)	(0.017)	(0.019)	(0.014)	(0.018)	(0.019)
Lev	-0.063***	0.006	0.078***	0.063*	0.067***	0.065**	0.051+
	(0.006)	(0.009)	(0.024)	(0.026)	(0.020)	(0.024)	(0.026)
Liq	-0.003	-0.023*	0.002	-0.137***	0.065**	0.219***	0.203***
	(0.007)	(0.010)	(0.028)	(0.030)	(0.023)	(0.029)	(0.031)
Model	FE	FE	FE	FE	FE	FE	FE
Num.Obs.	3662	3662	3660	3660	3660	3660	3662
R2	0.115	0.008	0.007	0.033	0.016	0.03	0.019
AIC	-1924.3	849.6	8230.1	8828.5	6895.4	8444.5	9088.5
				Panel 2.Europe			
S	0.050***	0.034***	-0.02	0.074***	-0.068***	-0.123***	-0.115***
	(0.006)	(0.007)	(0.018)	(0.022)	(0.015)	(0.018)	(0.020)
Main Economy	-0.166***	0.141***	0.147*	0.233**	-0.228***	-0.332***	-0.438***
	(0.024)	(0.027)	(0.071)	(0.090)	(0.062)	(0.074)	(0.081)
Size	-0.063**	-0.003	-0.101	-0.559***	0.386***	0.048	0.073
	(0.022)	(0.025)	(0.065)	(0.083)	(0.058)	(0.068)	(0.075)
MTB	0.006	0.006	-0.007	0.001	-0.006	-0.01	-0.011
	(0.007)	(0.008)	(0.020)	(0.025)	(0.017)	(0.021)	(0.023)
ROA	0.036***	-0.006	-0.048*	-0.160***	-0.066***	-0.005	0.018
	(0.007)	(0.007)	(0.019)	(0.024)	(0.017)	(0.020)	(0.022)
Lev	-0.124***	-0.050***	0.028	0.009	0.039	0.217***	0.205***
	(0.010)	(0.011)	(0.029)	(0.037)	(0.025)	(0.030)	(0.033)
Liq	0.000	-0.003	-0.006	0.015	0.015	0.013	0.018
	(0.005)	(0.005)	(0.013)	(0.017)	(0.012)	(0.014)	(0.015)
Model	FE	FE	FE	FE	FE	FE	FE
Num.Obs.	3485	3485	3483	3483	3483	3483	3485
R2	0.102	0.024	0.007	0.028	0.033	0.041	0.033
AIC	-691.9	150	6757.8	8409.3	5858	7041.4	7715.8

This table reports the panel regression results regarding the impact of the S score on risk measures at the firm level for an unbalanced panel of 490 firms and a period of 21 years (2000-2021). Panel 1 corresponds to the US sample and Panel 2 corresponds to the European sample.All variables have been standardized using annual data, with independent variables lagged by one year. DD is Merton's distance-to-default, Z-score the insolvency risk, Asyn is the asynchronicity risk. Alpha is the risk-adjusted excess return. Beta and IDS are the systematic and the idiosyncratic risks estimated from the CAPM; SD is the total risk. S is the annual Thomson Reuters Combined Ssocial score. Main Economy is a dummy that takes value 1 for firms from the biggest economies of Europe, and 0 otherwise. Size is the size of the firm. MTB is the Market-to-book ratio. ROA is the return on assets ratio. Lev is the leverage ratio. Liq is the turnover ratio. The model, Pooled (P), Fixed Effects (FE) or Random Effects (RE), is selected according to the results of Breusch-Pagan and the Hausman tests. Robust standard errors in parenthesis are computed by using the variance covariance matrix HC3, a hererocedasticity-consistent (HC) class estimator. +, *, **, *** denote 10, 5, 1 and 0.1%, significance at the respectively.

Table 12: Impact of Governance practices on risks by subsample

	DD	*Z-score*	*Asyn*	*Alpha*	*Beta*	*IDS*	*SD*
				Panel 1.US			
G	0.013**	0.023***	-0.008	0.038*	-0.021	-0.073***	-0.075***
	(0.004)	(0.006)	(0.017)	(0.019)	(0.014)	(0.018)	(0.019)
Size	-0.090***	0.042*	0.086	-0.485***	-0.160***	-0.226***	-0.166**
	(0.014)	(0.020)	(0.055)	(0.060)	(0.046)	(0.056)	(0.062)
MTB	0.004	0.004	0.004	0.022*	0.005	-0.007	-0.007
	(0.002)	(0.003)	(0.009)	(0.010)	(0.008)	(0.010)	(0.010)
ROA	0.061***	0.014*	-0.043*	-0.074***	-0.069***	-0.077***	-0.048*
	(0.004)	(0.006)	(0.017)	(0.019)	(0.014)	(0.018)	(0.019)
Lev	-0.060***	0.000	0.076**	0.064*	0.065***	0.081***	0.072**
	(0.006)	(0.009)	(0.023)	(0.025)	(0.020)	(0.024)	(0.026)
Liq	-0.003	-0.019+	0.002	-0.135***	0.064**	0.208***	0.190***
	(0.007)	(0.010)	(0.028)	(0.030)	(0.023)	(0.029)	(0.031)
Model	FE	FE	FE	FE	FE	FE	FE
Num.Obs.	3662	3662	3660	3660	3660	3660	3662
R2	0.107	0.01	0.007	0.033	0.016	0.034	0.022
AIC	-1892.9	841.4	8230.9	8828	6896.2	8428.8	9079
				Panel 2.Europe			
G	0.023***	0.012+	0.024	0.005	-0.02	-0.036+	-0.036+
	(0.006)	(0.007)	(0.018)	(0.022)	(0.015)	(0.018)	(0.020)
Main Economy	-0.164***	0.140***	0.161*	0.222*	-0.225***	-0.327***	-0.434***
	(0.025)	(0.028)	(0.071)	(0.091)	(0.063)	(0.075)	(0.082)
Size	0.01	0.050*	-0.166**	-0.419***	0.274***	-0.157*	-0.114+
	(0.020)	(0.023)	(0.059)	(0.074)	(0.052)	(0.061)	(0.068)
MTB	0.005	0.005	-0.007	-0.001	-0.005	-0.006	-0.008
	(0.007)	(0.008)	(0.020)	(0.025)	(0.018)	(0.021)	(0.023)
ROA	0.040***	-0.003	-0.049*	-0.155***	-0.071***	-0.015	0.009
	(0.007)	(0.007)	(0.019)	(0.024)	(0.017)	(0.020)	(0.022)
Lev	-0.127***	-0.053***	0.033	0.002	0.044+	0.227***	0.213***
	(0.010)	(0.011)	(0.029)	(0.037)	(0.025)	(0.030)	(0.033)
Liq	-0.003	-0.004	-0.004	0.011	0.018	0.02	0.024
	(0.005)	(0.005)	(0.013)	(0.017)	(0.012)	(0.014)	(0.015)
Model	FE	FE	FE	FE	FE	FE	FE
Num.Obs.	3485	3485	3483	3483	3483	3483	3485
R2	0.074	0.009	0.017	0.023	0.023	0.023	0.016
AIC	-590	198.4	7008.9	8425.5	5888.7	7104.3	7775.4

This table reports the panel regression results regarding the impact of the G score on risk measures at the firm level for an unbalanced panel of 490 firms and a period of 21 years (2000-2021). Panel 1 corresponds to the US sample and Panel 2 corresponds to the European sample. All variables have been standardized using annual data, with independent variables lagged by one year. DD is Merton's distance-to-default, Z-score the insolvency risk, Asyn is the asynchronicity risk. Alpha is the risk-adjusted excess return. Beta and IDS are the systematic and the idiosyncratic risks estimated from the CAPM; SD is the total risk. G is the annual Thomson Reuters Governance score. Main Economy is a dummy that takes value 1 for firms from the biggest economies of Europe, and 0 otherwise. Size is the size of the firm. MTB is the Market-to-book ratio. ROA is the return on assets ratio. Lev is the leverage ratio. Liq is the turnover ratio. The model, Pooled (P), Fixed Effects (FE) or Random Effects (RE), is selected according to the results of Breusch-Pagan and the Hausman tests. Robust standard errors in parenthesis are computed by using the variance covariance matrix HC3, a hererocedasticity-consistent (HC) class estimator. +, *, **, *** denote 10, 5, 1 and 0.1%, significance at the respectively.

Table 13: Endogeneity

	DD	Z-score	Asyn	Alpha	beta	IDS	SD
Panel 1: ESG score							
ESG	0.027***	0.008*	-0.057***	0.002	-0.004	-0.043***	-0.021+
	(0.004)	(0.003)	(0.011)	(0.017)	(0.012)	(0.013)	(0.012)
First stage	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Wu-Hausman	[0.400]	[0.301]	[0.004]	[0.092]	[0.059]	[0.643]	[0.697]
Panel 2: E score							
E	0.01*	0.008+	-0.038	0.023	-0.027+	-0.046**	-0.025+
	(0.004)	(0.004)	(0.014)	(0.021)	(0.020)	(0.016)	(0.015)
First stage	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Wu-Hausman	[0.973]	[0.731]	[0.462]	[0.180]	[0.955]	[0.801]	[0.516]
Panel 3: S score							
S	0.111***	-0.002	-0.035*	0.01	0.003	0.001	0.01
	(0.004)	(0.003)	(0.014)	(0.020)	(0.014)	(0.012)	(0.011)
First stage	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Wu-Hausman	[0.455]	[0.777]	[0.014]	[0.104]	[0.277]	[0.085]	[0.246]
Panel 4: G score							
G	0.001	0.007*	-0.018+	0.006	-0.001	-0.023*	-0.02*
	(0.003)	(0.003)	(0.010)	(0.015)	(0.010)	(0.010)	(0.009)
First stage	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Wu-Hausman	[0.051]	[0.661]	[0.638]	[0.308]	[0.482]	[0.105]	[0.096]

This table reports a summary of the IV results regarding the estimation of ESG score (Panel 1), E score (Panel 2), S score (Panel 3) and G score (Panel 4), respectively on risk measures at the firm level for an unbalanced panel of 490 firms and a period of 21 years (2000-2021). All variables have been standardized using annual data. DD is the Merton's distance-to-default, Z-score is the insolvency risk, Asyn is the asyncronicity risk. Alpha is the risk-adjusted excess return. Beta and IDS are the systematic and the idiosyncratic risks respectively, estimated from the CAPM; SD is the total risk. ESG is the annual Thomson Reuters Combined ESG score. E score is the annual Environmental Thomson Reuters score, S score is the the annual Social Thomson Reuters score, and G score is the annual Governance Thomson Reuters score. Robust standard errors in parenthesis are used in the IV estimation. +, *, **, *** denote significance at the 10, 5, 1, and 0.1%, respectively. First stage test assesses whether the internal instruments are relevant (that is, if they are correlated with the endogenous regressor) under the null hypothesis. Wu-Hausman test asseses whether the FE estimation is consistent and efficient under the null. Corresponding p-values are in backects.

Table 14: Impact of ESG score commitment levels

	DD	*Z-score*	*Asyn*	*Alpha*	*Beta*	*IDS*	*SD*
P3	0.123***	0.069***	-0.051	0.119**	-0.072*	-0.229***	-0.189***
	(0.011)	(0.014)	(0.036)	(0.042)	(0.031)	(0.038)	(0.041)
P2	0.051***	0.037***	-0.102***	0.095**	-0.043+	-0.133***	-0.085**
	(0.008)	(0.010)	(0.027)	(0.032)	(0.023)	(0.028)	(0.031)
Size	-0.071***	0.022	0.029	-0.525***	0.051	-0.110*	-0.080+
	(0.012)	(0.016)	(0.042)	(0.049)	(0.036)	(0.043)	(0.048)
MTB	0.004+	0.004	0.003	0.018+	0.003	-0.006	-0.006
	(0.002)	(0.003)	(0.008)	(0.009)	(0.007)	(0.008)	(0.009)
ROA	0.050***	0.009+	-0.039**	-0.106***	-0.071***	-0.054***	-0.030*
	(0.004)	(0.005)	(0.013)	(0.015)	(0.011)	(0.013)	(0.014)
Lev	-0.084***	-0.017**	0.064***	0.046*	0.053***	0.126***	0.115***
	(0.005)	(0.007)	(0.018)	(0.021)	(0.015)	(0.019)	(0.020)
Liq	-0.002	-0.007	-0.003	-0.021	0.026*	0.061***	0.060***
	(0.004)	(0.005)	(0.013)	(0.015)	(0.011)	(0.013)	(0.014)
Model	FE	FE	FE	FE	FE	FE	FE
Num.Obs.	7147	7147	7143	7143	7143	7143	7147
R2	0.093	0.008	0.006	0.025	0.012	0.022	0.013
AIC	-2420.2	1067.3	15061.2	17266.1	12860.4	15634.6	16943.6

This table reports the panel regression results regarding the impact of the ESGG score on risk measures at the firm level for an unbalanced panel of 490 firms and a period of 21 years (2000-2021). All variables have been standardized using annual data, with independent variables lagged by one year. DD is Merton's distance-to-default, Z-score the insolvency risk, Asyn is the asynchronicity risk. Alpha is the risk- adjusted excess return. Beta and IDS are the systematic and the idiosyncratic risk estimated from the CAPM; SD is the total risk. P1 identifies high-committed firms and is equal to 1 for firms whose combined ESG score is below the 20% of the total distribution of the ESG scores, and zero otherwise; P2 identifies medium-committed firms and equal to 1 for firms whose combined ESG score is between 20% and 80%; P3 identifies high-committed firms and is equal to 1 for firms whose combined ESG score is above the 80%, and 0 otherwise. P1 is the reference group. ESG is the annual Thomson Reuters Combined ESG score. Size is the size of the firm. MTB is the Market-to-book ratio. ROA is the return on assets ratio. Lev is the leverage ratio. Liq is the turnover ratio. The model, Pooled (P), Fixed Effects (FE), or Random Effects (RE), is selected according to the resutls of the Breusch-Pagan and the Hausman tests. Robust standard errors in parenthesis are computed by using the variance covariance matrix HC3, a hererocedasticity-consistent (HC) class estimator. +, *, **, *** denote significance at the 10, 5, 1, and 0.1%, respectively.

Table 15: Impact of ESG practices and GHG emissions intensity

	DD	Z-score	Asyn	Alpha	Beta	IDS	SD
Panel 1: ESG score							
ESG	0.065***	0.031***	-0.033*	0.047**	-0.032**	-0.114***	-0.097***
	(0.004)	(0.005)	(0.014)	(0.016)	(0.012)	(0.014)	(0.016)
ESGxEE	-0.055***	-0.031***	0.016	-0.013	-0.004	0.100***	0.110***
	(0.007)	(0.009)	(0.024)	(0.029)	(0.021)	(0.025)	(0.028)
Panel 2: E score							
E	0.057***	0.032***	-0.023	0.093***	-0.035**	-0.136***	-0.115***
	(0.004)	(0.006)	(0.016)	(0.018)	(0.013)	(0.016)	(0.018)
ExEE	-0.088***	-0.045***	-0.077**	-0.068*	-0.039+	0.105***	0.146***
	(0.007)	(0.010)	(0.026)	(0.030)	(0.022)	(0.027)	(0.030)
Panel 3: S score							
S	0.070***	0.015**	-0.015	0.055**	-0.023+	-0.064***	-0.050**
	(0.004)	(0.006)	(0.015)	(0.017)	(0.013)	(0.016)	(0.017)
SxEE	-0.082***	-0.020*	-0.032	0.014	-0.082***	0.036	0.056*
	(0.007)	(0.009)	(0.025)	(0.029)	(0.021)	(0.026)	(0.029)
Panel 4: G score							
G	0.033***	0.022***	0.010	0.021	-0.018	-0.069***	-0.073***
	(0.004)	(0.005)	(0.014)	(0.016)	(0.012)	(0.014)	(0.016)
GxEE	-0.041***	-0.013	-0.03	0.02	0.01	0.028	0.048+
	(0.007)	(0.009)	(0.025)	(0.029)	(0.021)	(0.026)	(0.028)

This table reports a summary of the estimation results regarding the impact of the ESG score (Panel 1), the E score (Panel 2), S score (Panel 3) and G score (Panel 4) on risk measures at the firm level for an unbalanced panel of 490 firms and a period of 21 years (2000-2021). All variables have been standardized using annual data. DD is the Merton's distance-to-default, Z-score is the insolvency risk, Asyn is the asyncronicity risk. Alpha is the risk-adjusted excess return. Beta and IDS are the systematic and the idiosyncratic risks respectively, estimated from the CAPM; SD is the total risk. ESG is the annual Thomson Reuters Combined ESG score. E score is the annual Environmental Thomson Reuters score, S score is the the annual Social Thomson Reuters score, and G score is the annual Governance Thomson Reuters score. EE is a dummy that is equal to 1 when the effective emissions of each firm are above the 75% of the total distribution of the sample, and 0 otherwise. The interaction with the combined ESG score, E score, S score and G score respectively is included in the model. Fixed effects for firm and year are included in the models. Robust standard errors in parenthesis are used in the estimation. +, *, **, *** denote significance at the 10, 5, 1, and 0.1%, respectively.

Table 16: Sectoral Analysis

	DD	*Z-score*	*Asyn*	*Alpha*	*Beta*	*IDS*	*SD*
ESG	0.037***	0.020***	-0.022	0.081***	-0.046***	-0.085***	-0.067***
	(0.004)	(0.005)	(0.015)	(0.017)	(0.013)	(0.015)	(0.017)
ESGxEnergy	-0.026	-0.049*	-0.07	-0.364***	0.130*	0.160*	0.174*
	(0.019)	(0.024)	(0.065)	(0.076)	(0.056)	(0.068)	(0.074)
ESGxUtilities	0.007	-0.01	0.238***	-0.032	-0.058	0.029	0.021
	(0.015)	(0.019)	(0.051)	(0.059)	(0.044)	(0.053)	(0.058)
ESGxIndustrials	0.039***	0.015	-0.082**	-0.090**	0.058*	-0.016	-0.002
	(0.008)	(0.010)	(0.028)	(0.032)	(0.024)	(0.029)	(0.031)
ESGxMaterials	0.062***	0.028+	0.025	-0.074	0.007	-0.065	-0.093+
	(0.013)	(0.017)	(0.044)	(0.052)	(0.038)	(0.046)	(0.051)
Size	-0.100***	0.015	0.032	-0.542***	0.072+	-0.072	-0.048
	(0.013)	(0.016)	(0.043)	(0.050)	(0.037)	(0.045)	(0.049)
MTB	0.003	0.004	0.002	0.017+	0.003	-0.005	-0.005
	(0.002)	(0.003)	(0.008)	(0.009)	(0.007)	(0.008)	(0.009)
ROA	0.049***	0.008	-0.040**	-0.112***	-0.068***	-0.050***	-0.026+
	(0.004)	(0.005)	(0.013)	(0.015)	(0.011)	(0.013)	(0.015)
Lev	-0.083***	-0.017*	0.065***	0.041*	0.056***	0.127***	0.115***
	(0.005)	(0.007)	(0.018)	(0.021)	(0.015)	(0.019)	(0.020)
Liq	0.000	-0.006	-0.007	-0.022	0.027*	0.059***	0.059***
	(0.004)	(0.005)	(0.013)	(0.015)	(0.011)	(0.013)	(0.014)
Model	FE	FE	FE	FE	FE	FE	FE
Num.Obs.	7147	7147	7143	7143	7143	7143	7147
R2	0.104	0.009	0.01	0.029	0.014	0.025	0.015
AIC	-2502.5	1064.6	15041.2	17241.1	12847.5	15623.7	16937.9

This table reports the panel regression results regarding the impact of the ESG score and the carbon intensity by sector on risk measures at the firm level for an unbalanced panel of 490 firms and a period of 21 years (2000-2021). All variables have been standardized using annual data, with independent variables lagged by one year. DD is Merton's distance-to-default, Z-score the insolvency risk, Asyn is the asynchronicity risk. Alpha is the risk- adjusted excess return. Beta and IDS are the systematic and the idiosyncratic risk estimated from the CAPM; SD is the total risk. ESG is the annual Thomson Reuters Combined ESG score. Energy, identifies the energy sector and is equal to 1 for firms from it, and zero otherwise; Utilities, identifies the utilities sector and is equal to 1 for firms from it, and zero otherwise; Industrials identifies the industrials sector and is equal to 1 for firms from it, and zero otherwise; Materials identifies the materials sector and is equal to 1 for firms from this sector, and zero otherwise. The interaction with the combined ESG score is included in the model. ROA is the return on assets ratio. Lev is the leverage ratio. Liq is the turnover ratio. The model, Pooled (P), Fixed Effects (FE), or Random Effects (RE), is selected according to the resutls of the Breusch-Pagan and the Hausman tests. Robust standard errors in parenthesis are computed by using the variance covariance matrix HC3, a hererocedasticity-consistent (HC) class estimator. +, *, **, *** denote significance at the 10, 5, 1, and 0.1%, respectively.

Table 17: Covid impact

	DD	*Z-score*	*Asyn*	*Alpha*	*Beta*	*IDS*	*SD*
ESG	0.043***	0.035***	-0.014	0.052***	-0.034**	-0.111***	-0.100***
	(0.004)	(0.005)	(0.013)	(0.015)	(0.011)	(0.013)	(0.014)
Covid	0.109***	-0.217***	-0.022	0.002	-0.212***	0.420***	0.542***
	(0.010)	(0.013)	(0.035)	(0.041)	(0.030)	(0.036)	(0.039)
CovidxESG	0.009	-0.031*	-0.113**	-0.061	0.089**	0.068+	0.088*
	(0.010)	(0.013)	(0.035)	(0.041)	(0.030)	(0.036)	(0.039)
Size	-0.146***	0.110***	0.046	-0.532***	0.154***	-0.258***	-0.285***
	(0.013)	(0.016)	(0.045)	(0.053)	(0.039)	(0.046)	(0.050)
MTB	0.003	0.005+	0.002	0.018+	0.004	-0.008	-0.009
	(0.002)	(0.003)	(0.008)	(0.009)	(0.007)	(0.008)	(0.009)
ROA	0.047***	0.011*	-0.039**	-0.107***	-0.067***	-0.057***	-0.035*
	(0.004)	(0.005)	(0.013)	(0.015)	(0.011)	(0.013)	(0.014)
Lev	-0.092***	-0.003	0.068***	0.047*	0.066***	0.099***	0.079***
	(0.005)	(0.006)	(0.018)	(0.021)	(0.015)	(0.018)	(0.020)
Liq	0.000	-0.008+	-0.003	-0.02	0.023*	0.063***	0.064***
	(0.004)	(0.005)	(0.013)	(0.015)	(0.011)	(0.013)	(0.014)
Model	FE	FE	FE	FE	FE	FE	FE
Num.Obs.	7147	7147	7143	7143	7143	7143	7147
R2	0.122	0.077	0.007	0.025	0.02	0.058	0.061
AIC	-2655.7	552.2	15056.2	17265.2	12803.3	15374.2	16587.2

This table reports the panel regression results regarding the impact of the Covid19 on risk measures at the firm level for an unbalanced panel of 490 firms and a period of 21 years (2000-2021). All variables have been standardized using annual data, with independent variables lagged by one year. DD is the Merton's distance-to-default, Z-score the insolvency risk, Asyn is the asynchronicity risk Alpha is the risk- adjusted excess return. Beta and IDS are the systematic and the idiosyncratic risk estimated from the CAPM; SD is the total risk. ESG is the annual Thomson Reuters Combined ESG score. Covid is a dummy variable that takes value 1 for covid-years (2020 and 2021), and 0 otherwise. The interaction with the ESG score is included in ROA is the return on assets ratio. Lev is the leverage ratio. Liq is the turnover ratio. The model, Pooled (P), Fixed Effects (FE), or Random Effects (RE), is selected according to the resutls of the Breusch-Pagan and the Hausman tests. Robust standard errors in parenthesis are computed by using the variance matrix HC3, a hererocedasticity-consistent (HC) class estimator. +, *, **, *** denote significance at the 10, 5, 1, and 0.1%, respectively.