UNIVERSIDAD COMPLUTENSE DE MADRID

FACULTAD DE CIENCIAS ECONÓMICAS Y EMPRESARIALES

TESIS DOCTORAL

Ensayos sobre la Materialidad Financiera del ESG, la Diversidad de Género y el Riesgo de Biodiversidad

Essays on the Financial Materiality of ESG, Gender Diversity, and Biodiversity Risk

MEMORIA PARA OPTAR AL GRADO DE DOCTORA

PRESENTADA POR

Almudena María García Sanz

DIRIGIDA POR

Juan Ángel Jiménez Martín

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COMPLUTENSE UNIVERSITY OF MADRID

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DOCTORAL THESIS

Ensayos sobre la Materialidad Financiera del ESG, la Diversidad de Género y el Riesgo de Biodiversidad

Essays on the Financial Materiality of ESG, Gender Diversity, and Biodiversity Risk

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SUBMITTED BY

Almudena María García Sanz

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To my past, present, and future selves, for their perseverance, growth, and commitment throughout the journey.

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Resumen

La tesis *"Ensayos sobre la Materialidad Financiera del ESG, la Diversidad de Género y el Riesgo de Biodiversidad"* comprende tres ensayos que abordan cuestiones clave en la intersección entre las finanzas sostenibles y la gestión del riesgo corporativo. El objetivo general de esta investigación es proporcionar evidencia empírica sobre cómo los factores ambientales, sociales y de gobernanza (ESG por sus siglas en inglés), la diversidad de género y los riesgos relacionados con la biodiversidad influyen en la exposición al riesgo corporativo, contribuyendo así a la literatura sobre finanzas sostenibles y ofreciendo implicaciones tanto para la regulación como para la gestión empresarial.

El Capítulo 1, titulado *Sostenibilidad y Riesgos Financieros de las "Best-in-Class": Un Análisis Integral,* investiga la relación entre el desempeño en sostenibilidad corporativa y el riesgo financiero, utilizando un panel de 490 empresas con mejores prácticas ESG en EE.UU. y Europa durante el período 2000–2021. Esta rigurosa selección de la muestra aborda dos desafíos recurrentes en la investigación ESG: en primer lugar, la dificultad de identificar medidas confiables del desempeño en sostenibilidad, y en segundo lugar, el riesgo de greenwashing, por el cual las empresas pueden divulgar prácticas simbólicas más que sustantivas. Al centrarse en las compañías integrantes de los FTSE/S-Network ESG Best Practices Índices, reconocidas líderes en sostenibilidad, el análisis reduce estas preocupaciones y proporciona un marco más sólido para examinar la relación ESG–riesgo. Empleando múltiples medidas de riesgo financiero —incluyendo riesgo de impago (default risk), volatilidad de mercado y desempeño ajustado por riesgo (Alfa de Jensen)— los resultados muestran que un mejor desempeño ESG está consistentemente asociado con un menor riesgo financiero. Entre las dimensiones ESG, el pilar ambiental surge como el principal impulsor de la mitigación del riesgo, lo que subraya la importancia económica de la gestión proactiva del medio ambiente y las estrategias de control de la contaminación. El capítulo también revela heterogeneidad significativa entre las empresas estadounidenses y europeas, reflejando la influencia de marcos regulatorios, expectativas de mercado y normas culturales diferentes sobre la efectividad de las iniciativas de sostenibilidad. Pruebas de robustez para efectos no lineales, emisiones de efecto invernadero y problemas de endogeneidad confirman la estabilidad de los resultados, ofreciendo evidencia sólida de que

la integración ESG es una estrategia fundamental para la gestión del riesgo corporativo y para reforzar la estabilidad del mercado.

El capítulo 2, titulado *El papel del perfil ESG como moderador en la relación entre diversidad de género y riesgos a la baja y extremos*, examina cómo el desempeño ambiental, social y de gobernanza (ESG, por sus siglas en inglés) modera la relación entre la diversidad de género y el riesgo financiero a la baja y extremo. Basado en un panel de 3.718 empresas de Estados Unidos y Europa durante el período 2010–2022, el análisis utiliza regresiones de datos de panel sobre múltiples medidas de riesgo, con el fin de capturar la heterogeneidad entre niveles organizativos, sectores y contextos institucionales. Los resultados muestran que una mayor diversidad de género —especialmente a nivel de los consejos de administración— se asocia de manera consistente con menores riesgos a la baja y extremos, destacando el papel estabilizador de las estructuras de gobierno inclusivas. Sin embargo, la magnitud y dirección de estos efectos varían según el contexto: mientras que la diversidad entre directivos y empleados presenta impactos más heterogéneos, la diversidad a nivel del consejo se consolida como el factor más fiable de resiliencia financiera. El desempeño ESG refuerza esta relación, siendo los pilares Ambiental y Social los que muestran los efectos moderadores más fuertes, mientras que la dimensión de Gobernanza actúa principalmente como un facilitador estructural. Durante la crisis del COVID-19, la combinación de diversidad en los consejos y un alto compromiso ESG redujo significativamente las exposiciones a riesgos extremos, evidenciando su contribución complementaria a la resiliencia organizacional bajo condiciones de estrés. Los resultados se mantienen sólidos frente a medidas alternativas de diversidad, especificaciones de riesgo y estimaciones mediante variables instrumentales. En conjunto, el estudio demuestra que la diversidad de género y las prácticas ESG configuran de manera conjunta los perfiles de riesgo corporativo a través de mecanismos interrelacionados de sostenibilidad y gobernanza, ofreciendo orientaciones valiosas para responsables de políticas, inversores y líderes empresariales que buscan fortalecer la estabilidad financiera y fomentar la creación de valor a largo plazo.

El capítulo 3, titulado *¿Afecta el riesgo de biodiversidad al riesgo financiero? Evidencia de empresas estadounidenses*, investiga la relación entre el riesgo de biodiversidad y el riesgo financiero utilizando un panel de 1.993 empresas de Estados Unidos durante el

período 2010–2022. Evalúa cómo distintos indicadores de biodiversidad inciden en ocho dimensiones del riesgo financiero, incluyendo el riesgo sistemático, idiosincrático, a la baja y extremo. Los resultados demuestran que un mayor desempeño ambiental (pilar E) se asocia consistentemente con menores riesgos financieros, subrayando el papel fundamental de las prácticas ambientales en la configuración del vínculo entre biodiversidad y riesgo financiero. Entre los indicadores analizados, las medidas relacionadas con preocupaciones por la biodiversidad son las que muestran la asociación más fuerte con los perfiles de riesgo financiero de las empresas. Aquellas que revelan inquietudes sobre la pérdida de biodiversidad o están sujetas a regulaciones relacionadas presentan patrones de riesgo diferenciados, especialmente en las métricas de riesgo a la baja y extremo. Además, la dependencia e impacto de las empresas en los ecosistemas —capturando la perspectiva de doble materialidad— influyen significativamente en la intensidad de estas relaciones. Los hallazgos son robustos ante la estimación mediante variables instrumentales y frente a especificaciones alternativas del riesgo de biodiversidad. En conjunto, el estudio ofrece evidencia empírica y un marco integral para evaluar cómo las exposiciones vinculadas a la biodiversidad afectan la estabilidad financiera, proporcionando información valiosa para las estrategias de inversión sostenible y gestión del riesgo corporativo.

En conjunto, los tres ensayos ofrecen una evaluación integral de cómo los factores de sostenibilidad, diversidad de género y riesgo de biodiversidad se relacionan con el riesgo financiero corporativo. Al combinar un análisis empírico riguroso con una visión multidimensional del riesgo, esta investigación contribuye a la literatura en finanzas sostenibles y gobierno corporativo, y resalta estrategias accionables para fortalecer la estabilidad y resiliencia financiera en el contexto de desafíos ambientales y sociales.

Summary

The thesis *Essays on the Financial Materiality of ESG, Gender Diversity, and Biodiversity Risk* comprises three essays that address pressing questions at the intersection of sustainable finance and corporate risk management. The overall aim of this research is to provide empirical evidence on how environmental, social, and governance (ESG) factors, gender diversity, and biodiversity-related risks influence corporate risk exposure, thereby contributing to the literature on sustainable finance and informing regulatory and managerial practices.

Chapter 1, entitled *Sustainability and Financial Risks of the Best-in-class: A Comprehensive Analysis*, investigates the relationship between corporate sustainability performance and financial risk, using a panel of 490 best-in-class ESG firms from the U.S. and Europe over the period 2000–2021. This rigorous sample selection addresses two pervasive challenges in ESG research. First, the difficulty of identifying reliable measures of corporate sustainability performance, and second, the risk of greenwashing, whereby firms may disclose symbolic rather than substantive ESG practices. By focusing on constituents of the FTSE/S-Network ESG Best Practices Indices—recognized leaders in sustainability—the analysis reduces these concerns and provides a more credible setting for examining the ESG–risk nexus. Employing multiple financial risk measures, including default risk, market volatility, and risk-adjusted performance (Jensen's Alpha), the findings show that stronger ESG performance is consistently associated with lower financial risk. Among the ESG dimensions, the Environmental pillar emerges as the most influential driver of risk mitigation, underscoring the economic importance of proactive environmental management and pollution control strategies. The chapter also reveals significant heterogeneity between U.S. and European firms, reflecting the influence of differing regulatory frameworks, market expectations, and cultural norms on the effectiveness of sustainability initiatives. Robustness checks for non-linear effects, greenhouse gas (GHG) emissions, and potential endogeneity confirm the stability of the results, providing strong evidence that ESG integration is a fundamental strategy for corporate risk management and for enhancing market stability.

Chapter 2, entitled *The role of ESG Profile as a Moderator in the Gender Diversity - Downside and Extreme Risks Nexus*, examines how environmental, social, and governance

(ESG) performance moderates the relationship between gender diversity and downside financial risk. Drawing on a panel of 3,718 firms from the United States and Europe over the 2010–2022 period, the analysis employs panel regressions across multiple risk measures to capture heterogeneity across organizational levels, sectors, and institutional contexts. The results show that greater gender diversity—particularly at the board level—is consistently associated with lower downside and extreme risks, underscoring the stabilizing role of inclusive governance structures. However, the magnitude and direction of these effects vary across contexts: while diversity among managers and employees exhibits more heterogeneous impacts, board-level diversity emerges as the most reliable driver of financial resilience. ESG performance further reinforces this relationship, with the Environmental and Social pillars displaying the strongest moderating effects, whereas the Governance dimension functions primarily as a structural enabler. During the COVID-19 crisis, the combination of board diversity and strong ESG engagement significantly reduced extreme risk exposures, highlighting their complementary contribution to organizational resilience under conditions of stress. The findings remain robust across alternative diversity measures, risk specifications, and instrumental variable estimations. Overall, the study demonstrates that gender diversity and ESG practices jointly shape corporate risk profiles through interrelated governance and sustainability mechanisms, offering actionable insights for policymakers, investors, and corporate leaders seeking to strengthen financial stability and promote long-term value creation.

Chapter 3, entitled *Does Biodiversity Risk Affect Financial Risk? Evidence from U.S. Firms*, investigates the relationship between biodiversity risk and financial risk using a panel of 1,993 U.S. firms spanning the 2010–2022 period. It evaluates how multiple biodiversity proxies affect eight dimensions of financial risk, including systematic, idiosyncratic, downside, and extreme risks. The results demonstrate that stronger environmental (E) performance is consistently associated with lower financial risk, emphasizing the critical role of environmental practices in shaping the biodiversity–financial risk nexus. Among the biodiversity indicators analyzed, measures reflecting biodiversity-related concerns show the strongest association with firms' financial risk profiles. Companies disclosing concerns about biodiversity loss or exposed to biodiversity-related regulation exhibit distinct risk patterns, particularly in downside and extreme risk metrics. Furthermore, firms' dependency on and

impact within ecosystems—capturing the double materiality perspective—significantly influence the strength of these relationships. The findings are robust to instrumental variable estimation and alternative biodiversity risk specifications. Overall, the study provides empirical evidence and a comprehensive framework to assess how biodiversity-related exposures influence financial stability, offering valuable insights for sustainable investment and corporate risk management strategies.

Collectively, the three essays offer a comprehensive assessment of how sustainability, diversity, and biodiversity risk factors intersect with corporate financial risk. By combining rigorous empirical analysis with a multi-dimensional view of risk, this research contributes to the literature on sustainable finance and corporate governance and highlights actionable strategies for enhancing financial stability and resilience in the context of environmental and social challenges.

Contents

1

Sustainability and Financial Risks of the Best-in-class: A Comprehensive Analysis

ABSTRACT[1]

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 robustness 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 analysing 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.[2] 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

[2] 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 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 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).[3] 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

[3] 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 I 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).[4] 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).[5]

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

[4] 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).

[5] 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.[6] 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).

[6] 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 II 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 II).[7]

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

[7] 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 analyse 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 (Martielli et al., 2024; El Ghoul et al., 2019) 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 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 CO2) over the market

capitalization as in Garcia-Jorcano, et al. (2025).[8] 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.

[8] 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 II 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 behaviour 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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Tables

Table 1: Risk measures

Variable	*Formula*	*Description*	*References*
DD	$DD_i = \frac{log\left(\frac{V_i}{L_i}\right) + \left(\mu_{Vi} - \frac{1}{2}\sigma^2{}_{Vi}\right)}{\sigma_{Vi}}$	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	$Z_i = \frac{\overline{R_{it}} + 1}{\sigma_{R_{it}}}$	It expresses the distance at which corporate values fall into debt levels.	
Asyn	$Asyn_i = ln\left(\frac{1 - R2_i}{R2_i}\right)$	It measures the lack of synchronicity of stocks of a share market in a particular period of time	
Alpha	$\alpha_i = R_{it} - \beta_i R_{Mt}$	It is the excess return on the risky security in relation to the market as a whole.	
Beta	$\beta_i = \frac{Cov(R_{it}, R_{Mt})}{Var(R_{Mt})}$	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	$IDS_i = \sqrt{\frac{\sum_{i=1}^{n} \widehat{\varepsilon_i^2}}{n-k}}$	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	$SD_i = \sqrt{\frac{\sum_{i=1}^{n} (R_{it} - \overline{R_{it}})}{n-1}}$	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	$\text{MTB} = \frac{Market\ capitalization_i}{Total\ equity_i}$	Market to book ratio compares the firm's book value to its market value.	Maxfield & Wang (2021)
ROA	$\text{ROA} = \log\left(\frac{Net\ Income_i}{Total\ Assets_i}\right)$	Return on assets ratio measures the profitability of a business in relation to its total assets.	Maxfield & Wang (2021)
Lev	$\text{Lev} = \frac{Total\ Debt_i}{Total\ Assets_i}$	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	$\text{Liq} = \frac{Total\ shares\ traded_i}{Total\ shares\ outstanding_i}$	Stock market liquidity represents the percentage of a stock that has been replaced in a given year.	Maxfield & Wang (2021)

Table 2: ESG variables and control variables

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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)
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ROA	$\text{ROA} = \log\left(\frac{Net\ Income_i}{Total\ Assets_i}\right)$	Return on assets ratio measures the profitability of a business in relation to its total assets.	Maxfield & Wang (2021)
Lev	$\text{Lev} = \frac{Total\ Debt_i}{Total\ Assets_i}$	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	$\text{Liq} = \frac{Total\ shares\ traded_i}{Total\ shares\ outstanding_i}$	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.

Appendix I: 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).

$$DD_i = \frac{log\left(\frac{V_i}{L_i}\right) + \left(\mu_{Vi} - \frac{1}{2}\sigma^2{}_{Vi}\right)}{\sigma_{Vi}} \qquad (A.1)$$

where V_i 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_i 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_i 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 of daily excess stock returns, R_{it}.

$$SD_i = \sqrt{\frac{\sum_{i=1}^{n}(R_i - \overline{R_i})}{n-1}} \qquad (A.2)$$

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

$$R_{it} = \alpha_i + \beta_i R_{Mt} + \varepsilon_{it} \qquad (A.3)$$

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_i, in Model (A.3) for each firm and year. It measures the volatility of a security or portfolio compared to the market.

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

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:

$$IDS_i = \sqrt{\frac{\sum_{i=1}^{n} \widehat{\varepsilon_i^2}}{n-k}} \qquad (A.5)$$

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.

$$\alpha_i = R_{it} - \beta_i R_{Mt} \qquad (A.6)$$

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, R^2 is obtained for each estimation. As Durnev et al. (2004) explain, one minus R^2 represents the firm-specific return

variation, and R^2 represents the market variation. However, to avoid the econometric problems due to the bounded and highly skewed nature of R^2, 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:

$$Asyn_i = ln\left(\frac{1-R2_i}{R2_i}\right) \qquad (A.7)$$

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 ($\overline{R_{it}}$) plus one over the standard deviation (σ) of daily stock returns:

$$Z_i = \frac{\overline{R_{it}} + 1}{\sigma_{R_{it}}} \qquad (A.8)$$

Appendix II

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 sector

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 sectors within the sample

2

The role of ESG Profile as a Moderator in the Gender Diversity - Downside and Extreme Risks Nexus

ABSTRACT

This paper investigates how environmental, social, and governance (ESG) performance moderates the relationship between gender diversity and downside financial risk. Using a panel of 3,718 U.S. and European firms over 2010–2022, we estimate panel regressions across multiple risk measures to capture heterogeneity across organizational levels, sectors, and regions. The results reveal that greater gender diversity—particularly at the board level—is associated with lower downside and extreme risks, highlighting the stabilizing influence of inclusive governance structures. However, the magnitude and direction of this effect vary across contexts: while managerial and employee-level diversity exert more mixed impacts, board diversity consistently enhances financial resilience. ESG performance further strengthens this relationship, with the Environmental and Social pillars exhibiting the most pronounced moderating effects, whereas the Governance dimension plays a weaker, more enabling role. During the COVID-19 crisis, the combination of board diversity and strong ESG engagement significantly mitigated extreme risk exposures, underscoring their complementary role in fostering organizational resilience under stress. The results are robust to alternative diversity metrics, risk specifications, and instrumental variable approaches. Overall, the study demonstrates that gender diversity and ESG practices jointly shape firms' risk profiles through complementary governance and sustainability mechanisms, offering insights for policymakers, investors, and corporate leaders seeking to enhance financial stability and long-term value creation.

Keywords: gender diversity, ESG, financial risk, downside risk, extreme risk.

JEL Classification: C33, G32, M14.

1. Introduction

Understanding what makes companies financially resilient is a major concern for investors, managers, and policymakers. While relying on a wide range of factors, two areas have attracted significant attention: gender diversity in firms—an essential element of strong governance and social responsibility—and a firm's performance on Environmental, Social, and Governance (ESG) issues—often viewed as an indicator of good risk management. Previous research shows that gender diversity and ESG policies individually benefit firm performance and risk (Chen et al., 2025; Feng et al., 2022; Bernile et al., 2018; Adams & Ferreira, 2009). However, how these two factors work together to protect firms from large financial losses (downside and extreme risks) is not yet well understood. This paper aims to fill this research gap by exploring how ESG performance moderates the relationship between gender diversity and firms' adverse risk exposure.

The impulse for corporate gender diversity has shifted from a niche issue to a key focus in global policy and investment, driven by regulatory pressure and frameworks such as the UN's Sustainable Development Goals (Bernile et al., 2018; Falconieri & Akter, 2023). Theoretically, the premise that diversity should mitigate risk is well-established. The dominant view, rooted in Behavioral and Agency Theories, posits that female leaders are less overconfident, more risk-averse, and enhance board monitoring, leading to more prudent policies, lower leverage, and a reduced likelihood of stock price crashes (Huang & Kisgen, 2013; Faccio et al., 2016; Adams & Ferreira, 2009). Moreover, the Resource-Based and Stakeholder Theories argue that cognitive diversity improves strategic decision-making and strengthens stakeholder relations, further sustaining firm resilience (Brahma et al., 2021; Minutolo et al., 2019).

Despite this, the empirical evidence is surprisingly inconsistent. A significant body of work finds that gender diversity is associated with lower stock volatility and systematic risk (Hassan et al., 2025; Paolone et al., 2024), while other studies report mixed, statistically insignificant, or context-dependent results (Shakil, 2021; Nadeem et al., 2019; Sila et al., 2016). This empirical puzzle indicates that the gender diversity-risk relationship is complex, and missing contextual factors may influence this connection, prompting the search for a moderating variable.

At the same time, much research confirms ESG performance as an effective risk-reduction tool. The consensus view, grounded in Stakeholder Theory, is that firms with superior ESG profiles build intangible assets, such as "moral capital," by proactively managing stakeholder relationships

(Godfrey, 2005; Hill & Jones, 1992). This goodwill acts as an insurance-like buffer, reducing the firm's exposure to litigation, regulatory sanctions, and reputational damage, thereby lowering tail risk (Karwowski & Raulinajtys-Grzybek, 2021). The financial perspective suggests that socially responsible investors' growing demand for sustainable assets reduces stock volatility and lowers the cost of capital, especially during market downturns (Chava, 2014). While a critical view based on Agency Theory warns of opportunistic overinvestment in ESG (Barnea & Rubin, 2010), the empirical evidence supports its risk-reducing role across multiple markets, where higher ESG ratings are associated with lower downside and crash risk (Lööf et al., 2022; Bernile et al., 2018; Kim et al., 2014).

This paper argues that these two streams of literature are interconnected, with a firm's ESG performance being a crucial contextual factor. ESG can foster an environment that optimizes the risk-reducing benefits of gender diversity (Cheng et al., 2014). High-ESG firms encourage stakeholder-oriented cultures, making gender-diverse boards more responsive to stakeholder concerns and thereby enhancing resilience (Freeman, 1984). These firms also promote transparency and disclosure (Dhaliwal et al., 2011), thereby improving oversight and risk management, strengthening the gender-diverse board's ability to monitor effectively and detect and limit excessive risk-taking. Additionally, firms with high ESG performance promote long-term strategies aligned with diverse leadership's prudent decision-making (Eccles et al., 2014). Conversely, low-ESG firms, under short-term pressures, may gain fewer benefits from diversity. This theoretical interaction is supported by empirical evidence showing a positive correlation between gender diversity and ESG outcomes across all three pillars (Paolone et al., 2024). Diverse boards are associated with superior environmental stewardship (Liu, 2018), stronger stakeholder relations (Lewellyn et al., 2024), and more robust governance, including lower fraud and earnings management (Dimungu-Hewage & Poletti-Hughes, 2023). This consistent link suggests a natural and reinforcing relationship between the two concepts.

In this paper, we shift the focus from a causal chain to a question of context: Does the risk-mitigating effect of gender diversity depend on a firm's commitment to sustainability? Analyzing this interaction deepens understanding of how inclusivity and sustainability work together to enhance corporate resilience beyond their individual effects. Additionally, while most existing research on the importance of gender diversity focuses on board-level representation, we present a

more comprehensive view that spans executive, managerial, and workforce levels to better understand corporate resilience. This broader approach moves beyond the symbolic role often associated with board composition to focus on the meaningful inclusion required by Sustainable Development Goal 5 (SDG 5). The true impact of gender diversity becomes evident when it is incorporated into a firm's decision-making, from strategic planning to daily activities. Therefore, by connecting ESG practices with organizational gender diversity, our study fills a crucial gap in existing research and provides new insights into how governance, workforce composition, and sustainability interact in shaping firms' exposure to extreme and downside risks.

Previous studies on the relationship between gender diversity and firm financial risks have focused on unconditional (total risk) and conditional (market beta and idiosyncratic) risk measures. However, downside and extreme risks are still relatively underexplored, despite their key role in assessing firms' vulnerability to extreme adverse outcomes and for risk management and financial stability. Some exceptions are Wang and Fung (2022), who show that female CFOs reduce extreme risks measured by Value-at-Risk (VaR) and Expected Shortfall (ES), and Bernile et al. (2018), Perryman et al. (2016), and Lenard et al. (2014), who find the same for more diverse boards. We fill this gap by analyzing multiple downside and extreme risk measures, including a Lower Partial Moment, Downside-beta, Tail-beta, Value-at-Risk (VaR), and Expected Shortfall (ES).

We employ panel data models with a comprehensive set of firm- and board-level covariates. The empirical analysis relies on 3,718 firms (2326 U.S. and 1392 European). This sample enables us to examine differences between two leading corporate governance paradigms worldwide. The US market exemplifies the shareholder primacy model, in which demands for diversity and ESG are largely driven by market forces and institutional investors. Conversely, European markets are generally based on a stakeholder model, where institutional and regulatory pressures—including mandatory gender quotas in several countries—shape corporate decision-making differently.

ESG performance and its environmental, social, and governance dimensions are measured using LSGE Refinitive Thomson Reuters ESG scores (TR-ESG, TR-E, TR-S, and TR-G) that we use to identify firms with high, medium, and low levels of ESG (E, S, G) performance. The proxies for gender diversity analyzed are indicators of gender diversity at the workforce, management, and top levels, classified under the social and governance pillars.

The results indicate that firms' ESG profiles play a significant role in determining the effectiveness of gender diversity in mitigating downside and extreme risks. The impact of gender diversity at different organizational levels—employees, managers, and board members—produces mixed effects, suggesting that its impact on risks is influenced by hierarchical position and the broader institutional environment. Respecting the direct impact of the ESG profile helps reduce downside and extreme risks, with stronger ESG performance consistently associated with greater mitigating effects.

To determine the sensitivity of the main results, we further extend the analysis along several dimensions. The purpose is to enhance the understanding of how sustainability and gender diversity, at both the board and organizational levels, interact to shape firms' risk profiles, offering a comprehensive framework to guide future research and practical applications. First, we disaggregate ESG into its environmental, social, and governance components, building upon the findings of Lööf et al. (2022) while introducing the novel integration of downside and extreme risk measures. We find differences across the individual pillars, highlighting the need to differentiate between governance, environmental, and social practices when evaluating their impact on firm risk. Our results indicate that the Environmental and Social pillars play the most important role as risk mitigators. Firms with higher Environmental and Social scores consistently experience lower downside and extreme risks, reflecting the direct operational, regulatory, and stakeholder-oriented mechanisms through which these practices enhance firm stability. In contrast, the Governance pillar generally shows more limited explanatory power for risk outcomes, suggesting that while governance structures are essential for oversight and strategic guidance, they are less effective in directly mitigating financial risk (García-Sanz et al., 2024; Berg et al., 2022).

Second, we differentiate between U.S. and European firms to account for variations in institutional and regulatory frameworks. The results indicate that in the U.S., higher ESG scores consistently reduce all measures of financial risk, and gender diversity—whether at the board or managerial level—further strengthens this risk mitigation. In Europe, while ESG performance generally reduces LPM, VaR, and ES, it is associated with increases in Tailbeta and Downsidebeta, reflecting the influence of stricter governance codes, stakeholder orientations, and institutional differences. Gender diversity in European firms generally reduces risk for employees, managers, and board members, but higher Manager-to-Board and Executive-to-Board ratios may increase risk.

Notably, these negative effects are mitigated in medium- and high-ESG firms, underscoring that ESG performance enhances the risk-reducing potential of gender diversity. These findings highlight the notable divergence between regulatory philosophies and stakeholder orientations in both regions, affecting the relevance of ESG and gender diversity in enhancing corporate resilience.

Third, we distinguish between financial and non-financial firms, reflecting the differing regulatory and organizational contexts in which they operate. The results indicate that non-financial firms derive the clearest benefits from ESG engagement and gender diversity, with high-ESG performance and board diversity jointly contributing to lower downside and extreme risks. Financial firms, by contrast, display more heterogeneous patterns: ESG plays only a marginal and sporadic role, while gender diversity can sometimes increase risk, particularly in low-ESG firms. However, in medium- and high-ESG financial firms, ESG performance interacts positively with gender diversity, mitigating or even reversing risk-enhancing effects, highlighting the context-dependent nature of these mechanisms.

Finally, we incorporate the effects of the COVID-19 pandemic to examine organizational resilience during periods of crisis. The results indicate that ESG practices continued to provide risk mitigation throughout 2020–2022. Gender diversity, particularly at the board level, proved especially valuable: firms with more diverse boards experienced lower downside risks during the crisis, while higher MB ratios had mixed effects. Interaction terms with the COVID-19 dummy show that board diversity and, to some extent, managerial diversity reinforce the ESG-driven mitigation of risk under extreme uncertainty. These findings underscore that gender diversity is not merely a matter of equity but also a critical component of firms' strategic resilience, enhancing monitoring, decision-making, and operational stability during turbulent periods.

This study makes several contributions to the literature on corporate governance, ESG, and financial risk. First, it demonstrates that gender diversity is a primary driver of downside risk mitigation, with the strongest effects observed at the board level. Second, it establishes ESG performance as a moderator that amplifies, mitigates, or conditions the impact of gender diversity, highlighting the importance of disaggregating ESG into Environmental, Social, and Governance pillars. Third, by differentiating across regions, sectors, and crisis periods, the study provides new insights into the context-dependent effectiveness of gender diversity and ESG practices, revealing that institutional frameworks, regulatory environments, and firm-specific characteristics critically

shape these relationships. Finally, the analysis of the COVID-19 period emphasizes the strategic value of integrating diversity and sustainability initiatives, showing that they jointly enhance corporate resilience in times of extreme external shocks. Overall, the findings offer actionable insights for policymakers, corporate leaders, and scholars seeking to understand how gender diversity and ESG engagement jointly influence firm risk and stability.

The rest of the paper is structured as follows. Section 2 provides a theoretical framework, reviews the literature, and presents the hypothesis. Section 3 describes the research design, including methodology, data description, and analysis of the preliminary results. Section 4 presents the main results, while Section 5 provides robustness checks. Finally, section 6 concludes.

2. The Interaction Between Gender Diversity and Sustainability: a Framework for Risk Mitigation

Understanding the role of gender diversity in shaping corporate risk and the role of the ESG profile of firms in this relationship is central to sustainable finance research. The literature is fragmented across three related but often disconnected streams: the direct link between diversity and risk, the direct link between ESG performance and risk, and the interrelationship between gender diversity and ESG. Taken together, these streams provide valuable insights but leave important gaps unaddressed: they often neglect the broader organizational context beyond boards, overlook downside and extreme risks as more relevant measures of financial vulnerability, and underexplore the moderating role of ESG profile within the gender diversity–risk nexus. Addressing these shortcomings is critical because gender diversity and ESG profile are increasingly seen as complementary drivers of corporate resilience. By jointly reviewing these areas, we set the stage for an integrated framework that considers gender diversity across organizational levels, examines multiple proxies of financial risk, and explores how ESG performance conditions the risk-mitigating potential of gender diversity.

2.1. Gender diversity and firm risks

Corporate diversity has evolved from a niche concern into a central issue in political, regulatory, and public debates, placing firms under intense scrutiny to enhance gender representation, particularly on their boards (Bernile et al., 2018; Dutordoir et al., 2024). This pressure is not merely social; it stems from institutional investors, regulatory mandates, and global policy

frameworks (Chang et al., 2019; Falconieri & Akter, 2023). For instance, the United Nations Sustainable Development Goals (SDGs)—specifically SDG 5—explicitly call for gender equality, institutionalizing the expectation that corporations play a pivotal role in empowering women (Oyotode-Adebile & Ujah, 2021). This momentum has led to a rich body of research exploring the drivers of diversity[1] and, more importantly, its tangible impact on corporate outcomes.

Seminal work in economics and social psychology established that team composition fundamentally alters group decision-making dynamics, suggesting that gender differentiation can materially affect corporate strategy and risk-taking (Sah & Stiglitz, 1991, 1986; Moscovici & Zavalloni, 1969). Gender diversity at different organizational levels—particularly in top management and boards—has positively influenced firm performance and reduced risk through several theoretical lenses. The rationale is grounded in Behavioral Economics, which indicates that female executives tend to be more risk-averse and less overconfident than their male counterparts (Huang & Kisgen, 2013). This disposition translates into more prudent corporate policies. For example, firms with female CEOs or a higher representation of women in top management tend to engage in less aggressive risk-taking, resulting in lower stock price volatility and a reduced likelihood of stock price crashes (Chen et al., 2025; Bernile et al., 2018). Research by Faccio et al. (2016) shows that female-led firms tend to have lower leverage, less volatile earnings, and are more likely to survive. This cautious financial approach directly reduces their downside risk.

From an Agency Theory perspective, gender diversity serves as a governance mechanism. Female directors often improve board effectiveness by bringing diligence and a more robust monitoring of firms, which helps mitigate agency conflicts between managers and shareholders (Arora, 2021). Adams and Ferreira (2009) found that female directors have better attendance records and are more likely to join monitoring-intensive committees. This increased oversight results in more informed decisions, decreases managerial entrenchment, and improves governance quality, making the firm less susceptible to internal failures and external shocks.

The Resource-based view posits that diversity is a strategic asset. Gender-diverse teams bring a wider array of perspectives, skills, and experiences to the table, enhancing problem-solving and

[1] Prior research has identified several determinants of gender diversity in corporates, including ownership structures (Nekhili & Gatfaouri, 2013), societal attention to gender equality (Giannetti & Wang, 2023), top management composition (Guldiken et al., 2019), industry characteristics (Hillman et al., 2007), social networks (Oyotode-Adebile & Ujah, 2021), and gender quota regulations (Reguera-Alvarado et al., 2017).

fostering innovation (Brahma et al., 2021). This cognitive diversity reduces the risk of groupthink and leads to more comprehensive strategic analysis. By combining a broader range of human capital, firms are better equipped to navigate complex market environments, identify emerging risks and opportunities, and create sustainable long-term value, moving beyond short-term financial metrics.

In addition, gender diversity is a powerful signal of a firm's commitment to social responsibility and stakeholder engagement. From a Stakeholder Theory standpoint, diverse leadership can better understand and respond to the needs of different stakeholders, including employees, customers, and communities. This alignment enhances the firm's reputation and "social license to operate," which can be a critical buffer during times of crisis (Minutolo et al., 2019). Furthermore, as sustainability becomes central to investment decisions (Friede et al., 2015), gender diversity serves as a visible and credible indicator of strong social performance, granting the firm greater legitimacy and access to capital.

Finally, according to Institutional Theory, the benefits of diversity are not universal but are contingent on the external environment. The positive impact of gender diversity on firm outcomes is often stronger in countries with supportive regulatory frameworks and cultural norms that value inclusivity and equality (García-Sánchez et al., 2022). Policies like gender quotas, while sometimes controversial, can create an institutional context in which the contributions of female directors are more readily accepted and integrated into corporate governance, thereby amplifying their risk-mitigating effects (Dobbin & Jung, 2011).

Empirical research on the relationship between gender diversity and firm risk is extensive, though not completely consistent. A dominant stream finds that greater female representation on boards of directors is associated with lower firm risk, supporting the behavioral view that women are generally more risk-averse (Cho et al., 2021; Croson & Gneezy, 2009). These studies document the negative relationship between board gender diversity and traditional risk measures, including stock return volatility, idiosyncratic risk, and systematic risk (Hassan et al., 2025; Paolone et al., 2024; Adams & Ferreira, 2009). Chen et al. (2016) demonstrate that female directors contribute to more prudent oversight of R&D investments, thereby reducing associated volatility and enhancing risk management. Similarly, Liu and Wu (2023) find that female board members and executives in financial institutions exhibit more conservative risk-taking behavior, thereby contributing to greater financial stability. Chen et al. (2025) provide robust empirical evidence that increased female

representation on boards correlates with lower crash risk, particularly in firms with weak market competition and limited governance structures. However, a notable number of studies report mixed, statistically insignificant, or even context-dependent results, challenging the notion of a straightforward, risk-reducing effect (Shakil, 2021; Nadeem et al., 2019; Sila et al., 2016). This inconsistency suggests that the relationship is more complex and highlights significant gaps in current empirical research.

2.2. The role of ESG in mitigating firm risks

Independent of firm-specific governance attributes such as gender diversity, a significant body of literature suggests that high ESG performance is a strong risk-mitigation tool (see Linst et al., 2017; Krüger, 2015, among others). Although several theories examine this relationship, the literature mainly agrees that a firm's commitment to sustainability reduces its exposure to downside and extreme risks. The most influential explanation is grounded in Stakeholder Theory (Hill & Jones, 1992). This framework contends that firms with superior ESG performance proactively manage relationships with a broad set of stakeholders, including employees, suppliers, customers, and regulators, with fewer external information asymmetries and better reputations (Viviani et al., 2019). This proactive engagement builds intangible assets (Godfrey, 2005), which function as an insurance-like buffer during adverse economic shocks. Consequently, these firms face a lower probability of costly litigation, regulatory sanctions, and reputational damage, leading to more stable cash flows and a direct reduction in tail risk (Karwowski & Raulinajtys-Grzybek, 2021; Mishra & Modi, 2013).

A complementary financial perspective is rooted in incomplete-information asset pricing models (Merton, 1987). This view suggests that a growing clientele of socially responsible investors creates excess demand for high-ESG stocks. This expanded and more stable investor base reduces the stock's idiosyncratic volatility and lowers the firm's cost of capital. A superior ESG profile, therefore, enhances financial resilience and provides easier access to capital, particularly during periods of market stress (Chava, 2014).

Conversely, a critical perspective derived from Agency Theory posits an overinvestment hypothesis, suggesting that managers may engage in ESG initiatives opportunistically to enhance their reputation rather than to maximize firm value. Such behavior can lead to an inefficient allocation of corporate resources, thereby increasing agency costs and potentially elevating, rather than mitigating, firm risk (Barnea & Rubin, 2010).

The weight of the empirical evidence overwhelmingly supports the former two theories. There is a consensus that the genuine commitment to ESG practices ultimately translates into enhanced corporate resilience and a lower propensity for extreme negative outcomes. For instance, Bernile et al. (2018) find that sound corporate practices mitigate downside risk in US non-financial firms. Similar evidence is found in the Taiwanese and Vietnamese markets (Tran et al., 2020; Wang et al., 2015). Lööf et al. (2022) study 5,703 firms across ten countries and show that higher ESG ratings, including social and governance pillars, are associated with lower downside risk.

2.3. ESG Performance as a moderator of the gender diversity-risk nexus

While gender diversity is a critical governance attribute, its effectiveness as a risk-mitigation tool varies across corporate environments. ESG performance can serve as a key contextual factor that influences the connection between gender diversity and a firm's risk. Specifically, a strong ESG profile can foster an environment that enhances the risk-reducing advantages of diversity, while a weak ESG profile can offset or even eliminate them.

The theoretical foundation for this moderating effect is multifaceted. The primary mechanism is grounded in Stakeholder Theory (Freeman, 1984; Hill & Jones, 1992), which posits that firms with strong ESG performance actively manage relationships with a wide range of stakeholders, thereby accumulating moral capital. Such a stakeholder-oriented culture provides an enabling environment for gender-diverse boards—typically more sensitive to stakeholder interests—to function effectively. In high-ESG firms, the prudent, stakeholder-focused recommendations of diverse boards are more likely to be valued and incorporated into strategic decisions. This alignment enhances organizational resilience to litigation, regulatory scrutiny, and reputational shocks, thereby mitigating exposure to tail risks (Karwowski & Raulinajtys-Grzybek, 2021).

A second channel operates through the firm's information environment. High-ESG firms typically demonstrate greater transparency and richer non-financial disclosure, which reduces information asymmetry between managers and investors, thereby lowering the cost of capital and enhancing firm valuation (Dhaliwal et al., 2011). In such settings, the monitoring role of gender-diverse boards is strengthened, as access to higher-quality information enables more effective oversight and facilitates the early detection and mitigation of excessive risk-taking.

Finally, ESG performance is intrinsically linked to a firm's strategic time horizon. High-sustainability firms are shown to adopt a longer-term orientation, prioritizing sustainable value creation over short-term profits (Eccles et al., 2014). This long-term perspective aligns perfectly with the decision-making style often associated with gender-diverse boards. Conversely, a critical perspective derived from Agency Theory suggests that in low-ESG firms, managers may engage in opportunistic ESG initiatives merely for reputational gain—the overinvestment hypothesis (Barnea & Rubin, 2010). In such an environment, the risk-mitigating influence of diverse directors may be severely constrained. In contrast, strong ESG performance reduces agency risk and signals a corporate culture in which the benefits of diversity can fully materialize (Cheng et al., 2014).

From an empirical perspective, the growing body of literature examining the relationship between gender diversity and ESG performance finds that greater diversity is positively associated with superior ESG outcomes (Paolone et al., 2024; Khemakhem et al., 2023). This interrelationship is observable across all three ESG pillars. The link between gender diversity and environmental performance is particularly well-documented (Mohy-ud-Din, 2024). Empirically, firms with more women on their boards tend to exhibit superior environmental stewardship, with a lower incidence of environmental infringements (Liu, 2018), a higher propensity to disclose climate information voluntarily (Do et al., 2023), and a greater reliance on renewable energy (Atif et al., 2021). This pro-environmental orientation is also evident in strategic decisions; for instance, in the banking sector, gender-diverse leadership is associated with reduced lending to high-emission firms (Gambacorta et al., 2022).

From a social perspective, there is a strong interrelationship between gender diversity, stakeholder engagement, and corporate responsibility. Studies consistently find an association between board diversity and superior outcomes in stakeholder relations (Lewellyn et al., 2024; Poletti-Hughes & Martinez-García, 2022) and the development of stronger, more inclusive corporate cultures (Wongsinhirun et al., 2023).

Finally, there is also a significant correlation between gender diversity and the strength of the governance pillar, particularly concerning board oversight and prudent decision-making. Consistent with Behavioral Theory on risk aversion, firms with female CEOs or directors tend to adopt more cautious corporate policies (Francis et al., 2015), show a lower incidence of corporate fraud

(Dimungu-Hewage & Poletti-Hughes, 2023), and are associated with lower levels of opportunistic earnings management (Fan et al., 2019).

These consistent patterns suggest that the link between gender diversity and a firm's overall sustainability profile is fundamental. ESG performance and gender diversity can reinforce risk-mitigation mechanisms, thereby enhancing financial resilience by improving monitoring, stakeholder trust, and adaptive capacity. This interrelationship, in turn, points to a potential mechanism connected to mitigating downside and extreme risks. The impact is likely to vary across organizational levels and risk dimensions. For instance, while board-level diversity may directly enhance governance quality, managerial or workforce-level diversity may yield more indirect spillover effects.

2.4. Hypothesis to be tested

We argue that the risk-mitigating effects of gender diversity are not absolute but are conditional upon the firm's commitment to sustainability. By analyzing diversity across organizational levels and focusing on downside and extreme risks, we test the hypothesis that ESG performance is a powerful moderator, amplifying the benefits of an inclusive corporate structure. From the exposed framework, the main hypotheses that we test in the paper are:

H1: Higher ESG performance is negatively associated with a firm's downside and extreme risks.

H2: Higher gender diversity is negatively associated with a firm's downside and extreme risks.

H3: The negative relationship between gender diversity and downside and extreme risks is significantly stronger for firms with high ESG performance.

H4: The impact of gender diversity on downside and extreme risks depends on the organizational level.

3. Research Design

3.1. Methodology

To examine the moderating role of ESG profile in the relationship between gender diversity and downside and extreme risks, we treat ESG as a discrete variable (e.g., High, Medium, and Low) rather than a continuous variable. This method aims not just to detect non-linearities in the direct

ESG-risk link; its main goal is to assess how varying degrees of ESG commitment influence the relationship between gender diversity and risk nexus. The panel data model is:

$$\begin{aligned} Y_{i,T} = \mu_0 + \ & \mu_1 ESG\ high_{i,T-1} + \mu_2 ESG\ medium_{i,T-1} + \mu_3 Gender_{i,T-1} \\ & + \mu_4 ESG\ high_{i,T-1} * Gender_{i,T-1} + \mu_5 ESG\ medium_{i,T-1} * Gender_{i,T-1} \\ & + \Sigma i\ \theta i Control_{i,T-1} + \varepsilon_{I,T} \end{aligned} \quad (1)$$

where Y_{iT} is the risk proxy for firm *i* in year T, $ESG\ high_{i,T-1}$ and $ESG\ medium_{i,T-1}$ represents the two ESG discrete levels (being the low level the reference group), and $Gender_{i,T-1}$ is the measure for gender diversity for firm *i* in year *T-1*. $Controls_{i,T-1}$ is a vector of control variables including relevant firms' characteristics described below and is $\varepsilon_{i,T}$ the error term. We include industry and year fixed effects or random effects, depending on the Hausman test. All explanatory variables are lagged by 1 year to mitigate potential endogeneity concerns arising from simultaneity and reverse causality, as in Maxfield and Wang (2021). Additionally, we use instrumental variables to check the robustness of our results (see Section 5).

We estimate Equation (1) for each risk measure and each independent variable. According to the theoretical framework, we expect that μ_1 and μ_2 will be negative, reflecting the risk-mitigating effect of ESG on financial risks, also consistent with prior research (see García-Sanz et al., 2024). We anticipate that μ_1 will be larger in magnitude than μ_2 because high-ESG firms are likely to have more robust risk management systems and stronger stakeholder trust, which amplifies the reduction in downside and extreme risks.

The coefficient μ_3 measures the marginal effect of gender diversity on firm risk. We hypothesize that the sign of this coefficient depends on the organizational level being analyzed. At the board level, we anticipate a negative and significant coefficient. The literature mainly supports the view that the presence of women enhances the board's monitoring function and promotes a more prudent approach to strategic oversight, thereby mitigating downside and extreme risks. Conversely, the effect on the managerial and workforce levels is theoretically ambiguous. While diversity at these operational levels can enhance innovation and stakeholder relations, the link to financial risk is less direct. Some literature suggests that female managers may face pressure to adopt riskier behaviors to advance in male-dominated environments. Furthermore, broad workforce diversity could introduce coordination challenges that, in the short term, might not reduce—or could even elevate—certain

operational risks. Therefore, the sign of μ_3 for these sub-board dimensions remains an open empirical question.

Regarding the interaction effects of gender diversity and the ESG levels (μ_4 and μ_5), corresponding to ESG-high- and ESG-medium firms, respectively, we expect they be negative, as risk-mitigating role of gender diversity should be reinforced by the ESG level. We also expect strong reinforcement for higher levels of ESG profile (μ_4 greater than μ_5).

3.2.Risk measures

We analyze five dimensions of financial risk among downside and extreme risks. In the downside set, we count for Lower Partial Moment (LPM) formally quantify the dispersion of returns that fall below a specified minimum acceptable return (the mean, in our case), thereby capturing the magnitude of undesirable outcomes; Downside beta (Downsidebeta) formally measures a firm's systematic risk exclusively during periods of negative market returns, indicating its sensitivity to market downturns. For the worst scenarios, Tail beta (Tailbeta) formally assesses a firm's sensitivity to the market during periods of severe market stress, calculated using only the returns that fall into the lowest quantile of the market's distribution (10th percentile in our case). Collectively, these measures provide practical value for risk management by highlighting how negative shocks affect firms differently than the overall variance captured by unconditional measures.

For the extreme risk set we include Value-at-Risk (VaR) and Expected Shortfall (ES), which identify extreme negative outcomes that exceed normal market fluctuations. Value-at-Risk (VaR) formally estimates the maximum potential loss a firm could experience over a specific time horizon at a given confidence level (5% in our case). Complementing this, Expected Shortfall (ES) formally calculates the expected value of losses that exceed the VaR threshold, thus quantifying the average severity of these extreme tail events. These measures are particularly valuable for contingency planning and portfolio insurance, capturing unlikely but severe losses that could threaten a firm's financial stability.

Table 1 provides the definition, and a brief description of the financial risk measures outlined above. All risk measures are calculated from excess daily returns for each firm on an annual basis. Appendix I offers a more detailed explanation of their definitions and calculations.

[Insert table 1 about here]

3.3.Sustainability measures

We employ the LSGE Refinitive Thomson Reuters ESG (TR-ESG) score and each individual pillar score: TR-E (Environmental), TR-S (Social), and TR-G (Governance). These scores range from 0 to 100, with higher values indicating stronger ESG performance. The TR-ESG score provides a comprehensive assessment of firm-level ESG practices based on reported information across the individual pillars, complemented by an ESG controversy overlay derived from global media. Particular attention is given to the Social and Governance pillars: Social encompasses workforce-related factors, including Women employees and Women managers, while Governance includes management-related factors, including Board diversity. This score is widely accepted measures of firms' sustainability (Gallucci et al., 2022). They are specifically elaborated to measure the ESG profile and give homogeneous measures across firms and regions, which allows comparable results. In fact, 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).[2]

We use these scores to create dummy variables that classify firms according to their degree of ESG commitment. Specifically, ESG low takes value 1 if the firm's ESG score falls below the 25th percentile of the overall ESG distribution, and 0 otherwise. ESG medium equals 1 if the ESG score is between the 25th and 75th percentiles, and 0 otherwise. ESG high takes value 1 for firms with ESG scores above the 75th percentile. Across all models, the lowest degree of ESG commitment (ESG low) is used as the reference category. Additionally, $\text{ESG high}_{i,T-1} * \text{Gender}_{i,T-1}$ and $\text{ESG medium}_{i,T-1} * \text{Gender}_{i,T-1}$ is the interaction variable between each of the ESG thresholds and each gender measure for firm i in year T-1. Same reasoning applies for the analysis by pillars, when we classify firms in high, medium and low levels of E, S and G respectively.

[2] 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.

3.4.Gender diversity variables

The organizational hierarchy has direct implications for firm outcomes and risk exposure. By analyzing gender diversity across multiple organizational levels, we acknowledge that the impact of women in firms' risk can differ depending on their decision-making level, operational responsibilities, and strategic influence, offering deeper insights into the mechanisms through which gender diversity interacts with ESG profile to mitigate downside and extreme risks and capturing multi-level view of gender diversity.

Among the organizational levels, women in the workforce level refers to the aggregate composition of a company's employees below the managerial or executive ranks — essentially, the broader employee base that constitutes the organization's operational structure (Blau & Kahn, 2017). Women managers operate at the middle levels of the firm, and are linked to operational activities, overseeing day-to-day operations, and coordinating teams, resources, and objectives (Floyd & Wooldridge, 1997; Mintzberg, 1979). Women executives are generally part of the top management team (TMT) and are responsible for translating board-level strategies into operational plans (Bertrand & Schoar, 2003; Hambrick & Mason, 1984). They report directly to the board and significantly influence the company's overall direction, resource allocation, and strategic decision-making. Finally, women on the board provide governance and high-level monitoring, shaping corporate policies and long-term strategies, aligning them with the interests of stakeholders and shareholders (Terjesen et al., 2016; Adams & Ferreira, 2009).

So, we employ five measures sourced from Refinitiv DataStream. Three of these are direct representation metrics: Women employees, defined as the percentage of female employees relative to the total workforce; Women managers, the percentage of female managers relative to the total number of managers; and Board diversity, the proportion of female directors on the board.

Beyond these absolute measures, we construct two innovative relational metrics to understand more about the gender representation balance across corporate hierarchy levels. M.B and E.B are useful to analyze the pipeline and distribution of female talent across the firm's upper echelons. M.B, or the Manager-to-Board ratio, is defined as the percentage of women managers divided by the percentage of women on the board, intuitively capturing the internal leadership pipeline, that is, the flow of women progressing from mid-level management to the board (Adams & Kirchmaier, 2016). A ratio greater than one suggests a strong pool of female talent in middle management relative to the

board, whereas a ratio less than one may indicate a leaky pipeline, where the board is more diverse than the managerial ranks.

Similarly, E.B, or the Executive-to-Board ratio, is defined as the percentage of female executives divided by the percentage of women on the board. This ratio compares the two highest centers of power, capturing power asymmetry between executive decision-making and board oversight (Terjesen et al., 2016). A ratio less than one is particularly revealing, as it can help identify a "glass ceiling" where women may be present on the board but are blocked from the top executive.

3.5. Control variables

Finally, we follow the main literature (Fandella et al., 2023; Maxfield & Wang, 2021; Eliwa et al., 2021; Ji et al., 2021; Bruna et al., 2019; Bernile et al., 2018; Benlemlih & Gired-Potin, 2017; Sila et al., 2016; among others) in selecting a set of control variables regarding firm and board characteristics that may covariate with downside risks. ROA is the return on assets ratio ($ROA_{i,T-1}$), as more profitable firms can generate more capital to reduce their reliance on external financing and provide a cushion against financial risks distress. MTB ($MTB_{i,T-1}$), is the Market-to-book ratio measured as the stock market capitalization over the total equity of the firm, as a proxy for growth opportunities and intangible assets. Size *($Size_{i,T-1}$)* is the size of the firm, calculated as the log of the 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). Lev ($Lev_{i,T-1}$), is the leverage ratio, measured as 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). Board size *($Board\ size_{i,T-1}$)* is the total number of board members at the end of the fiscal year. Average board tenure *($Avg\ board\ tenure_{i,T-1}$)* is the average number of years each board member has been on board. A long tenure can influence the oversight of directors on CEOs, given that extended service time may also make a director more likely to be friends with the management at the cost of shareholders (Ji et al., 2021; Vafeas, 2003), resulting in less scrutiny from the board in monitoring CEO's decisions (Ji et al., 2021). So, it is relevant for governance mechanism (Abdelkader et al., 2024; Elms & Publiese, 2023; Patro et al., 2018). In fact, a positive link between board tenure diversity and firm outcomes (Phuong et al., 2022), and higher investment efficiency and effectiveness of earnings management (Katmon at al., 2019) are shown in the literature.

Table 2 summarizes all the explanatory variables and their definitions. Panel A shows the gender diversity measures and the ESG factors, and Panel B the covariates.

[Insert table 2 about here]

3.6. Data and preliminary analysis

We select 3718 firms (2326 US and 1392 Europeans[3]) using the LSGE Refinitiv US and EU indexes. Firms belong to different industries including Energy, Materials, Industrials, Consumer Discretionary and Staples, Health care, Financials, Information Technology, Real Estate, Communication Services and Utilities, following the Industry Classification Benchmark (ICB)[4]. In fact, Table A1 in Appendix II shows the number of firms by industry of our sample.

We gather daily closing stock prices of the firms from 2010 to 2022 from LSGE Refinitiv. Following Atilgan et al. (2019), all stock prices were converted to US dollars to ensure comparability of returns across countries. 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. Similarly, market excess returns are calculated by subtracting the risk-free rate from the market returns. The risk-free rate is proxied by the 3-month US Treasury bill rate for the US sample and the 3-month BD Fibor rate for the European sample, using daily observations.

Table 3 presents the descriptive statistics for risk measures. The mean value for Downsidebeta is 1.092 and for Tailbeta is 1.082 (Panel 1, Total sample), meaning that, for our sample of firms, the investment performance during market downturns is positive. Moreover, this data means that the average Downsidebeta of the sample is greater than the average Tailbeta. This indicates that, on average, assets are more sensitive to moderate market declines than to extreme negative events, as Downsidebeta measure captures the responsiveness of the assets to negative market movements, and Tailbeta measure isolates only the most severe market losses. Therefore, this suggests that assets exhibit stronger reactions during typical downturns, but they are relatively more resilient during extreme market shocks. This distinction has important implications for risk management, as it

[3] Countries included are Austria, Belgium, Cyprus, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxemburg, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, United Kingdom.

[4] ICB is an industry classification taxonomy launched by Dow Jones and FTSE in 2005 and now used by FTSE International and STOXX. It is similar to Global Industry Classification Standard (GICS), the taxonomy developed in 1999 by MSCI and S&P.

highlights that the assets may experience substantial risk in routine negative conditions while being less exposed to catastrophic market events. This trend holds across subsamples, with the exception of financial firms, where the opposite pattern emerges.

For the full sample (Panel 1, Table 3), the average Value-at-Risk (VaR) is 3%, indicating that with a 5% probability, the expected loss is 3%. The average Expected Shortfall (ES) is 4.4%, representing the mean loss among the worst 5% of outcomes— that is, the expected return in the tail of the distribution under the most adverse scenarios. By subsample, only European firms and financial firms (Panels 3 and 5) exhibit VaR below the full-sample average, whereas US firms and non-financial firms (Panels 2 and 4) display ES values below the overall sample mean.

[Insert table 3 about here]

Table 4 presents descriptive statistics for the independent and control variables. Across the full sample, the average percentage of women employees is 37.90%, indicating that approximately 38% of the workforce is female. This share is higher in the U.S. sample (39.17%, Panel 2) and reaches parity in the financial subsample (50.11%, Panel 5). The average proportion of women managers is 30.69%, meaning that roughly 31% of managerial positions are held by women. Again, this percentage is higher in the U.S. sample (33.67%) and the financial subsample (36.7%). Regarding board composition, the average proportion of women on board is 22.72%, or approximately 23% of board members. This figure is higher in the European subsample (26.78%) and in the financial subsample (23.71%). The ratio of women managers to women on boards (MB) averages 1.25, while the ratio of women executives to women on boards (EB) is 0.702. This means that for every woman on the board there are 1.25 women in managerial positions, while there are 0.702 women in executive positions. So, this points out a gap in the hierarchy as managerial roles are well-represented but the level decreases in terms of higher levels in the hierarchy. By subsample, these ratios are higher in the U.S. (1.425 and 0.783, respectively) and in the financial subsample (1.496 and 0.74, respectively). Finally, in terms of the ESG scores, the average ESG score is 46.382, while by pillars are 39.351, 51.216, and 52.093 respectively (E, S, G). These measures are higher only in the European and non-financial subsamples.

[Insert table 4 about here]

Table 5 provides a descriptive overview of risk measures and gender diversity across ESG levels, highlighting the potential interplay between sustainability, organizational diversity, and financial risk. The results indicate that firms with higher ESG scores generally exhibit lower average financial risk, a pattern that holds for the U.S. sample and non-financial firms but is less evident for European firms or financial institutions, suggesting that the ESG–risk relationship may vary across regions and sectors. Regarding gender diversity, firms with higher ESG scores tend to show greater diversity, although this pattern is less pronounced at the workforce level. In the U.S., higher ESG scores consistently correspond to higher diversity, whereas in European firms, the highest diversity is observed at medium ESG levels, a trend also seen in non-financial firms. Among financial firms, top-level diversity is highest for firms with high ESG scores, but workforce and managerial diversity do not follow this pattern.

These observations underscore that ESG, and gender diversity are interrelated but not perfectly aligned, and they motivate the need for a joint analysis to understand how the level and context of diversity influence downside and extreme risks. By summarizing these associations, Table 5 provides the basis for the subsequent econometric models and the examination of how ESG practices and gender diversity together shape firms' risk profiles.

[Insert table 5 about here]

We present the correlation matrix for all variables in Table A2 (Appendix II). Overall, correlations among the risk measures are generally low, with the expected exception of Value-at-Risk (VaR) and Expected Shortfall (ES), as ES is calculated based on the VaR threshold. Similarly, correlations with Lower Partial Moments (LPM) are higher, reflecting that while these measures differ in how they weight losses —VaR as a threshold, ES as an average beyond the threshold, and LPM with customizable orders—they capture substantially overlapping downside risk events. This finding supports the relevance of analyzing a comprehensive set of risk measures. Regarding gender diversity proxies, women managers show a strong positive correlation with women employees, while their correlation with women on boards is positive but relatively low. Overall, correlations among the gender diversity measures are low, suggesting that these proxies capture distinct dimensions of diversity across organizational levels. Finally, as anticipated, correlations between the overall ESG score and its individual pillars (environmental, social, and governance) are relatively high, reflecting the inherent interdependence of these components.

4. Empirical Analysis

Tables 6 to 14 display the results for the estimation of Equation (1). Table 6 presents the full sample analysis, while tables 7 to 9 display the results by pillars. Tables 10 and 11 show the results by regional subsamples and tables 12 and 13, the results by sector subsamples. Finally, table 14 displays the results for the Covid period analysis again using the full sample. Moreover, result tables are structured as follows. Each panel reports the coefficients of six key variables: two ESG score levels (high and medium), one of the five gender diversity proxies (Women employees in Panel 1; Women managers in Panel 2; Board diversity in Panel 3; Managers-to-women-on-board ratio in Panel 4; and Executives-to-women-on-board ratio in Panel 5), and two multiplicative interaction terms (each level of ESG and each of the gender diversity proxies). The columns correspond to the five downside risk proxies—Tailbeta, Downsidebeta, LPM, VaR, and ES. Furthermore, multicollinearity is not a concern, as evidenced by all Variance Inflation Factor (VIF) values (see Table A3 in Appendix II).

Although omitted from the main tables, all models include the set of control variables described earlier (full estimations are provided in the Appendix III). In general, the control variables exhibit a consistent pattern: most show a significant negative effect on downside risk, whereas leverage stands out by exerting a significant positive effect, reinforcing its role as a risk-enhancing factor.

4.1. Full sample analysis

Table 6 reports the estimation results of Equation (1) across all ESG dimensions and the various proxies for gender diversity, based on the full sample. Since all variables are standardized, the coefficient magnitudes are directly comparable across models.

[Insert table 6 about here]

Results indicate that greater female representation among employees (Panel 1) is associated with lower Downside beta (Downsidebeta) and Value-at-Risk (VaR) in low-ESG firms. This finding supports prior evidence that inclusive workforces enhance organizational stability, risk awareness, and operational prudence, thereby reducing downside exposure (Ingersoll et al., 2023; Glass & Cook, 2018). However, the stabilizing influence of workforce diversity may be constrained by employees

limited decision-making authority, implying that its effect operates mainly through improved workplace culture and process reliability rather than strategic oversight.

The moderating role of ESG performance at the employee level shows that firms with stronger ESG scores experience slightly greater risk reduction (LPM, VaR and ES), suggesting that ESG-oriented environments may reinforce the benefits of workforce inclusivity. However, the interaction analysis reveals diminishing marginal effects in high and medium ESG firms: when ESG systems already provide strong risk controls, the incremental contribution of employee diversity to stability becomes smaller (VaR, Panel 1), while when the moderator role of ESG is not significant to explain risks (Tailbeta, Panel 1), the interaction helps to reduce the firms' risk.

At the managerial level (Panel 2), gender diversity exhibits more complex dynamics. A higher proportion of female managers is sometimes associated with increased ES, possibly reflecting greater exposure to strategic decision-making risks, performance pressures, or heightened scrutiny in underrepresented contexts (Wang & Fung, 2022; Terjesen et al., 2016; Faccio et al., 2016). Nevertheless, gender-diverse management teams may also foster adaptability and innovation, which could offset certain risk exposures over time.

ESG performance moderates this relationship. Medium- and high-ESG firms exhibit strong association with financial risk, suggesting that ESG-oriented frameworks help to mitigate LPM, VaR and ES. Finally, the interaction results are modest: in some specifications, high and medium ESG mitigate the increase of certain extreme risks (ES), while in others it exerts limited influence for medium firms in downside risks (LPM). These findings imply that ESG engagement provides an enabling context that may reduce the performance pressures or strategic constraints faced by female managers, but only when sustainability practices are deeply institutionalized.

At the board level (Panel 3), gender diversity consistently exerts a strong effect in reducing both downside and extreme risks, underscoring the centrality of inclusive governance for corporate risk management. Firms with greater female board representation demonstrate enhanced monitoring capacity, broader cognitive perspectives, and improved strategic decision-making, all of which contribute to long-term financial stability (Bernile et al., 2018; Perryman et al., 2016; Lenard et al., 2014; Adams & Ferreira, 2009).

The moderating influence of ESG performance is particularly pronounced at this level. High-ESG firms with gender-diverse boards experience the largest reductions in downside and tail risks, consistent with ESG acting as an "insurance-like" mechanism that amplifies the protective effects of inclusive governance (García-Sanz et al., 2024; Albuquerque et al., 2019). The interaction results reveal a modest effect for high and medium ESG firms, highlighting the synergy between sustainability-oriented corporate cultures and inclusive leadership (Atif et al., 2021; Galbreath, 2018; Lins et al., 2017).

However, when the proportion of female executives exceeds that of female board members (higher EB ratio, Panel 5), risk tends to rise—suggesting that the reinforcing effect of ESG weakens when executive-level representation outpaces board oversight (Wang & Fung, 2022). This imbalance may signal governance misalignment, where inclusivity at the executive level is not yet matched by equivalent strategic support or monitoring capacity at the board level.

Across organizational levels, the results identify board gender diversity as the most influential channel for mitigating downside and extreme risks. ESG performance serves as a critical moderating mechanism—most effective when integrated with board-level. These findings align with Agency Theory, which emphasizes that gender-diverse boards enhance monitoring and reduce managerial opportunism (Gul et al., 2011; Adams & Ferreira, 2009); and Stakeholder Theory, which posits that diversity and sustainability jointly strengthen legitimacy, trust, and stakeholder relationships, promoting firm resilience (Khemakhem et al., 2023; Freeman, 1984).

4.2. Diversity by pillars

Analyzing the ESG pillars separately offers deeper insights into their moderating role in the relationship between gender diversity and financial risk, as each pillar captures distinct dimensions of firm behavior and stakeholder engagement (García-Sanz et al., 2024; Berg et al., 2022). Thus, Tables 7, 8, and 9 present the estimation results for Equation (1) when applied separately to the Environmental (E), Social (S), and Governance (G) pillars and each of the gender diversity proxies. The results show that the patterns observed for the control variables remain consistent across all three dimensions.

[Insert table 7 about here]

In Table 7, results indicate that gender diversity, particularly at the board (Panel 3) and employee (Panel 1) levels—reduces downside and extreme financial risks within firms exhibiting strong environmental engagement. These results suggest that environmentally responsible organizations derive additional stability benefits from inclusivity, as diverse teams may be more attuned to long-term ecological and operational risks (Atif et al., 2021; Galbreath, 2018). Contrary, higher M.B. and E.B. ratios (Panels 4 and 5) will lead to an increase of LPM and extreme risks (VaR, ES). Meaning that when the proportion of women in managerial or executive positions exceeds their representation on the board, firms may experience greater exposure to operational and strategic risks—possibly due to limited board-level oversight or heightened performance pressures at upper management levels (Ingersoll et al., 2023; Glass & Cook, 2018; Adams & Ferreira, 2009).

The Environmental pillar also exerts a strong moderating effect: higher environmental scores amplify the risk-mitigating influence of gender diversity, indicating that firms integrating sustainability into operations are better able to translate inclusive governance into financial resilience. Interaction effects are modest, although they exhibit significant effects for medium and high ESG firms in the majority of the models, diminishing or neutralizing the direct effect of gender diversity. Together, these findings suggest that environmental commitment not only enhances the stabilizing role of gender diversity but can also neutralize potential risk-increasing effects associated with imbalances in female representation across organizational levels, reinforcing the importance of aligning inclusivity with sustainable governance practices.

[Insert table 8 about here]

Under the Social dimension, Table 8, gender diversity again exerts a strong effect: greater representation of women on boards (Panel 3) and among employees (Panel 1) is associated with lower downside and extreme risk, underscoring the social benefits of inclusivity for organizational cohesion, trust, and employee engagement. Contrary, higher proportion of executives with respect to women on boards will lead to higher LPM and extreme risks (VaR, ES, Panel 5), suggesting that imbalances between executive and board-level representation may heighten exposure to strategic and performance-related risks.

The Social pillar's moderating role is also positive and consistent firms with stronger social practices experience larger risk reductions linked to gender diversity. This suggests that gender inclusion reinforces broader social commitments such as labor rights, equity, and community

engagement, which collectively foster stakeholder trust and reduce reputational and regulatory vulnerabilities (García-Sanz et al., 2024; Berg et al., 2022). Interaction effects reveal that, in medium- and high-social-performance firms, the risk-reducing effect of board diversity remains, although at a weaker magnitude (Panel 3), whereas at the employee level, diversity becomes largely insignificant (Panel 1). Finally, the interaction involving the EB ratio (Panel 5) plays an important role at higher ESG levels, offsetting the increase in risk observed among low-ESG firms. Thus, the social dimension of ESG not only strengthens the stability benefits of gender diversity but also ensures that inclusivity translates into tangible risk mitigation when embedded within a broader culture of social responsibility.

[Insert table 9 about here]

In contrast, the Governance pillar, Table 9, exhibits a more limited relationship between gender diversity and financial risk. While female board representation (Panel 3) continues to correlate with reduced downside and extreme risks, the magnitude of this effect is smaller compared with the Environmental and Social pillars. The Governance pillar's moderating influence is also weaker, higher governance scores do not consistently amplify the stabilizing role of gender diversity. Instead, results suggest partial overlap: when board diversity is explicitly accounted for, the explanatory power of governance quality on risk diminishes, implying that gender diversity itself may be one of the operative channels through which governance strength manifests. Interaction effects show that higher and medium ESG firms regularly tend to display lower increase in risks (Panels 4 and 5), or lower risk reduction when the mitigating role of the board is already strong. This means that This means that the risk-mitigating effects of governance and gender diversity may operate through similar mechanisms—such as enhanced oversight and accountability—so that when governance structures are already robust, the incremental contribution of gender diversity to further reducing risk becomes less pronounced (Nadeem et al., 2019; Terjesen et al., 2016).

Taken together, the three ESG pillars reveal distinct yet interconnected pathways through which gender diversity influences financial risk. The Environmental and Social dimensions exhibit the strongest and most consistent moderating effects, reflecting their direct links to firms' operational processes, stakeholder relations, and reputational resilience. In these contexts, inclusivity complements sustainability practices, helping organizations internalize long-term risk awareness and stability-oriented decision-making. In contrast, the Governance dimension acts primarily as a

structural enabler of diversity rather than an independent amplifier of its effects; both governance quality and board diversity appear to operate through similar mechanisms of oversight and accountability, reducing the incremental impact of one when the other is already strong (Nadeem et al., 2019; Terjesen et al., 2016). Overall, board-level female representation emerges as the most reliable determinant of lower downside and extreme risk across all ESG pillars, while the magnitude and persistence of moderating and interaction effects depend on the specific sustainability mechanisms embedded within each pillar.

This disaggregated perspective highlights that ESG and gender diversity interact through differentiated but complementary channels—environmental and social engagement drive tangible reductions in financial risk via operational and stakeholder pathways, whereas governance ensures strategic coherence and institutional support for inclusion. Collectively, these findings provide a comprehensive understanding of how sustainability and inclusivity jointly enhance firms' resilience to financial distress and systemic shocks.

4.3. Regional analysis: European vs US firms

Firms in the US and Europe operate under distinct institutional and regulatory frameworks that influence their approaches to sustainability and gender equality (Krueger et al., 2020; EU, 2020; Terjesen et al., 2015). These institutional differences motivate a comparative examination of how firms in both regions promote workplace equality to moderate the relationship between the ESG goals and downside and extreme risks. Tables 10 (U.S.) and 11 (Europe) report the estimation results for Equation (1) by regional subsamples and each of the gender diversity proxies, showing that gender diversity exerts an effect on financial risk, but its strength and direction differ across regions. The trend of the control variables maintains across subsamples.

[Insert table 10 about here]

In the U.S. subsample, Table 10, gender diversity plays a more limited role in mitigating risk, particularly among low-ESG firms. A higher proportion of female managers (Panel 2) is associated with increases in Lower Partial Moments (LPM) and extreme risks (VaR and ES), indicating that gender diversity at the managerial level does not translate into a risk reduction. By contrast, leadership diversity—captured by the Manager–Board (MB) and Executive–Board (EB) ratios (Panels 4 and 5)—shows significant negative effects on downside risk, suggesting that when women occupy executive positions relative to board representation, they tend to adopt more prudent strategic

behaviors that partially offset firm risk (Cho et al., 2021; Terjesen et al., 2016; Croson & Gneezy, 2009). ESG performance further moderates these relationships, consistently reducing all measures of financial risk and reinforcing its role as a robust "insurance-like" mechanism (Bernile et al., 2018). Moreover, interaction effects between ESG and gender diversity indicate that higher ESG scores amplify the protective influence of both board and managerial diversity, leading to lower downside and tail betas. This pattern implies that in market-driven governance systems, ESG engagement enhances the monitoring and decision-making capacity of gender-diverse leadership, translating inclusivity into measurable financial resilience.

[Insert table 11 about here]

In contrast, the European subsample, Table 11, provides stronger evidence that gender diversity reduces financial risk even in low-ESG contexts. Greater female representation among employees (Panel 1), managers (Panel 2) and board (Panel 3) is significantly associated with lower downside and extreme risks, indicating a more consistent effect. However, a higher EB ratio (Panel 5) is linked to increased risk, potentially reflecting the heightened scrutiny and structural pressures faced by female executives in more institutionalized environments (Ingersoll et al., 2023; Glass & Cook, 2018). ESG performance again acts as an important moderator, but its influence is more heterogeneous than in the U.S. While higher ESG scores generally reduce LPM, VaR, and ES, they are associated with increases in Tailbeta and Downsidebeta, particularly among high-ESG firms. This divergence suggests that strong ESG commitments may coincide with greater exposure to systematic or reputational risks, possibly due to heightened stakeholder expectations in more transparent governance systems (Adams & Ferreira, 2009). Interaction effects further confirm this complexity: in Europe, the role of the ESG level is often weaker or statistically insignificant, while higher ESG attenuates the risk-reducing effect of board diversity. Yet, for the EB ratio, ESG moderates the initially positive association with risk—transforming it from risk-enhancing in low-ESG firms to risk-neutral at medium ESG and risk-reducing at high ESG—indicating that female executives are most effective at stabilizing firms when supported by strong ESG frameworks.

Overall, these findings underscore that institutional and regional contexts critically shape the diversity–risk relationship. In the U.S., where governance structures are primarily market-driven and ESG engagement remains largely voluntary, gender diversity mitigates risk mainly through operational and stakeholder-oriented mechanisms, consistent with Stakeholder Theory (García-

Castro et al., 2010; Hillman et al., 2002). Conversely, in Europe's more regulated and stakeholder-embedded governance environment, gender diversity influences risk primarily through board-level monitoring, compliance, and strategic oversight, in line with Agency and Institutional Theories (Nadeem et al., 2019; Terjesen et al., 2016). Taken together, these results highlight that while both gender diversity and ESG enhance corporate resilience, their effectiveness fundamentally depends on the institutional frameworks that shape firms' governance and sustainability practices.

4.4.Sectorial analysis: Non-financial vs financial firms

Non-financial and financial firms operate within distinct institutional, regulatory, and organizational contexts (Leaven & Levine, 2009). Financial institutions, in particular, serve as critical intermediaries by channeling capital toward sustainable initiatives, thereby influencing other sectors through lending and investment decisions (OECD, 2020). At the same time, they face greater public and regulatory scrutiny compared to non-financial firms, which often compels them to adopt more formalized and visible diversity and sustainability policies (Scholtens, 2009). This is particularly relevant given that the financial sector has traditionally been male dominated (Glass & Cook, 2016). These structural and institutional differences may shape how financial and non-financial firms approach sustainability and gender-related policies. Accordingly, this section compares these two groups to identify potential differences in their risk profiles.

Tables 12 (Non-financial) and 13 (Financials) present the estimation results for Equation (1) by sector subsamples and each of the gender diversity proxies. The trend of control variables remains consistent in the non-financial subsample, whereas in financial firms some controls, such as average board tenure and board size, show limited explanatory power for risk measures. Gender diversity exerts a significant effect on financial risk, though its magnitude and direction vary notably between non-financial and financial firms.

[Insert tables 12 and 13 about here]

In non-financial firms (Table 12), greater female representation among employees (Panel 1) and board members (Panel 3) consistently lowers downside and extreme risks (LPM, VaR, ES), suggesting that inclusive organizational cultures and gender-diverse governance structures enhance prudence and strategic oversight (Ingersoll et al., 2023; Glass & Cook, 2018). However, a higher Executive–Board (EB) ratio—reflecting stronger female presence in executive roles relative to boards—is associated with greater risk, implying that unbalanced executive representation may

heighten exposure to strategic pressures or volatility (Faccio et al., 2016). ESG performance amplifies the overall risk-reducing effects, as medium- and high-ESG firms experience significant declines in downside and extreme risks, reaffirming ESG's "insurance-like" role (Albuquerque et al., 2019). The interaction between ESG and gender diversity remains modest, becoming more pronounced only in the case of high-ESG firms for the Executive–Board (EB) ratio. This suggests that the stabilizing influence of gender inclusion is largely embedded within firm operations and governance structures. In particular, when female executives operate within firms with strong ESG commitments, their decision-making effectiveness and strategic prudence are reinforced by sustainability-oriented oversight, allowing the EB ratio to reflect a genuine channel through which inclusive leadership contributes to financial stability.

By contrast, in financial firms (Table 13), higher female representation—particularly at the workforce (Panel 1), managerial (Panel 2), and board (Panel 3) levels—is consistently associated with increased financial risk. This pattern may reflect the sector's inherent exposure to market and credit risks, stringent regulatory requirements, and high-stakes decision-making environments that amplify the visibility and pressure on female leaders (Liang & Renneboog, 2020; García-Sánchez et al., 2019). The moderating role of ESG is comparatively limited: its influence on downside and tail risks is neither uniform across risk measures nor consistently significant. Nevertheless, the interaction terms indicate that high- and medium-ESG financial firms tend to experience lower levels of downside and extreme risk, with particularly notable effects on the workforce and managerial levels (Panels 1 and 2), suggesting that sustainability engagement can partially buffer the risk-enhancing dynamics observed in gender-diverse financial institutions.

Overall, these findings underscore that the diversity–risk relationship is highly sector-specific, reflecting structural differences in risk profiles, governance hierarchies, and exposure dynamics. In non-financial firms, where risks are primarily operational and environmental, gender diversity and ESG engagement operate synergistically to strengthen organizational resilience and long-term stability—consistent with Stakeholder Theory and the conceptualization of ESG as an "insurance-like" risk-buffering mechanism (Atif et al., 2021; Galbreath, 2018). In contrast, within financial institutions, where risks are largely market-driven and shaped by regulatory constraints, gender diversity and ESG integration function more as enabling conditions that support responsible decision-making rather than direct safeguards against volatility. Taken together, these results

highlight that the effectiveness of gender diversity in mitigating financial risk critically depends on sectoral context and on the degree of alignment between inclusivity initiatives, sustainability practices, and firms' intrinsic risk structures.

4.5.Gender diversity and Covid-19 crisis.

The COVID-19 pandemic has renewed interest in understanding the drivers of organizational resilience during periods of crisis. One line of research emphasizes the role of gender diversity in enhancing firms' ability to manage and mitigate risk, as it is associated with broader skills that are particularly valuable during turbulent periods (Post & Byron, 2015), and with lower firm risk (Sila et al., 2016), heling to firms' survival in market downtowns. Thus, we consider the variable Covid that is a dummy that takes value 1 for Covid19 years, that is, 2020, 2021 and 2022, and 0 otherwise to interact with the gender proxies. Table 14 presents the estimation results for Equation (1) considering the Covid period for each of the ESG levels and each of the gender diversity proxies. The trend of the control variables maintains also in this case.

[Insert table 14 about here]

The results reveal mixed effects of gender diversity on financial risk. Most gender diversity proxies significantly influence risk outcomes, with the exception of female managers, who show no discernible effect. Specifically, greater female representation among employees and higher board diversity are consistently associated with lower downside and extreme risks, while higher Manager–Board (MB) and Executive–Board (EB) ratios tend to increase risk in low-ESG firms. These findings suggest that, even in the absence of strong ESG engagement, the gender composition across organizational levels exerts heterogeneous effects on financial risk, reflecting differences in authority, influence, and exposure to strategic decision-making.

Moreover, when examining interaction effects of gender diversity proxies with the COVID-19 variable, the mitigating role of women on boards (Panel 3) remains statistically significant. This finding underscores that board diversity enhances monitoring quality, broadens cognitive perspectives, and strengthens decision-making capacity under heightened uncertainty (Terjesen et al., 2016; Adams & Ferreira, 2009). In terms of the MB ratio (Panel 4), during Covid19, a higher proportion of managers with respect to women on boards will lead to a decrease of risks. However, in the case of the EB ratios (Panel 5) interaction indicates that a higher proportion of female executives relative to women on boards further contributes to an increase of risks pandemic period.

This highlights the strategic importance of female managerial leadership in navigating crisis conditions and ensuring adaptive organizational responses. Finally, the moderating role of ESG is modest and with mixed behavior.

Overall, the results highlight that gender diversity is a key, yet context-dependent determinant of financial stability. Its effects vary across organizational levels and are conditioned by ESG performance and crisis environments. Board diversity consistently enhances firms' resilience by strengthening oversight and strategic adaptability, particularly under uncertainty, while female managerial representation supports operational stability during disruptions such as COVID-19. In contrast, disproportionate female presence at the executive level—relative to the board—may heighten strategic risk when not complemented by strong governance or ESG frameworks.

In sum, inclusivity and sustainability emerge as complementary mechanisms of corporate resilience: firms that integrate gender diversity within robust ESG structures exhibit superior capacity to absorb shocks, manage downside exposure, and sustain long-term financial performance.

5. Robustness Analysis

5.1.Endogeneity concerns

This study employs panel data models with firm-fixed effects and incorporates lagged ESG, gender diversity, 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 concerns may still remain, potentially biasing the results (Bouslah et al., 2013).

In fact, endogeneity is especially relevant in the leadership-performance nexus, as nearly all the characteristics around a board or top management team and a firm's performance can be endogenous, producing joint endogeneities (Hermalin & Weisbach, 2003). For instance, Hermalin and Weisbach (1998) find that unsatisfactory company performance can lead to boards becoming more independent as a reactive response. This highlights that certain firm characteristics can drive changes in board composition, which in turn may subsequently influence company performance through the board's proactive decision-making.

Not only that, but endogeneity is also relevant in terms of sustainability. Firms with stronger financial results may have more available resources to allocate toward sustainability initiatives, suggesting that financial strength drives ESG engagement rather than ESG performance leading to

improved financial outcomes. This issue has been consistently discussed in prior studies (e.g., Albuquerque et al., 2019).

To analyze 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 the endogenous variable), 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 (Martielli et al., 2024; El Ghoul et al., 2019) as instrumental variable for each of the ESG levels. 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 level, while capturing the relevant influence of the peer group sector.

Same strategy and reasoning apply for each of the gender diversity variables that also can be a source of endogeneity. Firms with lower inherent risk may be more likely to appoint women to leadership positions, while unobserved characteristics such as corporate culture could jointly influence both gender composition and risk (Faccio et al., 2016; Adams & Ferreira, 2009). Thus, each of the diversity variables is instrumentalized using the leave-one-out sector-average.

[Insert table 15 about here]

Table 15 presents the results of the instrumental variable (IV) estimations for each potentially endogenous variable, along with two specification tests assessing the validity and strength of the instruments. 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 high, ESG medium and each of the gender diversity variables respectively. The null hypothesis is that the instrument is weak. As reported, according to the p-value of the first-stage statistic, the null hypothesis is strongly rejected in all models, confirming that the selected instruments are relevant predictors. The second diagnostic examines the presence of endogeneity using the Wu-Hausman (WH) test. This test compares the coefficients from the model with those from the IV model. The null hypothesis is that the variable of interest is exogenous, which would imply IV estimator is not required. The test results indicate that, for most estimated models, the null hypothesis of exogeneity cannot be rejected at conventional significance levels. In the few cases where exogeneity is rejected, the sign and significance of the coefficients remain consistent with those obtained from the model.

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.

5.2.Alternative analysis by proxies

To ensure that our findings are not driven by the choice of a particular proxy for gender diversity we have considered, we extend the analysis using alternative indicators. Specifically, we consider two alternative proxies for our diversity variables that are very well established in literature (Mehedi et al., 2024; Abdelkader et al., 2024; Kuzey et al., 2022; Uyar et al., 2022; Zaid et al., 2020; Pucheta-Martínes & Gallego-Álvarez, 2019; Cucari et al., 2018).

First, the Shannon Index (Shannon, 1948), originally derived from information theory and widely applied in ecology and organizational studies, captures both the proportion of each category and the evenness of their distribution -that is, the degree to which observations are evenly spread across categories rather than concentrated in a few, according to the following formula:

$$H' = \sum_{i=1}^{S} p_i \, ln(p_i)$$

Where H' is the Shannon Index, S is the total number of categories and p the probability of each category. In the context of gender diversity, it reflects not only the share of the women in the specific category (that is, women on board, women managers, etc. for each of our categories) but also the balance between men and women, with higher values indicating greater diversity.

Second, the Blau Index (Blau, 1977) provides another widely used measure of heterogeneity, defined as $1 - \sum p_i^2$, where p_i^2 is the proportion of members in the category i. For gender diversity, this index increases as the distribution between men and women becomes more equal, reaching the maximum when the category is evenly split between genders. Thus, higher values of the index indicate greater heterogeneity in the category.

Tables 16 and 17 report the summary results for Equation (1), employing the Shannon Index and the Blau Index respectively, as alternative proxies for gender diversity across the respective

categories. The consistency of the results across these measures reinforces the robustness and reliability of the main findings.

[Insert tables 16 and 17 about here]

6. Concluding Remarks

This paper investigates how gender diversity interacts with firms' ESG practices to influence downside financial risk, using a panel of 3,718 firms (2,326 U.S. and 1,392 European) from Refinitiv DataStream. The results demonstrate that gender diversity exerts a clear and economically meaningful effect on financial risk, though its strength and direction vary across organizational levels, sectors, and regions. Among all diversity measures, board-level female representation emerges as the most robust and consistent determinant of lower downside and extreme risks. By contrast, gender diversity among managers and employees exerts more context-dependent effects, reflecting the board's central role in shaping strategic direction and risk oversight, while operational-level inclusivity affects firm stability through process efficiency, culture, and stakeholder relations (García-Castro et al., 2010; Hillman et al., 2002).

ESG performance functions as a critical moderating mechanism in this relationship. The Environmental and Social pillars consistently amplify the risk-mitigating effects of gender diversity, highlighting that sustainability initiatives addressing environmental stewardship, employee welfare, and stakeholder engagement translate most directly into financial resilience. In contrast, the Governance pillar exerts a weaker and more structural influence, suggesting that formal control mechanisms primarily enable rather than magnify the benefits of inclusivity. Interaction effects further reveal significant regional heterogeneity: in the U.S., ESG engagement strengthens the protective role of gender-diverse leadership, while in Europe, the effect is more institutionalized and less sensitive to incremental ESG improvements. During the COVID-19 period (2020–2022), gender-diverse boards proved particularly effective in reinforcing ESG's "insurance-like" function against extreme downside risk, underscoring the value of inclusive leadership during systemic crises.

Sectoral analysis confirms that non-financial firms derive the strongest and most consistent stability gains from gender diversity and ESG engagement, whereas financial institutions display more heterogeneous patterns, likely reflecting regulatory constraints, leverage dynamics, and macro-

financial exposures. Collectively, these findings emphasize that the diversity–ESG–risk nexus is inherently context-dependent, shaped by institutional frameworks, sectoral structures, and the maturity of ESG integration.

The study carries several important implications. For policymakers, promoting gender diversity alongside comprehensive ESG standards can enhance systemic financial stability and foster more resilient economies. For corporate leaders, embedding inclusivity within sustainability and risk management strategies, especially through diverse and empowered boards, offers a tangible path to improving governance quality and long-term performance. For scholars, the results underscore the need to disentangle how gender diversity and ESG pillars interact under different institutional, regional, and sectoral conditions to shape firms' adaptability, resilience, and strategic behavior in the face of uncertainty.

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TABLES

Table 1: Risk measures

Variable	Formula	Description
Downside beta	$Downsidebeta_i = \frac{Cov\,(R_i, R_M \mid R_M < \mu_M)}{VaR(R_M < \mu_M)}$	It captures the sensitivity of equity returns to market movements during market declines.
Lower Partial Moment (LPM)	$LPM_i = \int_{-\infty}^{h} (h - R)^m f_i(R) dr$	LPM measures losses relative to a reference point and ignores gains exceeding such a reference point. When the reference point is the mean, LPM corresponds to the semi-variance.
Tail beta	$Tailbeta_i = \frac{\mathrm{Cov}\,(R_i, R_M \mid R_M < P10_M)}{VaR(R_M < P10_M)}$	Tail beta is a measure of a firm's (or asset's) sensitivity to extreme market downturns.
Value-at-Risk (VaR)	$VaR_\alpha(R) = -inf\,\{x \in \mathbb{R} \mid F(x) > \alpha\}$	It calculates the financial predicted loss with a given probability (α) for a specific time horizon.
Expected Shortfall (ES)	$ES_\alpha(R) = -E\big(R \big\vert R \leq q_\alpha(R)\big)$	It calculates the expected loss based on the α % worst cases.

Table 2: Independent and control variables

Panel 1: Gender diversity and ESG variables

Variable	Formula	Description
Women employees	Women employees = $\frac{N\ of\ women\ employees}{Total\ n\ of\ employees}\ x\ 100$	It represents the percentage of women over the total number of firm's workers
Women managers	Women employees = $\frac{N\ of\ women\ managers}{Total\ n\ of\ managers}\ x\ 100$	It represents represents the percentage of women managers over the total number of managers
Board diversity	Board diversity = $\frac{N\ of\ women\ on\ board}{Total\ n\ of\ board\ members}\ x\ 100$	It represents the percentage of female on the board
M.B.	M.B. = $\frac{N\ of\ women\ managers}{N\ of\ women\ on\ board}\ x\ 100$	It is the ratio of women managers with respect the women on board
E.B.	E.B. = $\frac{N\ of\ women\ executives}{N\ of\ women\ on\ board}\ x\ 100$	It is the ratio of women executives with respect the women on board
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.
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.
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.
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.

Panel 2: Control variables

Variable	Formula	Description
Size	$\text{Size} = \log(Total\ Assets_i)$	The size of the firm
MTB	$\text{MTB} = \frac{Market\ capitalization_i}{Total\ equity_i}$	Market to book ratio compares the firm's book value to its market value.
ROA	$\text{ROA} = \log\left(\frac{Net\ Income_i}{Total\ Assets_i}\right)$	Return on assets ratio measures the profitability of a business in relation to its total assets.
Lev	$\text{Lev} = \frac{Total\ Debt_i}{Total\ Assets_i}$	Leverage ratio indicates how the company's assets and business operations are financed (using debt or equity).
Liq	$\text{Liq} = \frac{Total\ shares\ traded_i}{Total\ shares\ outstanding_i}$	Stock market liquidity represents the percentage of a stock that has been replaced in a given year.
Average board tenure	$\text{Average Board Tenure} = \frac{\sum_{i=1}^{N} Tenure_i}{N}$	It measures the average number of years each board member has been on the board
Board size	$\text{Board size} = N$	It measures is the total number of board members at the end of the fiscal year

Table 3: Descriptive statistics of the risk measures

	N obs.	*Mean*	*Median*	*St.D.*	*Min*	*Max*	*Skew*	*Kurt*
Panel 1.Total Sample (3718 firms)								
Tailbeta	28094	1.082	1.010	1.148	-1.206	4.81	0.805	2.219
Downsidebeta	28884	1.092	1.056	0.424	0.385	1.983	0.349	-0.529
LPM	28884	0.023	0.020	0.01	0.011	0.048	0.955	0.046
VaR	28757	0.034	0.030	0.015	0.016	0.069	0.896	-0.028
ES	28757	0.051	0.044	0.024	0.023	0.11	0.987	0.147
Panel 2. US (2326 US firms)								
Tailbeta	17960	1.119	1.025	1.223	-1.206	4.81	0.795	1.795
Downsidebeta	17961	1.121	1.079	0.44	0.385	1.983	0.304	-0.656
LPM	17961	0.024	0.020	0.011	0.011	0.048	0.858	-0.358
VaR	17909	0.035	0.030	0.016	0.016	0.069	0.848	-0.322
ES	17909	0.053	0.045	0.025	0.023	0.11	0.898	-0.245
Panel 3. Europe (1392 firms)								
Tailbeta	10134	1.016	0.985	0.997	-1.206	4.81	0.704	2.919
Downsidebeta	10923	1.044	1.018	0.393	0.385	1.983	0.367	-0.350
LPM	10923	0.022	0.020	0.009	0.011	0.048	1.009	0.670
VaR	10848	0.033	0.031	0.013	0.016	0.069	0.880	0.346
ES	10848	0.049	0.044	0.02	0.023	0.11	1.030	0.727
Panel 4. No Financial Firms (3098 firms)								
Tailbeta	23401	1.073	1.000	1.184	-1.321	4.846	0.740	2.120
Downsidebeta	24021	1.093	1.060	0.429	0.378	1.990	0.340	-0.540
LPM	24026	0.024	0.020	0.011	0.011	0.049	0.930	0.000
VaR	23924	0.035	0.030	0.015	0.016	0.071	0.880	-0.060
ES	23924	0.053	0.050	0.024	0.023	0.112	0.960	0.090
Panel 5. Financial (620 firms)								
Tailbeta	4693	1.120	1.030	0.980	-0.660	4.670	1.140	2.890
Downsidebeta	4858	1.080	1.050	0.400	0.420	1.950	0.360	-0.490
LPM	4858	0.020	0.020	0.010	0.010	0.040	1.070	0.330
VaR	4833	0.030	0.030	0.010	0.010	0.060	0.980	0.220
ES	4833	0.040	0.040	0.020	0.020	0.100	1.140	0.530

This table reports the descriptive statistics of risk measures at firm level for an unbalanced panel of 3718 firms and a period of 12 years (2010-2022).It contains five different panels. The first is for the total sample. The first and second are related to USA and EU samples respectively, while the last two are for non-financial and financial firms, respectively. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the average market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. Variables are measured using yearly basis and winsorized at 5%.

Table 4: Descriptive statistics of independent variables, ESG scores and control variables

	N obs.	*Mean*	*Median*	*St.D.*	*Min*	*Max*	*Skew*	*Kurt*
Panel 1. Total Sample (3718 firms)								
Women employees	15605	37.896	36.000	16.236	16.700	100.000	0.510	-0.569
Women managers	11526	30.690	28.000	13.060	15.740	100.000	0.998	0.823
Board diversity	28883	22.722	22.220	12.427	0.000	45.000	-0.003	-0.760
M.B	11186	1.250	1.000	0.865	0.535	8.966	2.835	12.247
E.B	26423	0.702	0.587	0.732	0.000	9.827	1.798	6.157
ESG score	28883	46.382	45.530	18.165	16.820	78.200	0.109	-1.054
E score	28883	39.351	37.840	29.256	0.000	87.300	0.130	-1.331
S score	28883	51.216	50.040	21.718	16.540	88.240	0.107	-1.148
G score	28883	52.093	53.490	21.616	13.950	86.050	-0.152	-1.095
ROA	28883	4.993	4.820	7.299	-12.970	19.430	-0.338	0.617
Lev	28883	94.527	60.220	106.205	0.000	407.000	1.673	2.149
Size	28883	15.482	15.379	1.674	12.690	18.756	0.235	-0.762
MTB	28883	3.128	2.130	2.800	0.530	11.300	1.675	2.069
Average board tenure	28883	7.697	7.210	3.289	2.810	14.700	0.500	-0.592
Board size	28883	9.943	10.000	2.691	6.000	16.000	0.520	-0.375
Panel 2. US (2326 US firms)								
Women employees	6511	39.171	37.240	16.316	16.700	96.000	0.507	-0.518
Women managers	4282	33.671	31.000	13.768	15.740	93.230	0.796	0.177
Board diversity	17960	20.258	20.000	11.263	0.000	45.000	0.117	-0.460
M.B	4209	1.425	1.218	0.833	0.535	7.950	2.273	8.310
E.B	16273	0.783	0.667	0.760	0.000	9.827	1.644	5.459
ESG score	17960	42.103	40.115	17.278	16.820	78.200	0.382	-0.820
E score	17960	30.836	23.770	27.857	0.000	87.300	0.511	-1.049
S score	17960	46.330	43.475	20.390	16.540	88.240	0.374	-0.889
G score	17960	51.302	52.560	21.448	13.950	86.050	-0.129	-1.090
ROA	17960	4.640	4.760	7.757	-12.970	19.430	-0.427	0.359
Lev	17960	94.924	60.745	107.664	0.000	407.000	1.646	2.033
Size	17960	15.393	15.347	1.589	12.690	18.756	0.204	-0.636
MTB	17960	3.423	2.340	2.958	0.530	11.300	1.506	1.342
Average board tenure	17960	8.571	8.400	3.353	2.810	14.700	0.178	-0.818
Board size	17960	9.745	10.000	2.249	6.000	16.000	0.442	-0.105
Panel 3. Europe (1392 firms)								
Women employees	9094	36.983	34.800	16.117	16.700	100.000	0.513	-0.620
Women managers	7244	28.927	26.000	12.288	15.740	100.000	1.129	1.421
Board diversity	10923	26.775	28.570	13.168	0.000	45.000	-0.393	-0.794
M.B	6977	1.146	0.884	0.868	0.535	8.966	3.321	15.809
E.B	10149	0.573	0.445	0.665	0.000	7.194	2.137	8.217
ESG score	10923	53.418	54.520	17.381	16.820	78.200	-0.343	-0.804
E score	10923	53.352	56.980	25.926	0.000	87.300	-0.396	-0.977
S score	10923	59.251	62.030	21.445	16.540	88.240	-0.376	-0.971
G score	10923	53.395	55.070	21.827	13.950	86.050	-0.196	-1.098
ROA	10923	5.574	4.930	6.434	-12.970	19.430	0.045	0.794
Lev	10923	93.874	59.620	103.762	0.000	407.000	1.720	2.351
Size	10923	15.630	15.448	1.795	12.690	18.756	0.219	-0.998
MTB	10923	2.643	1.780	2.444	0.530	11.300	2.002	3.808
Average board tenure	10923	6.259	5.750	2.607	2.810	14.700	1.059	1.046
Board size	10923	10.268	10.000	3.265	6.000	16.000	0.374	-1.038
Panel 4. No financial firms (3098 firms)								
Women employees	13358	35.911	33.000	15.977	16.000	100.000	0.690	-0.240
Women managers	9877	29.703	26.790	13.039	15.000	100.000	1.090	1.110
Board diversity	24025	22.514	22.220	12.406	0.000	44.440	-0.020	-0.770
M.B	9565	1.210	0.980	0.800	0.535	7.950	2.607	10.008
E.B	21839	0.695	0.580	0.710	0.000	7.194	1.650	4.870
ESG score	24025	47.063	46.570	18.357	0.000	86.730	0.070	-1.080
E score	24025	40.367	40.450	29.138	0.000	86.730	0.040	-1.340
S score	24025	52.112	51.500	21.969	16.560	88.860	0.060	-1.160
G score	24025	52.392	53.750	21.401	14.760	85.970	-0.150	-1.110
ROA	24025	5.069	5.380	7.874	-15.780	19.290	-0.740	1.060
Lev	24025	88.968	61.100	96.680	0.000	355.550	1.500	1.640
Size	24025	15.272	15.210	1.557	12.596	18.224	0.150	-0.800
MTB	24025	3.416	2.390	2.990	0.560	12.170	1.660	2.070
Average board tenure	24025	7.669	7.190	3.260	2.800	14.580	0.490	-0.600
Board size	24025	9.767	9.000	2.489	6.000	15.000	0.410	-0.570
Panel 5. Financial firms (620 firms)								
Women employees	2247	50.110	50.810	11.820	31.670	94.000	0.170	-0.490
Women managers	1649	36.700	35.000	11.620	22.900	93.230	0.800	0.300
Board diversity	4858	23.710	22.220	12.420	0.000	46.670	0.070	-0.770
M.B	1621	1.496	1.155	1.138	0.535	8.966	2.870	11.229
E.B	9566	0.740	0.590	0.830	0.000	9.830	2.190	8.790
ESG score	4858	42.990	41.440	16.770	16.540	75.050	0.290	-0.850
E score	4858	34.360	22.460	29.400	0.000	90.190	0.590	-0.970
S score	4858	46.780	43.370	19.860	16.450	83.570	0.310	-1.020
G score	4858	50.640	52.330	22.570	11.230	86.390	-0.160	-1.080
ROA	4858	4.180	1.630	5.680	-1.690	20.430	1.690	1.920
Lev	4858	125.930	54.440	168.940	0.000	623.770	1.840	2.380
Size	4858	16.600	16.440	2.020	13.450	20.500	0.250	-0.860
MTB	4858	1.770	1.210	1.500	0.470	6.440	2.000	3.250
Average board tenure	4858	7.840	7.320	3.460	2.830	15.460	0.560	-0.490
Board size	4858	10.650	10.000	3.400	5.000	18.000	0.350	-0.470

This table reports the descriptive statistics of independent and control variables at the firm level for an unbalanced panel of 3718 firms and a period of 12 years (2010-2022). It contains five different panels. The first is for the total sample. The first and second are related to USA and EU samples respectively, while the last two are for non-financial and financial firms, respectively. The variables in the table are defined as follows: Women employees is the percentage of women employees. Women managers is the percentage of women managers. Board diversity is the percentage of female on the board. M.B is a variable that represents the ratio of women managers over women on the boards. E.B is a variable that represents the ratio of women executives over women on the boards. ESG is the annual Thomson Reuters Combined ESG score. E, S, and G are the environmental, social, and governance scores, respectively. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. Average board tenure is the average number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. Variables are measured using yearly basis and winsorized at 5%.

Table 5: Mean of risk measures by ESG score quartiles

	ESG low	*ESG medium*	*ESG high*
Panel 1.Total Sample (3718 firms)			
Tailbeta	1.15	1.07	1.03
Downsidebeta	1.13	1.09	1.06
LPM	0.03	0.023	0.021
VaR	0.04	0.034	0.032
ES	0.06	0.050	0.048
Women employees	38.28	38.21	37.44
Women managers	29.79	30.71	30.76
Board diversity	16.02	23.23	28.41
MB	0.12	0.51	0.87
EB	0.70	0.71	0.70
Panel 2. USA (2326 firms)			
Tailbeta	1.19	1.14	1.0
Downsidebeta	1.18	1.12	1.06
LPM	0.03	0.02	0.02
VaR	0.04	0.03	0.03
ES	0.06	0.05	0.05
Women employees	39.98	38.29	38.11
Women managers	32.39	33.26	33.28
Board diversity	14.48	20	25.51
MB	0.07	0.43	0.72
EB	0.73	0.76	0.78
Panel 3. European (1392 firms)			
Tailbeta	0.95	1.01	1.09
Downsidebeta	0.98	1.06	1.08
LPM	0.02	0.02	0.02
VaR	0.03	0.03	0.03
ES	0.05	0.05	0.05
Women employees	35.96	36.98	36.75
Women managers	27.47	28.55	28.35
Board diversity	21.57	27.24	25.35
MB	0.41	0.84	0.71
EB	0.5	0.57	0.55
Panel 4. No financial firms (3098 firms)			
Tailbeta	1.16	1.1	1.0
Downsidebeta	1.15	1.08	1.05
LPM	0.03	0.023	0.022
VaR	0.04	0.034	0.032
ES	0.06	0.052	0.048
Women employees	36.87	35.94	36.05
Women managers	28.98	29.57	29.52
Board diversity	15.35	23.27	20.63
MB	1.25	0.52	0.4
EB	0.71	0.69	0.7
Panel 5. Financial firms (620 firms)			
Tailbeta	1.07	1.13	1.15
Downsidebeta	1.04	1.09	1.13
LPM	0.019	0.020	0.021
VaR	0.029	0.030	0.032
ES	0.043	0.049	0.047
Women employees	46.17	50.50	50.27
Women managers	35.07	36.93	36.64
Board diversity	19.00	22.73	30.39
MB	0.09	0.45	1.04
EB	0.62	0.80	0.72

This table reports the mean of risk measures and gender diversity variablesat firm level sorted by each ESG score quartile for an unbalanced panel of 3718 firms and a period of 12 years (2010-2022). Thresholds for each quartile are: ESG scores below the 25% of all the ESG scores distribution for ESG low, between the 25% and the 75% of the ESG socres distribution for ESG medium, and above the 75% of the ESG socres distribution for ESG high. It contains five different panels. The first is for the total sample. The first and second are related to USA and EU samples respectively, while the last two are for non-financial and financial firms, respectively. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the average market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. Variables are measured using yearly basis and winsorized at 5%.

Table 6: Impact of ESG on the gender diversity-risk relationship, Total sample

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	*ES*
ESG high	-0.021	0.027	-0.159***	-0.175***	-0.157***
	(0.033)	(0.031)	(0.024)	(0.025)	(0.024)
ESG medium	-0.053+	-0.027	-0.123***	-0.143***	-0.120***
	(0.031)	(0.030)	(0.023)	(0.023)	(0.023)
Women employees	0.036	-0.053+	-0.034	-0.063**	-0.022
	(0.031)	(0.029)	(0.023)	(0.023)	(0.022)
ESG highxWomen employees	-0.062+	0.001	0.023	0.045+	0.009
	(0.033)	(0.031)	(0.024)	(0.024)	(0.024)
ESG mediumxWomen employees	-0.063*	0.008	0.02	0.041+	0.007
	(0.032)	(0.031)	(0.024)	(0.024)	(0.023)
Model	FE	FE	RE	RE	RE
ESG high	0.009	0.077	-0.128***	-0.142***	-0.134***
	(0.044)	(0.042)	(0.032)	(0.032)	(0.032)
ESG medium	-0.031	0.02	-0.099**	-0.122***	-0.105***
	(0.043)	(0.041)	(0.032)	(0.032)	(0.031)
Women managers	-0.007	-0.009	0.049	0.037	0.063*
	(0.043)	(0.041)	(0.031)	(0.031)	(0.031)
ESG highxWomen managers	-0.01	-0.023	-0.049	-0.046	-0.064*
	(0.045)	(0.043)	(0.033)	(0.033)	(0.032)
ESG mediumxWomen managers	-0.025	-0.026	-0.060+	-0.051	-0.075*
	(0.044)	(0.042)	(0.032)	(0.032)	(0.032)
Model	FE	FE	RE	RE	RE
ESG high	-0.055**	-0.040*	-0.096***	-0.080***	-0.100***
	(0.020)	(0.019)	(0.015)	(0.014)	(0.014)
ESG medium	-0.045**	-0.041**	-0.068***	-0.063***	-0.072***
	(0.016)	(0.015)	(0.012)	(0.011)	(0.011)
Board diversity	-0.007	-0.027*	-0.053***	-0.057***	-0.052***
	(0.012)	(0.011)	(0.009)	(0.009)	(0.009)
ESG highxBoard diversity	0.002	0.030+	0.004	-0.001	0.002
	(0.018)	(0.016)	(0.013)	(0.013)	(0.012)
ESG mediumxBoard diversity	-0.034*	-0.025+	0.000	0.001	-0.001
	(0.015)	(0.014)	(0.011)	(0.010)	(0.010)
Model	FE	FE	FE	FE	FE
ESG high	-0.008	0.074	-0.113**	-0.120***	-0.115***
	(0.048)	(0.045)	(0.035)	(0.035)	(0.034)
ESG medium	-0.053	0.009	-0.090**	-0.107**	-0.093**
	(0.047)	(0.044)	(0.034)	(0.034)	(0.033)
M.B	-0.05	-0.041	0.02	0.012	0.027
	(0.036)	(0.035)	(0.027)	(0.027)	(0.026)
ESG highxM.B	0.065+	0.051	-0.002	0.014	-0.006
	(0.039)	(0.037)	(0.029)	(0.029)	(0.028)
ESG mediumxM.B	0.036	0.044	0.008	0.019	-0.002
	(0.038)	(0.037)	(0.028)	(0.028)	(0.027)
Model	FE	FE	RE	RE	RE
ESG high	-0.056**	-0.043*	-0.129***	-0.118***	-0.132***
	(0.019)	(0.018)	(0.014)	(0.014)	(0.014)
ESG medium	-0.047**	-0.055***	-0.087***	-0.085***	-0.091***
	(0.016)	(0.015)	(0.011)	(0.011)	(0.011)
E.B	-0.005	0.005	0.031***	0.028***	0.031***
	(0.011)	(0.010)	(0.008)	(0.008)	(0.008)
ESG highxE.B	-0.012	-0.055***	-0.035**	-0.030*	-0.034**
	(0.017)	(0.016)	(0.013)	(0.013)	(0.012)
ESG mediumxE.B	0.014	0.009	0.001	0.003	-0.001
	(0.014)	(0.013)	(0.010)	(0.010)	(0.010)
Model	FE	RE	FE	FE	FE

This table reports a summary of the panel regression results regarding the impact of ESG on the gender diversity-risk relationship at the firm level for an unbalanced panel of 3718 firms and a period of 12 years (2010-2022). All variables are standarized, winsorized at 5%, and data are annual. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the average market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG score is the ESG combined score by Thomson Reuters. ESG high is a dummy variable that takes value 1 when the ESG score of the firm is above the 75% of the ESG socres distribution, and 0 othervise. ESG medium is a dummy variable that takes value 1 when the ESG score of the firm is between the 25% and the 75% of the ESG socres distribution, and 0 othervise. Women employees is the percentage of women employees. Women managers is the percentage of women managers. Board diversity is the percentage of women on the board. M.B is a variable that represents the ratio of women managers over women on the boards. E.B is a variable that represents the ratio of women executives over women on the boards. The interactions between each of the ESG dummies and each of the independet variables are also inlcuded in the model. 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 7: Impact of E on the gender diversity-risk relationship, Total sample

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	*ES*
E high	-0.05	-0.056	-0.199***	-0.219***	-0.201***
	(0.039)	(0.037)	(0.029)	(0.029)	(0.028)
E medium	-0.067+	-0.083*	-0.141***	-0.162***	-0.141***
	(0.036)	(0.035)	(0.027)	(0.027)	(0.026)
Women employees	0.006	-0.065*	-0.055*	-0.073**	-0.057**
	(0.030)	(0.029)	(0.022)	(0.022)	(0.022)
E highxWomen employees	-0.028	0.018	0.052*	0.062**	0.052*
	(0.032)	(0.031)	(0.024)	(0.024)	(0.023)
E mediumxWomen employees	-0.028	0.016	0.031	0.038	0.032
	(0.031)	(0.030)	(0.023)	(0.023)	(0.023)
Model	RE	RE	RE	RE	RE
E high	-0.030	0.027	-0.136***	-0.142***	-0.135***
	(0.050)	(0.048)	(0.037)	(0.037)	(0.036)
E medium	-0.059	-0.012	-0.083*	-0.095**	-0.078*
	(0.048)	(0.046)	(0.035)	(0.035)	(0.034)
Women managers	-0.044	0.018	0.038	0.044+	0.04
	(0.035)	(0.034)	(0.026)	(0.026)	(0.025)
E highxWomen managers	0.006	-0.058	-0.039	-0.057*	-0.043
	(0.038)	(0.036)	(0.028)	(0.028)	(0.027)
E mediumxWomen managers	0.032	-0.051	-0.055*	-0.064*	-0.055*
	(0.037)	(0.036)	(0.027)	(0.027)	(0.027)
Model	FE	FE	RE	RE	RE
E high	-0.050*	-0.046*	-0.098***	-0.078***	-0.100***
	(0.021)	(0.020)	(0.015)	(0.015)	(0.015)
E medium	-0.045**	-0.044**	-0.090***	-0.080***	-0.090***
	(0.016)	(0.015)	(0.012)	(0.012)	(0.011)
Board diversity	-0.015	-0.034**	-0.054***	-0.056***	-0.053***
	(0.012)	(0.011)	(0.009)	(0.009)	(0.009)
E highxBoard diversity	0.012	0.024	-0.01	-0.014	-0.013
	(0.018)	(0.017)	(0.013)	(0.013)	(0.012)
E mediumxBoard diversity	-0.022	-0.005	0.005	0.002	0.003
	(0.015)	(0.014)	(0.011)	(0.010)	(0.010)
Model	FE	FE	RE	RE	FE
E high	-0.003	0.033	-0.105**	-0.106**	-0.107**
	(0.053)	(0.050)	(0.038)	(0.039)	(0.038)
E medium	-0.031	-0.009	-0.056	-0.063+	-0.055
	(0.050)	(0.048)	(0.037)	(0.037)	(0.036)
M.B	-0.038	-0.006	0.065**	0.077**	0.069**
	(0.034)	(0.033)	(0.025)	(0.025)	(0.024)
E highxM.B	0.037	0.016	-0.039	-0.045+	-0.043
	(0.036)	(0.035)	(0.027)	(0.027)	(0.026)
E mediumxM.B	0.036	0.001	-0.052*	-0.065*	-0.056*
	(0.036)	(0.035)	(0.027)	(0.027)	(0.026)
Model	FE	FE	RE	RE	RE
E high	-0.066**	-0.068***	-0.145***	-0.128***	-0.147***
	(0.021)	(0.020)	(0.015)	(0.015)	(0.015)
E medium	-0.060***	-0.063***	-0.111***	-0.103***	-0.112***
	(0.016)	(0.015)	(0.012)	(0.012)	(0.012)
E.B	0.002	0.001	0.027***	0.028***	0.027***
	(0.011)	(0.010)	(0.008)	(0.008)	(0.008)
E highxE.B	-0.025	-0.049**	-0.030*	-0.032**	-0.028*
	(0.017)	(0.016)	(0.013)	(0.012)	(0.012)
E mediumxE.B	0.002	0.012	0.000	-0.002	-0.001
	(0.014)	(0.013)	(0.010)	(0.010)	(0.010)
Model	FE	RE	FE	RE	FE

This table reports a summary of the panel regression results regarding the impact of E on the gender diversity-risk relationship at the firm level for an unbalanced panel of 3718 firms and a period of 12 years (2010-2022). All variables are standarized, winsorized at 5%, and data are annual. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the average market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG score is the ESG combined score by Thomson Reuters. E high is a dummy variable that takes value 1 when the Environmental score of the firm is above the 75% of the E socre distribution, and 0 othervise. E medium is a dummy variable that takes value 1 when the Environmental score of the firm is between the 25% and the 75% of the E socre distribution, and 0 othervise. Women employees is the percentage of women employees. Women managers is the percentage of women managers. Board diversity is the percentage of women on the board. M.B is a variable that represents the ratio of women managers over women on the boards. E.B is a variable that represents the ratio of women executives over women on the boards. The interactions between each of the E dummies and each of the independet variables are also inlcuded in the model. 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 8: Impact of S on the gender diversity-risk relationship, Total sample

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	*ES*
S high	-0.011	0.047	-0.189***	-0.200***	-0.178***
	(0.032)	(0.030)	(0.023)	(0.024)	(0.023)
S medium	-0.024	0.032	-0.099***	-0.111***	-0.089***
	(0.030)	(0.028)	(0.022)	(0.022)	(0.021)
Women employees	0.014	-0.024	-0.043*	-0.064**	-0.043*
	(0.028)	(0.026)	(0.020)	(0.020)	(0.020)
S highxWomen employees	-0.031	-0.028	0.040+	0.055*	0.041+
	(0.030)	(0.028)	(0.022)	(0.022)	(0.021)
S mediumxwomen employees	-0.046	-0.026	0.023	0.036+	0.023
	(0.029)	(0.028)	(0.021)	(0.022)	(0.021)
Model	FE	FE	RE	RE	RE
S high	-0.025	0.038	-0.216***	-0.218***	-0.203***
	(0.044)	(0.041)	(0.032)	(0.032)	(0.031)
S medium	-0.054	0.000	-0.138***	-0.150***	-0.127***
	(0.042)	(0.040)	(0.030)	(0.030)	(0.030)
Women managers	-0.022	-0.01	0.016	-0.004	0.011
	(0.041)	(0.039)	(0.030)	(0.031)	(0.030)
S highxWomen managers	0.01	-0.026	-0.009	0.005	-0.002
	(0.043)	(0.041)	(0.031)	(0.032)	(0.031)
S mediumxWomen managers	-0.014	-0.03	-0.03	-0.013	-0.025
	(0.043)	(0.041)	(0.031)	(0.032)	(0.031)
Model	FE	RE	RE	RE	RE
S high	-0.039+	-0.041*	-0.132***	-0.121***	-0.130***
	(0.020)	(0.019)	(0.015)	(0.014)	(0.014)
S medium	-0.013	0.000	-0.040***	-0.037***	-0.041***
	(0.015)	(0.015)	(0.011)	(0.011)	(0.011)
Board diversity	-0.034**	-0.045***	-0.065***	-0.069***	-0.064***
	(0.012)	(0.011)	(0.009)	(0.009)	(0.009)
S highxBoard diversity	0.029	0.049**	0.021+	0.023+	0.020
	(0.018)	(0.017)	(0.013)	(0.013)	(0.012)
S mediumxBoard diversity	0.007	0.003	0.016	0.015	0.015
	(0.015)	(0.014)	(0.011)	(0.010)	(0.010)
Model	FE	FE	FE	FE	FE
S high	-0.024	0.048	-0.199***	-0.201***	-0.193***
	(0.045)	(0.043)	(0.032)	(0.033)	(0.032)
S medium	-0.056	0.004	-0.129***	-0.142***	-0.125***
	(0.043)	(0.041)	(0.031)	(0.031)	(0.030)
M.B	0.008	0.033	0.03	0.006	0.012
	(0.035)	(0.034)	(0.026)	(0.027)	(0.026)
S highxM.B	0.003	-0.029	-0.009	0.020	0.013
	(0.038)	(0.036)	(0.028)	(0.029)	(0.028)
S mediumxM.B	-0.029	-0.038	-0.006	0.024	0.012
	(0.037)	(0.036)	(0.027)	(0.029)	(0.028)
Model	FE	FE	RE	RE	RE
S high	-0.047*	-0.048**	-0.157***	-0.149***	-0.155***
	(0.020)	(0.019)	(0.014)	(0.014)	(0.014)
S medium	-0.02	-0.018	-0.053***	-0.053***	-0.053***
	(0.016)	(0.015)	(0.011)	(0.011)	(0.011)
E.B	0.006	0.008	0.027***	0.022**	0.025***
	(0.011)	(0.010)	(0.008)	(0.008)	(0.008)
S highxE.B	-0.016	-0.056***	-0.036**	-0.030*	-0.031*
	(0.018)	(0.017)	(0.013)	(0.013)	(0.012)
S mediumxE.B	-0.007	0.002	0.006	0.011	0.006
	(0.014)	(0.013)	(0.010)	(0.010)	(0.010)
Model	FE	FE	FE	FE	FE

This table reports a summary of the panel regression results regarding the impact of S on the gender diversity-risk relationship at the firm level for an unbalanced panel of 3718 firms and a period of 12 years (2010-2022). All variables are standarized, winsorized at 5%, and data are annual. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the average market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG score is the ESG combined score by Thomson Reuters. S high is a dummy variable that takes value 1 when the Social score of the firm is above the 75% of the S socres distribution, and 0 othervise. ESG medium is a dummy variable that takes value 1 when the S score of the firm is between the 25% and the 75% of the S socres distribution, and 0 othervise. Women employees is the percentage of women employees. Women managers is the percentage of women managers. Board diversity is the percentage of women on the board. M.B is a variable that represents the ratio of women managers over women on the boards. E.B is a variable that represents the ratio of women executives over women on the boards. The interactions between each of the S dummies and each of the independet variables are also inlcuded in the model. 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 9: Impact of G on the gender diversity-risk relationship, Total sample

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	*ES*
G high	-0.007	0.011	-0.026	-0.030+	-0.028
	(0.024)	(0.022)	(0.017)	(0.017)	(0.017)
G medium	-0.016	-0.007	-0.017	-0.026	-0.022
	(0.022)	(0.021)	(0.016)	(0.016)	(0.016)
Women employees	-0.014	-0.046*	0.008	-0.015	0.01
	(0.019)	(0.018)	(0.014)	(0.014)	(0.014)
G highxWomen employees	-0.018	0.006	-0.018	0.002	-0.023
	(0.023)	(0.022)	(0.017)	(0.017)	(0.016)
G mediumxWomen employees	-0.006	-0.009	-0.035*	-0.02	-0.035*
	(0.021)	(0.020)	(0.016)	(0.016)	(0.015)
Model	FE	FE	RE	RE	RE
G high	0.001	0.028	-0.024	-0.034	-0.033+
	(0.028)	(0.027)	(0.021)	(0.021)	(0.020)
G medium	-0.011	0.006	-0.022	-0.034+	-0.03
	(0.027)	(0.025)	(0.019)	(0.019)	(0.019)
Women managers	-0.032	-0.029	0.039*	0.034*	0.039*
	(0.023)	(0.021)	(0.016)	(0.017)	(0.016)
G highxWomen managers	0.007	-0.015	-0.044*	-0.050*	-0.048*
	(0.027)	(0.026)	(0.020)	(0.020)	(0.019)
G mediumxWomen managers	0.011	0.003	-0.057**	-0.056**	-0.055**
	(0.025)	(0.024)	(0.018)	(0.018)	(0.018)
Model	FE	RE	RE	RE	RE
G high	-0.017	-0.023	0.015	0.009	0.010
	(0.018)	(0.017)	(0.013)	(0.013)	(0.013)
G medium	-0.013	-0.012	-0.002	-0.013	-0.009
	(0.015)	(0.014)	(0.011)	(0.011)	(0.010)
Board diversity	-0.030**	-0.036***	-0.082***	-0.079***	-0.079***
	(0.011)	(0.011)	(0.008)	(0.008)	(0.008)
G highxBoard diversity	0.009	0.027+	0.025*	0.018	0.023+
	(0.017)	(0.016)	(0.012)	(0.012)	(0.012)
G mediumxBoard diversity	0.003	-0.007	0.030**	0.019+	0.024*
	(0.014)	(0.013)	(0.010)	(0.010)	(0.010)
Model	FE	FE	RE	FE	FE
G high	0.012	0.031	-0.010	-0.020	-0.020
	(0.030)	(0.028)	(0.021)	(0.022)	(0.021)
G medium	-0.004	0.014	-0.01	-0.022	-0.019
	(0.028)	(0.026)	(0.020)	(0.020)	(0.020)
M.B	0.008	0.019	0.046***	0.046***	0.045***
	(0.019)	(0.018)	(0.014)	(0.014)	(0.013)
G highxM.B	-0.014	-0.066**	-0.047*	-0.049**	-0.048**
	(0.026)	(0.024)	(0.019)	(0.019)	(0.018)
G mediumxM.B	-0.018	0.001	-0.019	-0.010	-0.015
	(0.023)	(0.022)	(0.016)	(0.017)	(0.016)
Model	FE	FE	RE	RE	RE
G high	-0.029	-0.030+	-0.022+	-0.027*	-0.025*
	(0.018)	(0.017)	(0.013)	(0.013)	(0.013)
G medium	-0.019	-0.022	-0.022+	-0.032**	-0.028*
	(0.015)	(0.014)	(0.011)	(0.011)	(0.011)
E.B	0.013	0.015	0.041***	0.038***	0.041***
	(0.011)	(0.011)	(0.008)	(0.008)	(0.008)
G highxE.B	-0.023	-0.047**	-0.033**	-0.033**	-0.033**
	(0.017)	(0.016)	(0.013)	(0.012)	(0.012)
G mediumxE.B	-0.016	-0.012	-0.018+	-0.013	-0.019+
	(0.014)	(0.013)	(0.010)	(0.010)	(0.010)
Model	FE	RE	FE	FE	FE

This table reports a summary of the panel regression results regarding the impact of G on the gender diversity-risk relationship at the firm level for an unbalanced panel of 3718 firms and a period of 12 years (2010-2022). All variables are standarized, winsorized at 5%, and data are annual. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the average market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG score is the ESG combined score by Thomson Reuters. G high is a dummy variable that takes value 1 when the Governance score of the firm is above the 75% of the G scores distribution, and 0 othervise. G medium is a dummy variable that takes value 1 when the G score of the firm is between the 25% and the 75% of the ESG socres distribution, and 0 othervise. Women employees is the percentage of women employees. Women managers is the percentage of women managers. Board diversity is the percentage of women on the board. M.B is a variable that represents the ratio of women managers over women on the boards. E.B is a variable that represents the ratio of women executives over women on the boards. The interactions between each of the G dummies and each of the independet variables are also inkuded in the model. 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 10: Impact of ESG on the gender diversity-risk relationship, Total sample, USA sample

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	*ES*
ESG high	-0.105+	-0.122*	-0.193***	-0.222***	-0.190***
	(0.057)	(0.051)	(0.041)	(0.041)	(0.040)
ESG medium	-0.100+	-0.145**	-0.145***	-0.164***	-0.137***
	(0.057)	(0.050)	(0.040)	(0.040)	(0.039)
Women employees	0.067	-0.048	-0.023	-0.063	-0.015
	(0.054)	(0.048)	(0.038)	(0.039)	(0.038)
ESG highxWomen employees	-0.135*	0.007	0.009	0.04	-0.001
	(0.056)	(0.050)	(0.040)	(0.040)	(0.039)
ESG mediumxWomen employees	-0.091	-0.003	-0.001	0.032	-0.012
	(0.056)	(0.050)	(0.040)	(0.040)	(0.039)
Model	FE	FE	FE	FE	FE
ESG high	-0.137	-0.11	-0.237***	-0.238***	-0.225***
	(0.085)	(0.074)	(0.059)	(0.059)	(0.057)
ESG medium	-0.142+	-0.125+	-0.175**	-0.163**	-0.158**
	(0.085)	(0.074)	(0.059)	(0.059)	(0.057)
Women managers	0.033	0.062	0.135*	0.119*	0.165**
	(0.084)	(0.074)	(0.058)	(0.059)	(0.057)
ESG highxWomen managers	-0.078	-0.081	-0.115+	-0.105+	-0.150**
	(0.086)	(0.075)	(0.060)	(0.060)	(0.058)
ESG mediumxWomen managers	-0.085	-0.078	-0.114+	-0.104+	-0.149*
	(0.086)	(0.076)	(0.060)	(0.060)	(0.058)
Model	FE	FE	FE	FE	RE
ESG high	-0.061*	-0.037	-0.086***	-0.084***	-0.087***
	(0.027)	(0.024)	(0.018)	(0.018)	(0.018)
ESG medium	-0.023	-0.052**	-0.060***	-0.060***	-0.064***
	(0.022)	(0.020)	(0.015)	(0.015)	(0.015)
Board diversity	0.025	0.02	0.013	0.011	0.013
	(0.017)	(0.015)	(0.012)	(0.011)	(0.011)
ESG highxBoard diversity	-0.056*	-0.052*	0.001	-0.004	-0.004
	(0.026)	(0.023)	(0.017)	(0.017)	(0.017)
ESG mediumxBoard diversity	-0.070***	-0.063***	-0.005	-0.011	-0.005
	(0.021)	(0.019)	(0.014)	(0.014)	(0.014)
Model	FE	FE	FE	FE	FE
ESG high	-0.194*	-0.148+	-0.299***	-0.261***	-0.273***
	(0.093)	(0.082)	(0.065)	(0.065)	(0.063)
ESG medium	-0.199*	-0.166*	-0.233***	-0.188**	-0.202**
	(0.093)	(0.082)	(0.065)	(0.065)	(0.063)
M.B	-0.105+	-0.077	-0.023	0.004	0.005
	(0.055)	(0.048)	(0.038)	(0.038)	(0.037)
ESG highxM.B	0.091	0.038	-0.023	-0.057	-0.045
	(0.060)	(0.053)	(0.042)	(0.042)	(0.040)
ESG mediumxM.B	0.081	0.074	0.012	-0.012	-0.014
	(0.059)	(0.052)	(0.041)	(0.041)	(0.040)
Model	FE	FE	RE	RE	FE
ESG high	-0.058*	-0.036	-0.083***	-0.081***	-0.086***
	(0.025)	(0.023)	(0.017)	(0.017)	(0.017)
ESG medium	-0.011	-0.046*	-0.062***	-0.064***	-0.067***
	(0.021)	(0.019)	(0.014)	(0.014)	(0.014)
E.B	-0.024+	-0.027*	-0.001	0.004	0.001
	(0.014)	(0.013)	(0.010)	(0.010)	(0.010)
ESG highxE.B	0.004	-0.022	-0.022	-0.035*	-0.025
	(0.023)	(0.020)	(0.016)	(0.015)	(0.015)
ESG mediumxE.B	0.019	0.021	0.010	0.000	0.006
	(0.018)	(0.016)	(0.012)	(0.012)	(0.012)
Model	FE	FE	FE	FE	FE

This table reports a summary of the panel regression results regarding the impact of ESG on the gender diversity-risk relationship at the firm level for an unbalanced panel of 2326 USA firms and a period of 12 years (2010-2022). All variables are standarized, winsorized at 5%, and data are annual. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the average market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG score is the ESG combined score by Thomson Reuters. ESG high is a dummy variable that takes value 1 when the ESG score of the firm is above the 75% of the ESG socres distribution, and 0 othervise. ESG medium is a dummy variable that takes value 1 when the ESG score of the firm is between the 25% and the 75% of the ESG socres distribution, and 0 othervise. Women employees is the percentage of women employees. Women managers is the percentage of women managers. Board diversity is the percentage of women on the board. M.B is a variable that represents the ratio of women managers over women on the boards. E.B is a variable that represents the ratio of women executives over women on the boards. The interactions between each of the ESG dummies and each of the independet variables are also inlcuded in the model. 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 11: Impact of ESG on the gender diversity-risk relationship, Total sample, European sample

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	*ES*
ESG high	0.061*	0.129***	-0.052*	-0.062**	-0.054*
	(0.031)	(0.031)	(0.023)	(0.023)	(0.022)
ESG medium	0.009	0.093***	-0.007	-0.018	-0.005
	(0.027)	(0.027)	(0.020)	(0.020)	(0.019)
Women employees	0.002	-0.059*	-0.042*	-0.052**	-0.033+
	(0.025)	(0.025)	(0.018)	(0.018)	(0.018)
ESG highxWomen employees	-0.001	-0.006	0.014	0.023	0.009
	(0.030)	(0.030)	(0.022)	(0.022)	(0.021)
ESG mediumxWomen employees	-0.022	0.006	0.029	0.03	0.02
	(0.027)	(0.027)	(0.020)	(0.020)	(0.019)
Model	RE	FE	RE	RE	RE
ESG high	0.073+	0.142***	-0.058*	-0.052+	-0.062*
	(0.038)	(0.038)	(0.028)	(0.028)	(0.027)
ESG medium	-0.006	0.085*	-0.026	-0.023	-0.024
	(0.034)	(0.034)	(0.025)	(0.025)	(0.025)
Women managers	-0.002	-0.087**	-0.046*	-0.042+	-0.044+
	(0.031)	(0.031)	(0.023)	(0.023)	(0.023)
ESG highxWomen managers	0.015	0.051	0.023	0.015	0.023
	(0.037)	(0.037)	(0.027)	(0.027)	(0.027)
ESG mediumxWomen managers	-0.032	0.028	0.018	0.01	0.016
	(0.034)	(0.034)	(0.025)	(0.025)	(0.025)
Model	RE	FE	RE	RE	RE
ESG high	0.070*	0.121***	-0.026	-0.035	-0.034
	(0.029)	(0.030)	(0.023)	(0.022)	(0.022)
ESG medium	0.036+	0.129***	0.050*	0.034*	0.045**
	(0.022)	(0.024)	(0.021)	(0.017)	(0.016)
Board diversity	-0.037*	-0.014	-0.100***	-0.105***	-0.097***
	(0.015)	(0.018)	(0.016)	(0.012)	(0.011)
ESG highxBoard diversity	0.056*	0.040+	0.080***	0.072***	0.078***
	(0.023)	(0.024)	(0.021)	(0.018)	(0.017)
ESG mediumxBoard diversity	0.015	-0.014	0.033+	0.034*	0.033*
	(0.019)	(0.022)	(0.018)	(0.014)	(0.014)
Model	RE	FE	RE	RE	RE
ESG high	0.093*	0.151***	-0.056*	-0.055*	-0.056*
	(0.037)	(0.037)	(0.027)	(0.028)	(0.027)
ESG medium	0.019	0.093**	-0.005	-0.004	0.000
	(0.033)	(0.033)	(0.024)	(0.024)	(0.024)
M.B	0.03	-0.017	0.035	0.016	0.023
	(0.032)	(0.033)	(0.024)	(0.024)	(0.024)
ESG highxM.B	-0.022	0.034	-0.026	0.007	-0.013
	(0.037)	(0.037)	(0.028)	(0.028)	(0.027)
ESG mediumxM.B	-0.044	0.011	0.001	0.027	0.013
	(0.035)	(0.036)	(0.026)	(0.026)	(0.026)
Model	RE	FE	RE	RE	RE
ESG high	0.083**	0.137***	-0.028	-0.045*	-0.034
	(0.028)	(0.029)	(0.021)	(0.021)	(0.021)
ESG medium	0.03	0.117***	0.035*	0.019	0.032+
	(0.024)	(0.024)	(0.018)	(0.018)	(0.017)
E.B	0.028	0.036*	0.085***	0.096***	0.079***
	(0.018)	(0.018)	(0.013)	(0.013)	(0.013)
ESG highxE.B	-0.049+	-0.114***	-0.104***	-0.098***	-0.094***
	(0.027)	(0.028)	(0.020)	(0.021)	(0.020)
ESG mediumxE.B	-0.013	-0.023	-0.037*	-0.043*	-0.033*
	(0.022)	(0.023)	(0.017)	(0.017)	(0.016)
Model	RE	FE	RE	RE	RE

This table reports a summary of the panel regression results regarding the impact of ESG on the gender diversity-risk relationship at the firm level for an unbalanced panel of 1392 EU firms and a period of 12 years (2010-2022). All variables are standarized, winsorized at 5%, and data are annual. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the average market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG score is the ESG combined score by Thomson Reuters. ESG high is a dummy variable that takes value 1 when the ESG score of the firm is above the 75% of the ESG socres distribution, and 0 othervise. ESG medium is a dummy variable that takes value 1 when the ESG score of the firm is between the 25% and the 75% of the ESG socres distribution, and 0 othervise. Women employees is the percentage of women employees. Women managers is the percentage of women managers. Board diversity is the percentage of women on the board. M.B is a variable that represents the ratio of women managers over women on the boards. E.B is a variable that represents the ratio of women executives over women on the boards. The interactions between each of the ESG dummies and each of the independet variables are also inlcuded in the model. 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 12: Impact of ESG on the gender diversity-risk relationship, Total sample, Non-financial sample

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	*ES*
ESG high	-0.014	0.006	-0.179***	-0.202***	-0.177***
	(0.035)	(0.034)	(0.026)	(0.026)	(0.026)
ESG medium	-0.047	-0.042	-0.148***	-0.177***	-0.145***
	(0.034)	(0.032)	(0.025)	(0.025)	(0.024)
Women employees	0.034	-0.053+	-0.036	-0.066**	-0.023
	(0.033)	(0.031)	(0.024)	(0.024)	(0.024)
ESG highxWomen employees	-0.074*	-0.018	0.001	0.024	-0.013
	(0.035)	(0.033)	(0.026)	(0.026)	(0.025)
ESG mediumxWomen employees	-0.061+	0.014	0.022	0.038	0.008
	(0.034)	(0.033)	(0.025)	(0.025)	(0.025)
Model	FE	FE	RE	RE	RE
ESG high	0.009	0.077+	-0.128***	-0.142***	-0.134***
	(0.044)	(0.042)	(0.032)	(0.032)	(0.032)
ESG medium	-0.031	0.02	-0.099**	-0.122***	-0.105***
	(0.043)	(0.041)	(0.032)	(0.032)	(0.031)
Women managers	-0.007	-0.009	0.049	0.037	0.063*
	(0.043)	(0.041)	(0.031)	(0.031)	(0.031)
ESG highxWomen managers	-0.01	-0.023	-0.049	-0.046	-0.064*
	(0.045)	(0.043)	(0.033)	(0.033)	(0.032)
ESG mediumxWomen managers	-0.025	-0.026	-0.060+	-0.051	-0.075*
	(0.044)	(0.042)	(0.032)	(0.032)	(0.032)
Model	FE	FE	RE	RE	RE
ESG high	-0.066**	-0.058*	-0.136***	-0.117***	-0.141***
	(0.022)	(0.024)	(0.025)	(0.016)	(0.016)
ESG medium	-0.063***	-0.068***	-0.109***	-0.102***	-0.113***
	(0.018)	(0.018)	(0.020)	(0.013)	(0.013)
Board diversity	-0.004	-0.021	-0.028*	-0.033***	-0.025**
	(0.013)	(0.015)	(0.012)	(0.010)	(0.010)
ESG highxBoard diversity	-0.005	0.017	-0.009	-0.009	-0.010
	(0.020)	(0.019)	(0.017)	(0.014)	(0.014)
ESG mediumxBoard diversity	-0.032*	-0.027+	-0.021	-0.016	-0.022+
	(0.016)	(0.015)	(0.013)	(0.012)	(0.011)
Model	FE	FE	FE	FE	FE
ESG high	-0.021	-0.032	-0.100***	-0.101***	-0.118***
	(0.037)	(0.036)	(0.028)	(0.027)	(0.027)
ESG medium	-0.048	-0.086*	-0.088***	-0.098***	-0.102***
	(0.035)	(0.034)	(0.026)	(0.026)	(0.025)
M.B	0.019	0.015	0.003	0.005	0.000
	(0.033)	(0.032)	(0.025)	(0.025)	(0.024)
ESG highxM.B	-0.032	-0.005	-0.004	-0.006	-0.007
	(0.037)	(0.036)	(0.027)	(0.027)	(0.027)
ESG mediumxM.B	-0.012	-0.012	0.013	0.003	0.011
	(0.036)	(0.035)	(0.027)	(0.027)	(0.027)
Model	FE	FE	FE	FE	RE
ESG high	-0.072***	-0.063**	-0.155***	-0.141***	-0.159***
	(0.021)	(0.020)	(0.015)	(0.015)	(0.015)
ESG medium	-0.067***	-0.088***	-0.121***	-0.118***	-0.125***
	(0.018)	(0.016)	(0.013)	(0.012)	(0.012)
E.B	-0.007	0.005	0.021*	0.016+	0.022*
	(0.012)	(0.011)	(0.009)	(0.009)	(0.008)
ESG highxE.B	-0.009	-0.048**	-0.034*	-0.031*	-0.034*
	(0.019)	(0.018)	(0.014)	(0.013)	(0.013)
ESG mediumxE.B	0.007	0.001	0.001	0.004	-0.001
	(0.015)	(0.014)	(0.011)	(0.011)	(0.011)
Model	RE	FE	RE	FE	FE

This table reports a summary of the panel regression results regarding the impact of ESG on the gender diversity-risk relationship at the firm level for an unbalanced panel of 3098 non-financial firms and a period of 12 years (2010-2022). All variables are standarized, winsorized at 5%, and data are annual. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the average market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG score is the ESG combined score by Thomson Reuters. ESG high is a dummy variable that takes value 1 when the ESG score of the firm is above the 75% of the ESG socres distribution, and 0 othervise. ESG medium is a dummy variable that takes value 1 when the ESG score of the firm is between the 25% and the 75% of the ESG socres distribution, and 0 othervise. Women employees is the percentage of women employees. Women managers is the percentage of women managers. Board diversity is the percentage of women on the board. M.B is a variable that represents the ratio of women managers over women on the boards. E.B is a variable that represents the ratio of women executives over women on the boards. The interactions between each of the ESG dummies and each of the independet variables are also inlcuded in the model. 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 13: Impact of ESG on the gender diversity-risk relationship, Total sample, Financial sample

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	*ES*
ESG high	-0.196*	-0.229*	-0.181	-0.042	-0.165
	(0.097)	(0.107)	(0.122)	(0.119)	(0.124)
ESG medium	-0.193*	-0.177+	-0.111	0.019	-0.098
	(0.094)	(0.103)	(0.117)	(0.114)	(0.119)
Women employees	0.039	0.195*	0.285**	0.223*	0.279**
	(0.073)	(0.086)	(0.098)	(0.096)	(0.100)
ESG highxWomen employees	-0.033	-0.210*	-0.286**	-0.252*	-0.283**
	(0.080)	(0.092)	(0.105)	(0.102)	(0.107)
ESG mediumxWomen employees	-0.072	-0.245**	-0.256*	-0.189+	-0.250*
	(0.078)	(0.088)	(0.100)	(0.097)	(0.102)
Model	RE	FE	FE	FE	FE
ESG high	-0.026	-0.159	-0.182	-0.038	-0.21
	(0.138)	(0.170)	(0.194)	(0.187)	(0.198)
ESG medium	-0.017	-0.049	-0.104	0.03	-0.122
	(0.137)	(0.166)	(0.189)	(0.182)	(0.193)
women managers	-0.091	0.142	0.429*	0.389+	0.480*
	(0.128)	(0.191)	(0.218)	(0.210)	(0.222)
ESG highxWomen managers	0.131	-0.101	-0.440*	-0.401+	-0.487*
	(0.133)	(0.193)	(0.220)	(0.212)	(0.224)
ESG mediumxWomen managers	0.051	-0.064	-0.335	-0.244	-0.357
	(0.132)	(0.190)	(0.217)	(0.208)	(0.220)
Model	RE	FE	FE	FE	FE
ESG high	-0.048	-0.122*	-0.019	0.056	0.004
	(0.058)	(0.055)	(0.057)	(0.054)	(0.061)
ESG medium	0.021	0.011	0.024	0.061	0.04
	(0.043)	(0.042)	(0.043)	(0.040)	(0.045)
Board diversity	-0.065*	-0.056+	0.096**	0.074*	0.094**
	(0.031)	(0.034)	(0.030)	(0.029)	(0.034)
ESG highxBoard diversity	0.034	0.117**	-0.024	-0.023	-0.023
	(0.047)	(0.045)	(0.045)	(0.044)	(0.049)
ESG mediumxBoard diversity	0.01	0.03	0.025	0.005	0.024
	(0.038)	(0.039)	(0.035)	(0.035)	(0.039)
Model	RE	FE	FE	RE	FE
ESG high	-0.033	-0.033	-0.001	0.103	-0.022
	(0.153)	(0.163)	(0.186)	(0.179)	(0.190)
ESG medium	-0.012	0.053	0.071	0.153	0.052
	(0.153)	(0.159)	(0.182)	(0.176)	(0.186)
M.B	-0.096	0.224+	0.033	-0.011	0.034
	(0.084)	(0.118)	(0.135)	(0.130)	(0.138)
ESG highxM.B	0.103	-0.250*	-0.049	0.003	-0.058
	(0.087)	(0.120)	(0.138)	(0.133)	(0.140)
ESG mediumxM.B	0.075	-0.199+	-0.033	0.037	-0.037
	(0.088)	(0.118)	(0.135)	(0.130)	(0.138)
Model	RE	FE	FE	FE	FE
ESG high	-0.079	-0.132**	0.061	0.110+	0.083
	(0.054)	(0.051)	(0.057)	(0.056)	(0.059)
ESG medium	0.021	-0.019	0.073	0.099*	0.087+
	(0.043)	(0.040)	(0.045)	(0.045)	(0.046)
E.B	0.000	0.044	-0.019	0.002	-0.012
	(0.033)	(0.032)	(0.036)	(0.036)	(0.037)
ESG highxE.B	-0.050	-0.173***	-0.003	0.016	-0.005
	(0.054)	(0.050)	(0.056)	(0.055)	(0.058)
ESG mediumxE.B	0.016	-0.064+	-0.006	-0.008	-0.013
	(0.038)	(0.035)	(0.040)	(0.039)	(0.040)
Model	RE	FE	FE	FE	FE

This table reports a summary of the panel regression results regarding the impact of ESG on the gender diversity-risk relationship at the firm level for an unbalanced panel of 620 financial firms and a period of 12 years (2010-2022). All variables are standarized, winsorized at 5%, and data are annual. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the average market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG score is the ESG combined score by Thomson Reuters. ESG high is a dummy variable that takes value 1 when the ESG score of the firm is above the 75% of the ESG socres distribution, and 0 othervise. ESG medium is a dummy variable that takes value 1 when the ESG score of the firm is between the 25% and the 75% of the ESG socres distribution, and 0 othervise. Women employees is the percentage of women employees. Women managers is the percentage of women managers. Board diversity is the percentage of women on the board. M.B is a variable that represents the ratio of women managers over women on the boards. E.B is a variable that represents the ratio of women executives over women on the boards. The interactions between each of the ESG dummies and each of the independet variables are also inlcuded in the model. 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 14: Impact of ESG on the gender diversity-risk relationship, Covid19 period

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	*ES*
ESG high	-0.021	0.025	-0.160***	-0.174***	-0.158***
	(0.033)	(0.031)	(0.024)	(0.025)	(0.024)
ESG medium	-0.053+	-0.027	-0.123***	-0.143***	-0.121***
	(0.031)	(0.030)	(0.023)	(0.023)	(0.023)
Women employees	0.032	-0.052+	-0.041+	-0.064**	-0.027
	(0.032)	(0.030)	(0.023)	(0.024)	(0.023)
Women employeesxCovid	0.010	(0.006)	0.017	0.003	0.013
	(0.019)	(0.018)	(0.014)	(0.014)	(0.014)
ESG highxWomen employees	-0.062+	0.002	0.022	0.045+	0.009
	(0.033)	(0.031)	(0.024)	(0.024)	(0.024)
ESG mediumxWomen employees	-0.063*	0.008	0.02	0.041+	0.007
	(0.032)	(0.031)	(0.024)	(0.024)	(0.023)
Model	FE	RE	RE	FE	RE
ESG high	0.008	0.076+	-0.128***	-0.142***	-0.134***
	(0.044)	(0.042)	(0.032)	(0.032)	(0.032)
ESG medium	-0.033	0.019	-0.098**	-0.121***	-0.105***
	(0.043)	(0.041)	(0.032)	(0.032)	(0.031)
Women managers	0.006	-0.002	0.039	0.036	0.056+
	(0.044)	(0.042)	(0.032)	(0.032)	(0.031)
Women managersxCovid	(0.027)	(0.016)	0.018	0.001	0.013
	(0.020)	(0.019)	(0.015)	(0.015)	(0.014)
ESG highxWomen managers	-0.01	-0.024	-0.049	-0.046	-0.064*
	(0.045)	(0.043)	(0.033)	(0.033)	(0.032)
ESG mediumxWomen managers	-0.027	-0.027	-0.059+	-0.05	-0.074*
	(0.044)	(0.042)	(0.032)	(0.032)	(0.032)
Model	FE	FE	RE	FE	RE
ESG high	-0.055**	-0.040*	-0.095***	-0.079***	-0.099***
	(0.020)	(0.019)	(0.015)	(0.014)	(0.014)
ESG medium	-0.045**	-0.041**	-0.068***	-0.063***	-0.071***
	(0.016)	(0.015)	(0.012)	(0.011)	(0.011)
board diversity	-0.002	-0.025*	-0.027**	-0.035***	-0.026**
	(0.013)	(0.012)	(0.009)	(0.009)	(0.009)
Board diversityxCovid	(0.016)	(0.005)	-0.094***	-0.085***	-0.093***
	(0.013)	(0.012)	(0.010)	(0.009)	(0.009)
ESG highxBoard diversity	0.004	0.030+	0.015	0.009	0.013
	(0.018)	(0.017)	(0.013)	(0.013)	(0.012)
ESG mediumxBoard diversity	-0.032*	-0.024+	0.007	0.008	0.006
	(0.015)	(0.014)	(0.011)	(0.011)	(0.010)
Model	FE	FE	RE	FE	RE
ESG high	-0.054*	-0.020	-0.136***	-0.133***	-0.141***
	(0.022)	(0.021)	(0.016)	(0.016)	(0.016)
ESG medium	-0.034+	-0.030+	-0.091***	-0.093***	-0.096***
	(0.019)	(0.018)	(0.014)	(0.013)	(0.013)
M.B	-0.021	-0.045*	0.037*	0.051**	0.038*
	(0.022)	(0.021)	(0.016)	(0.016)	(0.016)
M.BxCovid	-0.030*	-0.043***	-0.086***	-0.099***	-0.083***
	(0.013)	(0.012)	(0.009)	(0.009)	(0.009)
ESG highxM.B	0.053*	0.064**	-0.001	-0.003	-0.004
	(0.024)	(0.023)	(0.017)	(0.017)	(0.017)
ESG mediumxM.B	0.003	0.031	-0.006	-0.011	-0.012
	(0.023)	(0.021)	(0.017)	(0.016)	(0.016)
Model	FE	FE	FE	RE	FE
ESG high	-0.056**	-0.043*	-0.129***	-0.119***	-0.132***
	(0.019)	(0.018)	(0.014)	(0.014)	(0.014)
ESG medium	-0.047**	-0.055***	-0.087***	-0.085***	-0.091***
	(0.016)	(0.015)	(0.011)	(0.011)	(0.011)
E.B	-0.004	0.012	0.026**	0.022**	0.027**
	(0.012)	(0.011)	(0.008)	(0.008)	(0.008)
E.BxCovid	(0.006)	-0.024*	0.018+	0.019*	0.016+
	(0.013)	(0.012)	(0.009)	(0.009)	(0.009)
ESG highxE.B	-0.012	-0.055***	-0.035**	-0.030*	-0.034**
	(0.017)	(0.016)	(0.013)	(0.013)	(0.012)
ESG mediumxE.B	0.015	0.01	0.000	0.002	-0.002
	(0.014)	(0.013)	(0.010)	(0.010)	(0.010)
Model	FE	RE	FE	RE	FE

This table reports a summary of the panel regression results regarding the impact of ESG on thegender diversity -risk relationship at the firm level for an unbalanced panel of 3718 firms and a period of 12 years (2010-2022). All variables are standarized, winsorized at 5%, and data are annual. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the average market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG score is the ESG combined score by Thomson Reuters. ESG high is a dummy variable that takes value 1 when the ESG score of the firm is above the 75% of the ESG socres distribution, and 0 othervise. ESG medium is a dummy variable that takes value 1 when the ESG score of the firm is between the 25% and the 75% of the ESG socres distribution, and 0 othervise. Women employees is the percentage of women employees. Women managers is the percentage of women managers. Board diversity is the percentage of women on the board. M.B is a variable that represents the ratio of women managers over women on the boards. E.B is a variable that represents the ratio of women executives over women on the boards. The interaction between each of the independent variable and the covid varaible is also included in the model. Being covid a dummy variable that takes value 1 for covid years of the sample (2020,2021,2022), and 0 otherwise. The interactions between each of the ESG dummies and each of the independet variables are also inlcuded in the model. 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 15: Endogeneity

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	*ES*
			Panel 1: ESG distrib3		
ESG distrib3	0.271	0.365	0.222	0.202	0.219
	(0.206)	(0.221)	(0.191)	(0.169)	(0.193)
First stage	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Wu-Hausman	[0.497]	[0.626]	[0.459]	[0.194]	[0.631]
			Panel 2: ESG distrib2		
ESG distrib2	-0.289	-0.365	-0.077	-0.063	-0.091
	(0.208)	(0.221)	(0.147)	(0.149)	(0.144)
First stage	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Wu-Hausman	[0.967]	[0.626]	[0.255]	[0.242]	[0.181]
			Panel 3: Women employees		
Women employees	-0.178	-0.123	0.003	-0.016	-0.002
	(0.128)	(0.135)	(0.092)	(0.118)	(0.091)
First stage	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Wu-Hausman	[0.207]	[0.626]	[0.111]	[0.661]	[0.122]
			Panel 4: Women Managers		
Women managers	-0.119	-0.136	-0.092	-0.073	-0.097
	(0.110)	(0.117)	(0.057)	(0.104)	(0.102)
First stage	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Wu-Hausman	[0.778]	[0.173]	[0.363]	[0.232]	[0.452]
			Panel 5: Board diversity		
Board diversity	-0.187+	-0.182	-0.146+	-0.156+	-0.142+
	(0.109)	(0.117)	(0.081)	(0.079)	(0.078)
First stage	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Wu-Hausman	[0.503]	[0.385]	[0.033]	[0.037]	[0.026]
			Panel 6: M.B ratio		
M.B	-0.005	0.002	0.006	0.006	-0.001
	(0.009)	(0.009)	(0.009)	(0.008)	(0.009)
First stage	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Wu-Hausman	[0.759]	[0.305]	[0.152]	[0.023]	[0.236]
			Panel 7: E.B ratio		
E.B	-0.025	-0.125	-0.054	-0.054	-0.076
	(0.064)	(0.099)	(0.057)	(0.068)	(0.056)
First stage	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Wu-Hausman	[0.841]	[0.826]	[0.544]	[0.771]	[0.538]

This table reports a summary of the IV results regarding the estimation of each of the varaibles of intesrest , that is, ESG distrib 3 and 2 and the independent variables regarding gender diversity by panels (1 to 7 respectively) on risk measures at the firm level for an unbalanced panel of 3718 firms and a period of 12 years (2010-2022). All variables have been standardized using annual data. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the average market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG score is the ESG combined score by Thomson Reuters. ESG distrib3 is a dummy variable that takes value 1 when the ESG score of the firm is above the 75% of the ESG socres distribution, and 0 othervise. ESG distrib2 is a dummy variable that takes value 1 when the ESG score of the firm is between the 25% and the 75% of the ESG socres distribution, and 0 othervise. Women employees is the percentage of women employees. Women managers is the percentage of women managers. M.B is a variable that represents the ratio of women managers over women on the boards. E.B is a variable that represents the ratio of women executives over women on the boards. 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 16: Impact of ESG on the gender diversity-risk relationship, Total sample

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	*ES*
ESG high	-0.021	0.023	-0.158***	-0.174***	-0.156***
	(0.033)	(0.031)	(0.024)	(0.024)	(0.024)
ESG medium	-0.054+	-0.031	-0.124***	-0.146***	-0.122***
	(0.031)	(0.030)	(0.023)	(0.023)	(0.023)
Women employees Shan.Indx.	0.024	-0.093***	-0.069***	-0.092***	-0.057**
	(0.028)	(0.027)	(0.021)	(0.021)	(0.020)
ESG highxWomen employees Shan.Indx.	-0.066*	0.022	0.002	0.022	-0.008
	(0.030)	(0.029)	(0.022)	(0.023)	(0.022)
ESG mediumxWomen employees Shan.Indx.	-0.048+	0.064*	0.031	0.043*	0.021
	(0.029)	(0.028)	(0.022)	(0.022)	(0.021)
Model	FE	RE	RE	RE	RE
ESG high	0.008	0.078+	-0.128***	-0.141***	-0.134***
	(0.044)	(0.042)	(0.032)	(0.032)	(0.032)
ESG medium	-0.036	0.017	-0.102**	-0.125***	-0.108***
	(0.043)	(0.041)	(0.032)	(0.032)	(0.031)
Women managers Shan.Indx.	0.008	-0.017	0.021	0.000	0.027
	(0.036)	(0.033)	(0.025)	(0.025)	(0.025)
ESG highxWomen managers Shan.Indx.	-0.037	-0.021	-0.055*	-0.047+	-0.062*
	(0.038)	(0.036)	(0.027)	(0.027)	(0.027)
ESG mediumxWomen managers Shan.Indx.	-0.051	-0.029	-0.064*	-0.049+	-0.066*
	(0.037)	(0.035)	(0.027)	(0.027)	(0.026)
Model	FE	FE	RE	RE	RE
ESG high	-0.058**	-0.051**	-0.102***	-0.085***	-0.106***
	(0.020)	(0.019)	(0.015)	(0.014)	(0.014)
ESG medium	-0.049**	-0.047**	-0.074***	-0.069***	-0.077***
	(0.016)	(0.015)	(0.011)	(0.011)	(0.011)
Board diversity Shan.Indx.	0.002	-0.011	-0.038***	-0.043***	-0.037***
	(0.010)	(0.009)	(0.007)	(0.007)	(0.007)
ESG highxBoard diversity Shan.Indx.	-0.005	0.029	-0.019	-0.027*	-0.019
	(0.019)	(0.018)	(0.014)	(0.014)	(0.014)
ESG mediumxBoard diversity Shan.Indx.	-0.027*	-0.026*	-0.010	-0.012	-0.011
	(0.013)	(0.013)	(0.010)	(0.010)	(0.009)
Model	FE	FE	FE	FE	FE
ESG high	-0.008	0.073	-0.112**	-0.119***	-0.114***
	(0.048)	(0.045)	(0.035)	(0.035)	(0.034)
ESG medium	-0.052	0.008	-0.089**	-0.106**	-0.092**
	(0.047)	(0.045)	(0.034)	(0.034)	(0.033)
M.B Shan.Indx.	-0.047	-0.042	0.023	0.013	0.030
	(0.037)	(0.036)	(0.027)	(0.027)	(0.026)
ESG highxM.B Shan.Indx.	-0.035**	-0.034***	-0.032***	-0.035***	-0.036***
	(0.011)	(0.010)	(0.008)	(0.008)	(0.008)
ESG mediumxM.B Shan.Indx.	-0.015	-0.042***	-0.048***	-0.049***	-0.046***
	(0.010)	(0.010)	(0.007)	(0.007)	(0.007)
Model	FE	FE	RE	RE	RE
ESG high	-0.055**	-0.042*	-0.130***	-0.119***	-0.133***
	(0.019)	(0.018)	(0.014)	(0.014)	(0.014)
ESG medium	-0.047**	-0.056***	-0.089***	-0.086***	-0.092***
	(0.016)	(0.015)	(0.011)	(0.011)	(0.011)
E.B Shan.Indx.	-0.005	0.008	0.035***	0.030***	0.034***
	(0.011)	(0.010)	(0.008)	(0.008)	(0.008)
ESG highxE.B Shan.Indx.	-0.011	-0.058***	-0.038**	-0.031*	-0.036**
	(0.017)	(0.016)	(0.013)	(0.012)	(0.012)
ESG mediumxE.B Shan.Indx.	0.016	0.008	-0.003	0.000	-0.005
	(0.014)	(0.013)	(0.010)	(0.010)	(0.010)
Model	FE	RE	FE	FE	FE

This table reports a summary of the panel regression results regarding the impact of ESG on the gender diversity-risk relationship at the firm level for an unbalanced panel of 3718 firms and a period of 12 years (2010-2022). All variables are standarized, winsorized at 5%, and data are annual. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the average market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG score is the ESG combined score by Thomson Reuters. ESG high is a dummy variable that takes value 1 when the ESG score of the firm is above the 75% of the ESG socres distribution, and 0 othervise. ESG medium is a dummy variable that takes value 1 when the ESG score of the firm is between the 25% and the 75% of the ESG socres distribution, and 0 othervise. Women employees Shan.Indx. is the Shannon Index calculated for the women employees category. Women managers Shan.Indx. is the Shannon Index calculated for the women managers category. Board diversity Shan.Indx. is the Shannon Index calculated for the women on boards category. M.B Shan.Indx. is the Shannon Index calculated for the women managers over women on boards category. E.B Shan.Indx. is the Shannon Index calculated for the women executives over women on boards category. The interactions between each of the ESG dummies and each of the independet variables are also inlcuded in the model. 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 17: Impact of ESG on the gender diversity-risk relationship, Total sample

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	*ES*
ESG high	-0.021	0.023	-0.159***	-0.175***	-0.157***
	(0.033)	(0.032)	(0.024)	(0.024)	(0.024)
ESG medium	-0.054+	-0.032	-0.124***	-0.146***	-0.122***
	(0.031)	(0.030)	(0.023)	(0.023)	(0.023)
Women employees Blau.Indx.	0.024	-0.093***	-0.066**	-0.091***	-0.054**
	(0.028)	(0.027)	(0.021)	(0.021)	(0.021)
ESG highxWomen employees Blau.Indx.	-0.065*	0.023	0.001	0.023	-0.009
	(0.031)	(0.029)	(0.023)	(0.023)	(0.022)
ESG mediumxWomen employees Blau.Indx.	-0.049	0.061*	0.03	0.043+	0.02
	(0.030)	(0.029)	(0.022)	(0.022)	(0.022)
Model	FE	RE	RE	RE	RE
ESG high	0.008	0.078+	-0.129***	-0.142***	-0.134***
	(0.044)	(0.042)	(0.032)	(0.032)	(0.032)
ESG medium	-0.035	0.017	-0.102**	-0.125***	-0.108***
	(0.043)	(0.041)	(0.032)	(0.032)	(0.031)
Women managers Blau.Indx.	0.008	-0.019	0.028	0.006	0.035
	(0.037)	(0.035)	(0.026)	(0.027)	(0.026)
ESG highxWomen managers Blau.Indx.	-0.037	-0.02	-0.060*	-0.051+	-0.068*
	(0.039)	(0.037)	(0.028)	(0.028)	(0.028)
ESG mediumxWomen managers Blau.Indx.	-0.052	-0.029	-0.070*	-0.055*	-0.073**
	(0.039)	(0.036)	(0.028)	(0.028)	(0.027)
Model	FE	FE	RE	RE	RE
ESG high	-0.058**	-0.047*	-0.099***	-0.082***	-0.103***
	(0.020)	(0.019)	(0.015)	(0.015)	(0.014)
ESG medium	-0.048**	-0.045**	-0.072***	-0.067***	-0.075***
	(0.016)	(0.015)	(0.011)	(0.011)	(0.011)
Board diversity Blau.Indx.	0.000	-0.016	-0.042***	-0.047***	-0.041***
	(0.011)	(0.010)	(0.008)	(0.008)	(0.008)
ESG highxBoard diversity Blau.Indx.	-0.005	0.027	-0.014	-0.021	-0.014
	(0.019)	(0.017)	(0.013)	(0.013)	(0.013)
ESG mediumxBoard diversity Blau.Indx.	-0.032*	-0.028*	-0.009	-0.01	-0.01
	(0.014)	(0.013)	(0.010)	(0.010)	(0.010)
Model	FE	FE	FE	FE	FE
ESG high	-0.008	0.074	-0.112**	-0.120***	-0.114***
	(0.048)	(0.045)	(0.035)	(0.035)	(0.034)
ESG medium	-0.053	0.009	-0.090**	-0.107**	-0.093**
	(0.047)	(0.045)	(0.034)	(0.034)	(0.033)
M.B Blau.Indx.	-0.05	-0.041	0.021	0.012	0.028
	(0.036)	(0.035)	(0.027)	(0.027)	(0.026)
ESG highxM.B Blau.Indx.	-0.035**	-0.034***	-0.032***	-0.035***	-0.036***
	(0.011)	(0.010)	(0.008)	(0.008)	(0.008)
ESG mediumxM.B Blau.Indx.	-0.014	-0.042***	-0.049***	-0.049***	-0.046***
	(0.010)	(0.010)	(0.007)	(0.007)	(0.007)
Model	FE	FE	RE	RE	RE
ESG high	-0.056**	-0.043*	-0.129***	-0.118***	-0.132***
	(0.019)	(0.018)	(0.014)	(0.014)	(0.014)
ESG medium	-0.047**	-0.056***	-0.088***	-0.085***	-0.091***
	(0.016)	(0.015)	(0.011)	(0.011)	(0.011)
E.B Blau.Indx.	-0.005	0.005	0.032***	0.028***	0.032***
	(0.011)	(0.010)	(0.008)	(0.008)	(0.008)
ESG highxE.B Blau.Indx.	-0.012	-0.055***	-0.036**	-0.030*	-0.034**
	(0.017)	(0.016)	(0.013)	(0.013)	(0.012)
ESG mediumxE.B Blau.Indx.	0.015	0.009	0.000	0.002	-0.002
	(0.014)	(0.013)	(0.010)	(0.010)	(0.010)
Model	FE	RE	FE	FE	FE

This table reports a summary of the panel regression results regarding the impact of ESG on the gender diversity-risk relationship at the firm level for an unbalanced panel of 3718 firms and a period of 12 years (2010-2022). All variables are standarized, winsorized at 5%, and data are annual. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the average market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG score is the ESG combined score by Thomson Reuters. ESG high is a dummy variable that takes value 1 when the ESG score of the firm is above the 75% of the ESG socres distribution, and 0 othervise. ESG medium is a dummy variable that takes value 1 when the ESG score of the firm is between the 25% and the 75% of the ESG socres distribution, and 0 othervise. Women employees Blau.Indx. is the Blau Index calculated for the women employees category. Women managers Blau.Indx. is the Blau Index calculated for the women managers category. Board diversity Blau.Indx. is the Blau Index calculated for the women on boards category. M.B Blau.Indx. is the Blau Index calculated for the women managers over women on boards category. E.B Blau.Indx. is the Blau Index calculated for the women executives over women on boards category. The interactions between each of the ESG dummies and each of the independet variables are also inlcuded in the model. 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. □

Appendix I: Risk Measures

Donwside beta (Downsidebeta): we follow Bawa and Lindenberg (1977) and Ang et al. (2006) and Atilgan et al. (2019) to construct the measure as the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the average market excess return during the past year.

$$Downsidebeta_i = \frac{Cov\ (R_i, R_M | R_M < \mu_M)}{VaR(R_M < \mu_M)} \quad (1)$$

Being R_i the assets' excess return and R_M the market's excess return for each of the market indexes respectively, and μ_M the average market excess return during the past 250 trading days. Our proxy for market returns is equity the index provided by DataStream for EU and US.

Lower Partial Moment (LPM) captures the stock-specific downside risk. It is built on the notion of lower partial moment (LPM) of Markowitz (1959).

$$LPM_i = \int_{-\infty}^{h} (h - R)^m f_i(r) dr \quad (2)$$

Where *h* is the target return, *R* is the excess stock's return, *m* is the order of the moment, and f_i represents the probability density function of returns for asset *i*. LPM measures losses relative to a reference point and ignores gains exceeding such a reference point. As in our case, when the reference point is the mean of stock's return distribution during the past year, LPM coincides with the semi-variance.

Tail beta (Tailbeta): according to Atilgan et al. (2019), Tail beta is similar to Downside beta, but it focuses further to the left-tail of the market return distribution and is equal to the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year ($P10_M$):

$$Tailbeta_i = \frac{\text{Cov}\ (R_i, R_M | R_M < P10_M)}{VaR(R_M < P10_M)} \quad (3)$$

Value-at-Risk (VaR): is the negative α-th quantile ($q_\alpha(R)$) of the distribution of the company's returns, R. Therefore, VaR represents the maximum loss an investor would expect to experience on

an investment over a certain period of time with (1 – α) level of confidence. The formal definition of VaR (Artzner et al., 1999) is:

$$VaR_{\alpha}(R) = -q_{\alpha}(R) = -inf\ \{x \in \mathbb{R} | F(x) > \alpha\} \quad (4)$$

Where R is the returns and F the cumulative distribution function of R.

Expected Shortfall (ES): is the negative of the conditional expectation of exceedances beyond the $\alpha - th$ quantile of R, $q_{\alpha}(X)$. ES is the expected loss of a company if a catastrophic event happens. Therefore, the α-ES of a company returns, R, is defined as:

$$ES_{\alpha}(R) = -E\big(R\big|R \leq q_{\alpha}(R)\big)) = -E(R|R \leq -VaR_{\alpha}(R)) \quad (5)$$

Being R the returns, $q_{\alpha}(R)$ the VaR at the (1- α) confidence level (Yamai et al., 2002). For high values of α, it ignores the most profitable but unlikely scenarios, while for small values of α it focuses on the worst losses. Generally, the ES value is higher than the VaR. Moreover, the ES is considered a more useful risk measure than VaR because it represents a coherent spectral measure of financial risk calculated for a given quantile-level q and defined to be the mean loss of the portfolio or asset value, given that the loss is taking place at or below the q-quantile.

Appendix II

Table A1: Firms by industry

Basic Materials	164
Consumer Discretion	579
Consumer Staples	182
Energy	171
Financials	620
Health Care	463
Industrials	704
Real Estate	234
Technology	375
Telecommunications	92
Utilities	134
Total general	**3718**

This table shows the number of firms by industry under the ICB

Table A2: Correlation Matrix

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	*ES*	*Women employees*	*Women managers*	*Board diversity*	*M.B*	*E.B*	*ROA*	*Lev*	*Size*	*MTB*	*Avg board tenure*	*Board size*	*ESG*	*E*	*S*	*G*
Tailbeta	1.00	.																		
Downsidebeta	0.45	1.00																		
LPM	0.20	0.44	1.00																	
VaR	0.19	0.45	0.94	1.00																
ES	0.20	0.44	0.99	0.95	1.00															
Women employees	0.00	-0.05	-0.02	-0.02	-0.01	1.00														
Women managers	-0.02	-0.06	0.00	-0.01	0.00	0.74	1.00													
Board diversity	-0.03	-0.06	0.00	0.01	0.00	0.12	0.17	1.00												
M.B	0.03	-0.03	0.05	0.01	0.05	0.34	0.60	-0.58	1.00											
E.B	0.01	-0.13	-0.09	-0.11	-0.10	0.12	0.31	-0.37	0.54	1.00										
ROA	-0.07	-0.13	-0.24	-0.25	-0.23	-0.03	-0.01	0.02	-0.11	-0.08	1.00									
Lev	0.01	0.03	-0.01	0.00	-0.01	0.04	0.02	0.04	-0.01	-0.05	-0.12	1.00								
Size	-0.03	-0.05	-0.26	-0.25	-0.26	0.05	0.06	0.15	-0.03	-0.24	0.01	0.28	1.00							
MTB	0.00	0.03	0.06	0.05	0.06	0.06	0.10	0.05	-0.11	-0.06	0.16	0.19	-0.20	1.00						
Avg board tenure	-0.03	-0.04	-0.13	-0.14	-0.12	0.05	0.12	-0.17	0.17	-0.01	0.14	-0.07	0.04	0.02	1.00					
Board size	-0.02	-0.04	-0.17	-0.16	-0.17	0.01	0.03	0.12	0.17	0.05	-0.03	0.17	0.56	-0.10	0.04	1.00				
ESG	-0.04	-0.06	-0.12	-0.16	-0.12	-0.02	0.02	0.38	0.14	0.02	0.11	0.10	0.40	-0.01	-0.09	0.32	1.00			
E	-0.04	-0.06	-0.17	-0.16	-0.17	-0.09	-0.02	0.33	0.09	-0.11	0.12	0.15	0.52	-0.06	-0.12	0.40	0.81	1.00		
S	-0.03	-0.04	-0.11	-0.16	-0.11	0.01	0.05	0.36	0.04	-0.15	0.07	0.11	0.43	0.03	-0.13	0.34	0.83	0.75	1.00	
G	-0.03	-0.04	-0.09	-0.16	-0.08	-0.02	0.00	0.28	-0.21	-0.26	0.09	0.06	0.30	-0.04	0.02	0.17	0.65	0.40	0.39	1.00

This table reports the correlation coefficients of the risk measures and independent variables at firm level. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market's excess return is less than the average market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. Women employees is the percentage of women employees. Women managers is the percentage of women managers. Board diversity is the percentage of female on the board. M.B. is the ratio of women managers with respect the women on board, in percentage, while E.B. is the equivalent ratio for the executive women case ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. Average board tenure is the average number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. ESG is the annual Thomson Reuters Combined ESG score. E, S, and G are the environmental, social, and governance scores, respectively. Variables are winsorized at 5% and in annual basis.

Table A3: VIF

			Panel 1				
	Women employees	*Size*	*MTB*	*ROA*	*Lev*	*Avg board tenure*	*Board size*
Tailbeta	1.013	1.556	1.220	1.167	1.208	1.035	1.397
Downsidebeta	1.013	1.558	1.223	1.170	1.210	1.035	1.397
LPM	1.013	1.558	1.223	1.170	1.210	1.035	1.397
VaR	1.013	1.559	1.224	1.171	1.211	1.036	1.398
ES	1.013	1.559	1.224	1.171	1.211	1.036	1.398
			Panel 2				
	Women managers	*Size*	*MTB*	*ROA*	*Lev*	*Avg board tenure*	*Board size*
Tailbeta	1.028	1.534	1.274	1.229	1.230	1.044	1.395
Downsidebeta	1.029	1.540	1.277	1.235	1.232	1.045	1.396
LPM	1.029	1.540	1.277	1.235	1.232	1.045	1.396
VaR	1.029	1.541	1.278	1.236	1.234	1.046	1.398
ES	1.029	1.541	1.278	1.236	1.234	1.046	1.398
			Panel 3				
	Board diversity	*Size*	*MTB*	*ROA*	*Lev*	*Avg board tenure*	*Board size*
Tailbeta	1.182	1.769	1.183	1.096	1.214	1.071	1.475
Downsidebeta	1.182	1.766	1.183	1.096	1.214	1.071	1.474
LPM	1.182	1.766	1.183	1.096	1.214	1.071	1.474
VaR	1.182	1.767	1.183	1.096	1.215	1.071	1.474
ES	1.182	1.767	1.183	1.096	1.215	1.071	1.474
			Panel 4				
	M.B	*Size*	*MTB*	*ROA*	*Lev*	*Avg board tenure*	*Board size*
Tailbeta	1.030	1.745	1.186	1.099	1.212	1.053	1.455
Downsidebeta	1.029	1.742	1.186	1.100	1.213	1.052	1.455
LPM	1.029	1.742	1.186	1.100	1.213	1.052	1.455
VaR	1.029	1.742	1.186	1.100	1.213	1.052	1.455
ES	1.029	1.742	1.186	1.100	1.213	1.052	1.455
			Panel 5				
	E.B	*Size*	*MTB*	*ROA*	*Lev*	*Avg board tenure*	*Board size*
Tailbeta	1.005	1.735	1.186	1.099	1.212	1.045	1.451
Downsidebeta	1.005	1.732	1.186	1.100	1.213	1.044	1.449
LPM	1.005	1.732	1.186	1.100	1.213	1.044	1.449
VaR	1.005	1.733	1.187	1.100	1.214	1.044	1.450
ES	1.005	1.733	1.187	1.100	1.214	1.044	1.450

This table reports the variance inflation factor for all the risk measures and independent variables in each panel respectively. With an unbalanced panel of 3718 firms and a period of 12 years (2010-2022). All variables are standardized, and data are annual and winsorized at 5%. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the average market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. Women employees is the percentage of women employees. Women managers is the percentage of women managers. Board diversity is the percentage of female on the board. M.B is a variable that represents the ratio of women managers over women on the boards. E.B is a variable that represents the ratio of women executives over women on the boards. Size is the size of the firm, calculated as the log of the total assets. 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. Avg board tenure is the average number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year.

Appendix III: Extended Tables

Table 1: Impact of ESG on the women employees-risk relationship, Total sample

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
Intercept			0.022	0.061	0.017
			(0.052)	(0.052)	(0.054)
ESG high	-0.021	0.027	-0.159***	-0.175***	-0.157***
	(0.033)	(0.031)	(0.024)	(0.025)	(0.024)
ESG medium	-0.053+	-0.027	-0.123***	-0.143***	-0.120***
	(0.031)	(0.030)	(0.023)	(0.023)	(0.023)
Women employees	0.036	-0.053+	-0.034	-0.063**	-0.022
	(0.031)	(0.029)	(0.023)	(0.023)	(0.022)
Size	0.008	0.005	-0.130***	-0.128***	-0.126***
	(0.010)	(0.009)	(0.007)	(0.007)	(0.007)
MTB	-0.024**	0.006	-0.023***	-0.026***	-0.022***
	(0.009)	(0.008)	(0.006)	(0.007)	(0.006)
ROA	-0.045***	-0.104***	-0.146***	-0.153***	-0.145***
	(0.009)	(0.009)	(0.007)	(0.007)	(0.007)
Lev	0.031***	0.053***	0.068***	0.074***	0.068***
	(0.008)	(0.008)	(0.006)	(0.006)	(0.006)
Avg board tenure	-0.050***	-0.039***	-0.042***	-0.043***	-0.043***
	(0.009)	(0.008)	(0.006)	(0.006)	(0.006)
Board Size	-0.015+	-0.033***	-0.042***	-0.039***	-0.038***
	(0.009)	(0.008)	(0.006)	(0.006)	(0.006)
ESG highxWomen employees	-0.062+	0.001	0.023	0.045+	0.009
	(0.033)	(0.031)	(0.024)	(0.024)	(0.024)
ESG mediumxWomen employees	-0.063*	0.008	0.02	0.041+	0.007
	(0.032)	(0.031)	(0.024)	(0.024)	(0.023)
Model	FE	FE	RE	RE	RE
Num.Obs.	14931	10978	10978	10912	10912
R2	0.008	0.02	0.076	0.081	0.076
AIC	39610.1	28238	22251.4	22176.7	21530.9

This table reports the panel regression results regarding the impact of ESG on the gender diversity-risk relationship at the firm level for an unbalanced panel of 3718 firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG high isa dummy variable that takes value 1 when the ESG score of the firm is above the 75% of the ESG socres distribution, and 0 othervise. ESG medium is a dummy variable that takes value 1 when the ESG score of the firm is between the 25% and the 75% of the ESG socres distribution, and 0 othervise. Women employees is the percentage of women employees. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. 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 2: Impact of ESG on the women managers-risk relationship, Total sample

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
Intercept			0.000	0.041	0.002
			(0.056)	(0.056)	(0.057)
ESG high	0.009	0.077	-0.128***	-0.142***	-0.134***
	(0.044)	(0.042)	(0.032)	(0.032)	(0.032)
ESG medium	-0.031	0.02	-0.099**	-0.122***	-0.105***
	(0.043)	(0.041)	(0.032)	(0.032)	(0.031)
Women managers	-0.007	-0.009	0.049	0.037	0.063*
	(0.043)	(0.041)	(0.031)	(0.031)	(0.031)
Size	0.007	0.001	-0.134***	-0.131***	-0.129***
	(0.011)	(0.011)	(0.008)	(0.008)	(0.008)
MTB	-0.028**	-0.001	-0.025**	-0.023**	-0.024**
	(0.010)	(0.010)	(0.008)	(0.008)	(0.007)
ROA	-0.045***	-0.097***	-0.128***	-0.144***	-0.128***
	(0.011)	(0.011)	(0.008)	(0.008)	(0.008)
Lev	0.031**	0.054***	0.070***	0.075***	0.071***
	(0.010)	(0.009)	(0.007)	(0.007)	(0.007)
Avg board tenure	-0.034**	-0.035***	-0.033***	-0.035***	-0.036***
	(0.010)	(0.010)	(0.008)	(0.008)	(0.007)
Board Size	-0.016	-0.039***	-0.048***	-0.048***	-0.045***
	(0.010)	(0.009)	(0.007)	(0.007)	(0.007)
ESG highxWomen managers	-0.01	-0.023	-0.049	-0.046	-0.064*
	(0.045)	(0.043)	(0.033)	(0.033)	(0.032)
ESG mediumxWomen managers	-0.025	-0.026	-0.060+	-0.051	-0.075*
	(0.044)	(0.042)	(0.032)	(0.032)	(0.032)
Model	FE	FE	RE	RE	RE
Num.Obs.	14931	10978	10978	10912	10912
R2	0.008	0.02	0.076	0.081	0.076
AIC	39610.1	28238	22251.4	22176.7	21530.9

This table reports the panel regression results regarding the impact of ESG on the gender diversity-risk relationship at the firm level for an unbalanced panel of 3718 firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG high isa dummy variable that takes value 1 when the ESG score of the firm is above the 75% of the ESG socres distribution, and 0 othervise. ESG medium is a dummy variable that takes value 1 when the ESG score of the firm is between the 25% and the 75% of the ESG socres distribution, and 0 othervise. Women managers is the percentage of women managers. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. 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 3: Impact of ESG on the board diversity -risk relationship, Total sample

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
ESG high	-0.055**	-0.040*	-0.096***	-0.080***	-0.100***
	(0.020)	(0.019)	(0.015)	(0.014)	(0.014)
ESG medium	-0.045**	-0.041**	-0.068***	-0.063***	-0.072***
	(0.016)	(0.015)	(0.012)	(0.011)	(0.011)
Board diverstity	-0.007	-0.027*	-0.053***	-0.057***	-0.052***
	(0.012)	(0.011)	(0.009)	(0.009)	(0.009)
Size	0.001	0.007	-0.152***	-0.147***	-0.148***
	(0.008)	(0.007)	(0.006)	(0.006)	(0.006)
MTB	-0.016*	0.017**	-0.011*	-0.015**	-0.011*
	(0.007)	(0.006)	(0.005)	(0.005)	(0.005)
ROA	-0.055***	-0.133***	-0.184***	-0.197***	-0.183***
	(0.006)	(0.006)	(0.005)	(0.005)	(0.004)
Lev	0.026***	0.046***	0.056***	0.060***	0.057***
	(0.006)	(0.006)	(0.005)	(0.005)	(0.005)
Avg board tenure	-0.033***	-0.034***	-0.071***	-0.074***	-0.068***
	(0.006)	(0.006)	(0.004)	(0.004)	(0.004)
Board Size	-0.008	-0.022***	-0.027***	-0.022***	-0.024***
	(0.007)	(0.007)	(0.005)	(0.005)	(0.005)
ESG highxBoard diversity	0.002	0.030+	0.004	-0.001	0.002
	(0.018)	(0.016)	(0.013)	(0.013)	(0.012)
ESG mediumxBoard diversity	-0.034*	-0.025+	0.000	0.001	-0.001
	(0.015)	(0.014)	(0.011)	(0.010)	(0.010)
Model	FE	FE	FE	FE	FE
Num.Obs.	28093	28883	28883	28756	28756
R2	0.007	0.028	0.136	0.145	0.139
AIC	77230.9	76459.5	61260.2	60165	59488.6

This table reports the panel regression results regarding the impact of ESG on the gender diversity-risk relationship at the firm level for an unbalanced panel of 3718 firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG high isa dummy variable that takes value 1 when the ESG score of the firm is above the 75% of the ESG socres distribution, and 0 othervise. ESG medium is a dummy variable that takes value 1 when the ESG score of the firm is between the 25% and the 75% of the ESG socres distribution, and 0 othervise. Board diversity is the percentage of women on board. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. 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 4: Impact of ESG on the MB ratio-risk relationship, Total sample

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
Intercept			-0.020	0.015	-0.022
			(0.057)	(0.058)	(0.059)
ESG high	-0.008	0.074	-0.113**	-0.120***	-0.115***
	(0.048)	(0.045)	(0.035)	(0.035)	(0.034)
ESG medium	-0.053	0.009	-0.090**	-0.107**	-0.093**
	(0.047)	(0.044)	(0.034)	(0.034)	(0.033)
M.B.	-0.05	-0.041	0.02	0.012	0.027
	(0.036)	(0.035)	(0.027)	(0.027)	(0.026)
Size	0.006	0.000	-0.132***	-0.128***	-0.127***
	(0.011)	(0.011)	(0.008)	(0.008)	(0.008)
MTB	-0.030**	-0.007	-0.028***	-0.027***	-0.027***
	(0.010)	(0.010)	(0.008)	(0.008)	(0.007)
ROA	-0.044***	-0.096***	-0.123***	-0.138***	-0.123***
	(0.011)	(0.011)	(0.008)	(0.008)	(0.008)
Lev	0.034***	0.056***	0.070***	0.076***	0.072***
	(0.010)	(0.010)	(0.007)	(0.007)	(0.007)
Avg board tenure	-0.035**	-0.034***	-0.032***	-0.035***	-0.036***
	(0.011)	(0.010)	(0.008)	(0.008)	(0.008)
Board Size	-0.014	-0.042***	-0.049***	-0.049***	-0.046***
	(0.010)	(0.010)	(0.007)	(0.007)	(0.007)
ESG highxM.B	0.065+	0.051	-0.002	0.014	-0.006
	(0.039)	(0.037)	(0.029)	(0.029)	(0.028)
ESG mediumxM.B	0.036	0.044	0.008	0.019	-0.002
	(0.038)	(0.037)	(0.028)	(0.028)	(0.027)
Model	FE	FE	RE	RE	RE
Num.Obs.	10649	11186	11186	11110	11110
R2	0.007	0.017	0.079	0.084	0.081
AIC	28059.6	28920.7	23042.7	22889.8	22247.6

This table reports the panel regression results regarding the impact of ESG on the gender diversity-risk relationship at the firm level for an unbalanced panel of 3718 firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG high isa dummy variable that takes value 1 when the ESG score of the firm is above the 75% of the ESG socres distribution, and 0 othervise. ESG medium is a dummy variable that takes value 1 when the ESG score of the firm is between the 25% and the 75% of the ESG socres distribution, and 0 othervise. M.B. is the ratio of women managers with respect the women on board. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. 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 5: Impact of ESG on the EB ratio-risk relationship, Total sample

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
Intercept		-0.028			
		(0.030)			
ESG high	-0.056**	-0.043*	-0.129***	-0.118***	-0.132***
	(0.019)	(0.018)	(0.014)	(0.014)	(0.014)
ESG medium	-0.047**	-0.055***	-0.087***	-0.085***	-0.091***
	(0.016)	(0.015)	(0.011)	(0.011)	(0.011)
E.B.	-0.005	0.005	0.031***	0.028***	0.031***
	(0.011)	(0.010)	(0.008)	(0.008)	(0.008)
Size	0.001	0.005	-0.147***	-0.141***	-0.143***
	(0.008)	(0.008)	(0.006)	(0.006)	(0.006)
MTB	-0.019**	0.013*	-0.016**	-0.019***	-0.016***
	(0.007)	(0.006)	(0.005)	(0.005)	(0.005)
ROA	-0.055***	-0.130***	-0.178***	-0.191***	-0.178***
	(0.007)	(0.006)	(0.005)	(0.005)	(0.005)
Lev	0.029***	0.048***	0.061***	0.065***	0.062***
	(0.007)	(0.006)	(0.005)	(0.005)	(0.005)
Avg board tenure	-0.036***	-0.035***	-0.065***	-0.067***	-0.063***
	(0.006)	(0.006)	(0.005)	(0.004)	(0.004)
Board Size	-0.014+	-0.032***	-0.032***	-0.026***	-0.030***
	(0.007)	(0.007)	(0.005)	(0.005)	(0.005)
ESG highxE.B	-0.012	-0.055***	-0.035**	-0.030*	-0.034**
	(0.017)	(0.016)	(0.013)	(0.013)	(0.012)
ESG mediumxE.B	0.014	0.009	0.001	0.003	-0.001
	(0.014)	(0.013)	(0.010)	(0.010)	(0.010)
Model	FE	RE	FE	FE	FE
Num.Obs.	25667	26422	26422	26297	26297
R2	0.008	0.027	0.126	0.132	0.129
AIC	70197	69965.9	55929.5	54954.8	54291.2

This table reports the panel regression results regarding the impact of ESG on the gender diversity-risk relationship at the firm level for an unbalanced panel of 3718 firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG high isa dummy variable that takes value 1 when the ESG score of the firm is above the 75% of the ESG socres distribution, and 0 othervise. ESG medium is a dummy variable that takes value 1 when the ESG score of the firm is between the 25% and the 75% of the ESG socres distribution, and 0 othervise. E.B. is the equivalent ratio for the executive women. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. 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 E on the women employees-risk relationship, Total sample

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
Intercept	-0.006	-0.046	0.05	0.091+	0.047
	(0.040)	(0.043)	(0.053)	(0.055)	(0.055)
E high	-0.05	-0.056	-0.199***	-0.219***	-0.201***
	(0.039)	(0.037)	(0.029)	(0.029)	(0.028)
E medium	-0.067+	-0.083*	-0.141***	-0.162***	-0.141***
	(0.036)	(0.035)	(0.027)	(0.027)	(0.026)
Women employees	0.006	-0.065*	-0.055*	-0.073**	-0.057**
	(0.030)	(0.029)	(0.022)	(0.022)	(0.022)
Size	0.009	0.008	-0.123***	-0.120***	-0.118***
	(0.010)	(0.010)	(0.007)	(0.007)	(0.007)
MTB	-0.022*	0.007	-0.023***	-0.027***	-0.023***
	(0.009)	(0.008)	(0.006)	(0.007)	(0.006)
ROA	-0.043***	-0.101***	-0.144***	-0.150***	-0.143***
	(0.009)	(0.009)	(0.007)	(0.007)	(0.007)
Lev	0.028***	0.050***	0.070***	0.076***	0.070***
	(0.008)	(0.008)	(0.006)	(0.006)	(0.006)
Avg board tenure	-0.050***	-0.039***	-0.043***	-0.044***	-0.044***
	(0.009)	(0.008)	(0.006)	(0.006)	(0.006)
Board Size	-0.015+	-0.033***	-0.040***	-0.037***	-0.036***
	(0.009)	(0.008)	(0.006)	(0.006)	(0.006)
E high xWomen employees	-0.028	0.018	0.052*	0.062**	0.052*
	(0.032)	(0.031)	(0.024)	(0.024)	(0.023)
E medium xWomen employees	-0.028	0.016	0.031	0.038	0.032
	(0.031)	(0.030)	(0.023)	(0.023)	(0.023)
Model	RE	RE	RE	RE	RE
Num.Obs.	14931	15605	15605	15505	15505
R2	0.008	0.02	0.091	0.094	0.092
AIC	39822.7	40859.5	32832.4	32635.7	31797.2

This table reports the panel regression results regarding the impact of E on the gender diversity-risk relationship at the firm level for an unbalanced panel of 3718 firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. E high is a dummy variable that takes value 1 when the E score of the firm is above the 75% of the E socres distribution, and 0 othervise. E medium is a dummy variable that takes value 1 when the E score of the firm is between the 25% and the 75% of the E socres distribution, and 0 othervise. Women employees is the percentage of women employees. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. 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 7: Impact of E on the women managers-risk relationship, Total sample

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
Intercept			-0.007	0.025	-0.014
			(0.058)	(0.059)	(0.060)
E high	-0.03	0.027	-0.136***	-0.142***	-0.135***
	(0.050)	(0.048)	(0.037)	(0.037)	(0.036)
E medium	-0.059	-0.012	-0.083*	-0.095**	-0.078*
	(0.048)	(0.046)	(0.035)	(0.035)	(0.034)
Women managers	-0.044	0.018	0.038	0.044+	0.04
	(0.035)	(0.034)	(0.026)	(0.026)	(0.025)
Size	0.006	0.001	-0.127***	-0.124***	-0.122***
	(0.012)	(0.011)	(0.008)	(0.008)	(0.008)
MTB	-0.029**	-0.002	-0.025**	-0.023**	-0.024**
	(0.010)	(0.010)	(0.008)	(0.008)	(0.007)
ROA	-0.044***	-0.095***	-0.126***	-0.141***	-0.126***
	(0.011)	(0.011)	(0.008)	(0.008)	(0.008)
Lev	0.031**	0.054***	0.072***	0.077***	0.073***
	(0.010)	(0.009)	(0.007)	(0.007)	(0.007)
Avg board tenure	-0.033**	-0.036***	-0.035***	-0.037***	-0.038***
	(0.010)	(0.010)	(0.008)	(0.008)	(0.007)
Board Size	-0.016	-0.039***	-0.045***	-0.046***	-0.042***
	(0.010)	(0.010)	(0.007)	(0.007)	(0.007)
E high xWomen managers	0.006	-0.058	-0.039	-0.057*	-0.043
	(0.038)	(0.036)	(0.028)	(0.028)	(0.027)
E medium xWomen managers	0.032	-0.051	-0.055*	-0.064*	-0.055*
	(0.037)	(0.036)	(0.027)	(0.027)	(0.027)
Model	FE	FE	RE	RE	RE
Num.Obs.	10969	11526	11526	11448	11448
R2	0.007	0.018	0.083	0.088	0.084
AIC	28950.2	29826.5	23844.4	23667.9	23029.1

This table reports the panel regression results regarding the impact of E on the gender diversity-risk relationship at the firm level for an unbalanced panel of 3718 firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. E high is a dummy variable that takes value 1 when the E score of the firm is above the 75% of the E socres distribution, and 0 othervise. E medium is a dummy variable that takes value 1 when the E score of the firm is between the 25% and the 75% of the E socres distribution, and 0 othervise. Women managers is the percentage of women managers. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. 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 8: Impact of E on the board diversity-risk relationship, Total sample

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
Intercept			-0.027	-0.028	
			(0.047)	(0.047)	
E high	-0.050*	-0.046*	-0.098***	-0.078***	-0.100***
	(0.021)	(0.020)	(0.015)	(0.015)	(0.015)
E medium	-0.045**	-0.044**	-0.090***	-0.080***	-0.090***
	(0.016)	(0.015)	(0.012)	(0.012)	(0.011)
Board diverstity	-0.015	-0.034**	-0.054***	-0.056***	-0.053***
	(0.012)	(0.011)	(0.009)	(0.009)	(0.009)
Size	0.001	0.009	-0.150***	-0.146***	-0.145***
	(0.008)	(0.008)	(0.006)	(0.006)	(0.006)
MTB	-0.016*	0.016**	-0.012*	-0.015**	-0.012**
	(0.007)	(0.006)	(0.005)	(0.005)	(0.005)
ROA	-0.054***	-0.132***	-0.182***	-0.195***	-0.181***
	(0.006)	(0.006)	(0.005)	(0.005)	(0.004)
Lev	0.026***	0.046***	0.057***	0.061***	0.058***
	(0.006)	(0.006)	(0.005)	(0.005)	(0.005)
Avg board tenure	-0.034***	-0.035***	-0.072***	-0.076***	-0.070***
	(0.006)	(0.006)	(0.004)	(0.004)	(0.004)
Board Size	-0.009	-0.022**	-0.028***	-0.023***	-0.025***
	(0.007)	(0.007)	(0.005)	(0.005)	(0.005)
E high xBoard diversity	0.012	0.024	-0.01	-0.014	-0.013
	(0.018)	(0.017)	(0.013)	(0.013)	(0.012)
E medium xBoard diversity	-0.022	-0.005	0.005	0.002	0.003
	(0.015)	(0.014)	(0.011)	(0.010)	(0.010)
Model	FE	FE	RE	RE	FE
Num.Obs.	28093	28883	28883	28756	28756
R2	0.007	0.028	0.137	0.145	0.139
AIC	77231.9	76468.5	61403.2	60325.5	59474.3

This table reports the panel regression results regarding the impact of E on the gender diversity-risk relationship at the firm level for an unbalanced panel of 3718 firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. E high is a dummy variable that takes value 1 when the E score of the firm is above the 75% of the E socres distribution, and 0 othervise. E medium is a dummy variable that takes value 1 when the E score of the firm is between the 25% and the 75% of the E socres distribution, and 0 othervise. Board diversity is the percentage of women on board. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. 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 9: Impact of E on the MB ratio -risk relationship, Total sample

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
Intercept			-0.042	-0.014	-0.046
			(0.059)	(0.060)	(0.060)
E high	-0.003	0.033	-0.105**	-0.106**	-0.107**
	(0.053)	(0.050)	(0.038)	(0.039)	(0.038)
E medium	-0.031	-0.009	-0.056	-0.063+	-0.055
	(0.050)	(0.048)	(0.037)	(0.037)	(0.036)
M.B.	-0.038	-0.006	0.065**	0.077**	0.069**
	(0.034)	(0.033)	(0.025)	(0.025)	(0.024)
Size	0.005	0.000	-0.125***	-0.122***	-0.119***
	(0.012)	(0.011)	(0.008)	(0.009)	(0.008)
MTB	-0.031**	-0.007	-0.027***	-0.026***	-0.026***
	(0.010)	(0.010)	(0.008)	(0.008)	(0.007)
ROA	-0.043***	-0.095***	-0.121***	-0.136***	-0.121***
	(0.012)	(0.011)	(0.008)	(0.008)	(0.008)
Lev	0.033***	0.055***	0.072***	0.077***	0.073***
	(0.010)	(0.010)	(0.007)	(0.007)	(0.007)
Avg board tenure	-0.034**	-0.034***	-0.034***	-0.037***	-0.037***
	(0.011)	(0.010)	(0.008)	(0.008)	(0.008)
Board Size	-0.015	-0.043***	-0.047***	-0.048***	-0.044***
	(0.010)	(0.010)	(0.007)	(0.007)	(0.007)
E high xM.B	0.037	0.016	-0.039	-0.045+	-0.043
	(0.036)	(0.035)	(0.027)	(0.027)	(0.026)
E medium xM.B	0.036	0.001	-0.052*	-0.065*	-0.056*
	(0.036)	(0.035)	(0.027)	(0.027)	(0.026)
Model	FE	FE	RE	RE	RE
Num.Obs.	10649	11186	11186	11110	11110
R2	0.007	0.016	0.08	0.085	0.082
AIC	28066.7	28931.6	23034.1	22877.7	22236.9

This table reports the panel regression results regarding the impact of E on the gender diversity-risk relationship at the firm level for an unbalanced panel of 3718 firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. E high is a dummy variable that takes value 1 when the E score of the firm is above the 75% of the E socres distribution, and 0 othervise. E medium is a dummy variable that takes value 1 when the E score of the firm is between the 25% and the 75% of the E socres distribution, and 0 othervise. M.B. is the ratio of women managers with respect the women on board. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. 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 10: Impact of E on the EB ratio-risk relationship, Total sample

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
Intercept		-0.018		-0.006	
		(0.030)		(0.049)	
E high	-0.066**	-0.068***	-0.145***	-0.128***	-0.147***
	(0.021)	(0.020)	(0.015)	(0.015)	(0.015)
E medium	-0.060***	-0.063***	-0.111***	-0.103***	-0.112***
	(0.016)	(0.015)	(0.012)	(0.012)	(0.012)
E.B.	0.002	0.001	0.027***	0.028***	0.027***
	(0.011)	(0.010)	(0.008)	(0.008)	(0.008)
Size	0.004	0.009	-0.143***	-0.139***	-0.138***
	(0.009)	(0.008)	(0.006)	(0.006)	(0.006)
MTB	-0.019**	0.012+	-0.017***	-0.020***	-0.017***
	(0.007)	(0.006)	(0.005)	(0.005)	(0.005)
ROA	-0.054***	-0.128***	-0.176***	-0.189***	-0.175***
	(0.007)	(0.006)	(0.005)	(0.005)	(0.005)
Lev	0.030***	0.048***	0.062***	0.065***	0.062***
	(0.007)	(0.006)	(0.005)	(0.005)	(0.005)
Avg board tenure	-0.037***	-0.037***	-0.068***	-0.069***	-0.065***
	(0.006)	(0.006)	(0.005)	(0.004)	(0.004)
Board Size	-0.014+	-0.031***	-0.031***	-0.026***	-0.029***
	(0.008)	(0.007)	(0.005)	(0.005)	(0.005)
E high xE.B	-0.025	-0.049**	-0.030*	-0.032**	-0.028*
	(0.017)	(0.016)	(0.013)	(0.012)	(0.012)
E medium xE.B	0.002	0.012	0.000	-0.002	-0.001
	(0.014)	(0.013)	(0.010)	(0.010)	(0.010)
Model	FE	RE	FE	RE	FE
Num.Obs.	25667	26422	26422	26297	26297
R2	0.008	0.027	0.127	0.133	0.129
AIC	70192.6	69951.5	55913.7	55097.4	54277.9

This table reports the panel regression results regarding the impact of E on the gender diversity-risk relationship at the firm level for an unbalanced panel of 3718 firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. E high is a dummy variable that takes value 1 when the E score of the firm is above the 75% of the E socres distribution, and 0 othervise. E medium is a dummy variable that takes value 1 when the E score of the firm is between the 25% and the 75% of the E socres distribution, and 0 othervise. E.B. is the equivalent ratio for the executive women. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. 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 11: Impact of S on the women employees-risk relationship, Total sample

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
Intercept			0.016	0.049	0.004
			(0.051)	(0.052)	(0.054)
S high	-0.011	0.047	-0.189***	-0.200***	-0.178***
	(0.032)	(0.030)	(0.023)	(0.024)	(0.023)
S medium	-0.024	0.032	-0.099***	-0.111***	-0.089***
	(0.030)	(0.028)	(0.022)	(0.022)	(0.021)
Women employees	0.014	-0.024	-0.043*	-0.064**	-0.043*
	(0.028)	(0.026)	(0.020)	(0.020)	(0.020)
Size	0.008	0.006	-0.118***	-0.116***	-0.115***
	(0.010)	(0.009)	(0.007)	(0.007)	(0.007)
MTB	-0.024**	0.006	-0.020**	-0.024***	-0.020**
	(0.009)	(0.008)	(0.006)	(0.007)	(0.006)
ROA	-0.046***	-0.103***	-0.147***	-0.153***	-0.146***
	(0.009)	(0.009)	(0.007)	(0.007)	(0.007)
Lev	0.031***	0.053***	0.068***	0.073***	0.068***
	(0.008)	(0.008)	(0.006)	(0.006)	(0.006)
Avg board tenure	-0.049***	-0.039***	-0.045***	-0.046***	-0.046***
	(0.009)	(0.008)	(0.006)	(0.006)	(0.006)
Board Size	-0.015+	-0.033***	-0.037***	-0.034***	-0.034***
	(0.009)	(0.008)	(0.006)	(0.006)	(0.006)
S high xWomen employees	-0.031	-0.028	0.040+	0.055*	0.041+
	(0.030)	(0.028)	(0.022)	(0.022)	(0.021)
S medium xWomen employees	-0.046	-0.026	0.023	0.036+	0.023
	(0.029)	(0.028)	(0.021)	(0.022)	(0.021)
Model	FE	FE	RE	RE	RE
Num.Obs.	14931	15605	15605	15505	15505
R2	0.008	0.019	0.092	0.096	0.093
AIC	39616.3	40657.3	32796.4	32601.3	31769.4

This table reports the panel regression results regarding the impact of S on the gender diversity- risk relationship at the firm level for an unbalanced panel of 3718 firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. S high is a dummy variable that takes value 1 when the S score of the firm is above the 75% of the S socres distribution, and 0 othervise. S medium is a dummy variable that takes value 1 when the S score of the firm is between the 25% and the 75% of the S socres distribution, and 0 othervise. Women employees is the percentage of women employees. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. 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 12:Impact of S on the women managers-risk relationship, Total sample

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
Intercept		-0.123**	0.053	0.083	0.038
		(0.044)	(0.054)	(0.055)	(0.056)
S high	-0.025	0.038	-0.216***	-0.218***	-0.203***
	(0.044)	(0.041)	(0.032)	(0.032)	(0.031)
S medium	-0.054	0.000	-0.138***	-0.150***	-0.127***
	(0.042)	(0.040)	(0.030)	(0.030)	(0.030)
Women managers	-0.022	-0.01	0.016	-0.004	0.011
	(0.041)	(0.039)	(0.030)	(0.031)	(0.030)
Size	0.007	0.001	-0.122***	-0.119***	-0.118***
	(0.011)	(0.011)	(0.008)	(0.008)	(0.008)
MTB	-0.029**	0.000	-0.023**	-0.022**	-0.022**
	(0.010)	(0.010)	(0.008)	(0.008)	(0.007)
ROA	-0.045***	-0.098***	-0.130***	-0.145***	-0.129***
	(0.011)	(0.011)	(0.008)	(0.008)	(0.008)
Lev	0.031**	0.049***	0.071***	0.075***	0.072***
	(0.010)	(0.009)	(0.007)	(0.007)	(0.007)
Avg board tenure	-0.033**	-0.034***	-0.035***	-0.037***	-0.038***
	(0.010)	(0.010)	(0.008)	(0.008)	(0.007)
Board Size	-0.015	-0.040***	-0.042***	-0.042***	-0.039***
	(0.010)	(0.010)	(0.007)	(0.007)	(0.007)
S high xWomen managers	0.01	-0.026	-0.009	0.005	-0.002
	(0.043)	(0.041)	(0.031)	(0.032)	(0.031)
S medium xWomen managers	-0.014	-0.03	-0.03	-0.013	-0.025
	(0.043)	(0.041)	(0.031)	(0.032)	(0.031)
Model	FE	RE	RE	RE	RE
Num.Obs.	10969	11526	11526	11448	11448
R2	0.007	0.018	0.085	0.09	0.087
AIC	28950.1	30053	23817.5	23647	23006.4

This table reports the panel regression results regarding the impact of S on the gender diversity- risk relationship at the firm level for an unbalanced panel of 3718 firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. S high is a dummy variable that takes value 1 when the S score of the firm is above the 75% of the S socres distribution, and 0 othervise. S medium is a dummy variable that takes value 1 when the S score of the firm is between the 25% and the 75% of the S socres distribution, and 0 othervise. Women managers is the percentage of women managers. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. 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 13: Impact of S on the board diversity-risk relationship, Total sample

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
S high	-0.039+	-0.041*	-0.132***	-0.121***	-0.130***
	(0.020)	(0.019)	(0.015)	(0.014)	(0.014)
S medium	-0.013	0.000	-0.040***	-0.037***	-0.041***
	(0.015)	(0.015)	(0.011)	(0.011)	(0.011)
board diverstity	-0.034**	-0.045***	-0.065***	-0.069***	-0.064***
	(0.012)	(0.011)	(0.009)	(0.009)	(0.009)
Size	0.001	0.009	-0.144***	-0.139***	-0.141***
	(0.008)	(0.008)	(0.006)	(0.006)	(0.006)
MTB	-0.015*	0.017**	-0.009+	-0.013**	-0.009*
	(0.007)	(0.006)	(0.005)	(0.005)	(0.005)
ROA	-0.056***	-0.134***	-0.185***	-0.197***	-0.184***
	(0.006)	(0.006)	(0.005)	(0.004)	(0.004)
Lev	0.026***	0.045***	0.056***	0.060***	0.057***
	(0.006)	(0.006)	(0.005)	(0.005)	(0.005)
Avg board tenure	-0.034***	-0.035***	-0.074***	-0.078***	-0.072***
	(0.006)	(0.006)	(0.004)	(0.004)	(0.004)
Board Size	-0.008	-0.022**	-0.024***	-0.019***	-0.022***
	(0.007)	(0.007)	(0.005)	(0.005)	(0.005)
S high xBoard diversity	0.029	0.049**	0.021+	0.023+	0.02
	(0.018)	(0.017)	(0.013)	(0.013)	(0.012)
S medium xBoard diversity	0.007	0.003	0.016	0.015	0.015
	(0.015)	(0.014)	(0.011)	(0.010)	(0.010)
Model	FE	FE	FE	FE	FE
Num.Obs.	28093	28883	28883	28756	28756
R2	0.007	0.028	0.138	0.146	0.14
AIC	77238.8	76467.2	61214.5	60121.4	59449.2

This table reports the panel regression results regarding the impact of S on the gender diversity- risk relationship at the firm level for an unbalanced panel of 3718 firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. S high is a dummy variable that takes value 1 when the S score of the firm is above the 75% of the S socres distribution, and 0 othervise. S medium is a dummy variable that takes value 1 when the S score of the firm is between the 25% and the 75% of the S socres distribution, and 0 othervise. Board diversity is the percentage of women on board. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. 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 14: Impact of S on the MB ratio-risk relationship, Total sample

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
Intercept			0.033	0.064	0.024
			(0.056)	(0.057)	(0.058)
S high	-0.024	0.048	-0.199***	-0.201***	-0.193***
	(0.045)	(0.043)	(0.032)	(0.033)	(0.032)
S medium	-0.056	0.004	-0.129***	-0.142***	-0.125***
	(0.043)	(0.041)	(0.031)	(0.031)	(0.030)
M.B.	0.008	0.033	0.03	0.006	0.012
	(0.035)	(0.034)	(0.026)	(0.027)	(0.026)
Size	0.007	0.001	-0.120***	-0.118***	-0.116***
	(0.012)	(0.011)	(0.008)	(0.008)	(0.008)
MTB	-0.031**	-0.008	-0.026***	-0.025***	-0.025***
	(0.010)	(0.010)	(0.008)	(0.008)	(0.007)
ROA	-0.044***	-0.094***	-0.123***	-0.138***	-0.123***
	(0.011)	(0.011)	(0.008)	(0.008)	(0.008)
Lev	0.034***	0.055***	0.071***	0.076***	0.072***
	(0.010)	(0.010)	(0.007)	(0.007)	(0.007)
Avg board tenure	-0.033**	-0.033**	-0.034***	-0.037***	-0.038***
	(0.011)	(0.010)	(0.008)	(0.008)	(0.008)
Board Size	-0.015	-0.043***	-0.043***	-0.044***	-0.041***
	(0.010)	(0.010)	(0.007)	(0.007)	(0.007)
S high xM.B	0.003	-0.029	-0.009	0.02	0.013
	(0.038)	(0.036)	(0.028)	(0.029)	(0.028)
S medium xM.B	-0.029	-0.038	-0.006	0.024	0.012
	(0.037)	(0.036)	(0.027)	(0.029)	(0.028)
Model	FE	FE	RE	RE	RE
Num.Obs.	10649	11186	11186	11110	11110
R2	0.007	0.017	0.082	0.087	0.083
AIC	28062.4	28930.3	23006.6	22855.7	22212.4

This table reports the panel regression results regarding the impact of S on the gender diversity- risk relationship at the firm level for an unbalanced panel of 3718 firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. S high is a dummy variable that takes value 1 when the S score of the firm is above the 75% of the S socres distribution, and 0 othervise. S medium is a dummy variable that takes value 1 when the S score of the firm is between the 25% and the 75% of the S socres distribution, and 0 othervise. M.B. is the ratio of women managers with respect the women on board. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. 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 15: Impact of EB ratio on the S-downside risk relationship, Total sample

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
S high	-0.047*	-0.048**	-0.157***	-0.149***	-0.155***
	(0.020)	(0.019)	(0.014)	(0.014)	(0.014)
S medium	-0.02	-0.018	-0.053***	-0.053***	-0.053***
	(0.016)	(0.015)	(0.011)	(0.011)	(0.011)
E.B.	0.006	0.008	0.027***	0.022**	0.025***
	(0.011)	(0.010)	(0.008)	(0.008)	(0.008)
Size	0.002	0.009	-0.139***	-0.134***	-0.136***
	(0.008)	(0.008)	(0.006)	(0.006)	(0.006)
MTB	-0.018**	0.012+	-0.014**	-0.017***	-0.014**
	(0.007)	(0.006)	(0.005)	(0.005)	(0.005)
ROA	-0.057***	-0.131***	-0.180***	-0.192***	-0.179***
	(0.007)	(0.006)	(0.005)	(0.005)	(0.005)
Lev	0.029***	0.051***	0.061***	0.064***	0.061***
	(0.007)	(0.006)	(0.005)	(0.005)	(0.005)
Avg board tenure	-0.037***	-0.037***	-0.069***	-0.071***	-0.067***
	(0.006)	(0.006)	(0.005)	(0.004)	(0.004)
Board Size	-0.014+	-0.031***	-0.029***	-0.023***	-0.027***
	(0.008)	(0.007)	(0.005)	(0.005)	(0.005)
S high xE.B	-0.016	-0.056***	-0.036**	-0.030*	-0.031*
	(0.018)	(0.017)	(0.013)	(0.013)	(0.012)
S medium xE.B	-0.007	0.002	0.006	0.011	0.006
	(0.014)	(0.013)	(0.010)	(0.010)	(0.010)
Model	FE	FE	FE	FE	FE
Num.Obs.	25667	26422	26422	26297	26297
R2	0.007	0.027	0.128	0.134	0.13
AIC	70203.7	69704.5	55887.4	54912.7	54258.6

This table reports the panel regression results regarding the impact of S on the gender diversity- risk relationship at the firm level for an unbalanced panel of 3718 firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. S high is a dummy variable that takes value 1 when the S score of the firm is above the 75% of the S socres distribution, and 0 othervise. S medium is a dummy variable that takes value 1 when the S score of the firm is between the 25% and the 75% of the S socres distribution, and 0 othervise. E.B. is the equivalent ratio for the executive women. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. 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 16: Impact of G on the women employees-risk relationship, Total sample

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
Intercept			-0.087+	-0.058	-0.087+
			(0.049)	(0.050)	(0.051)
G high	-0.007	0.011	-0.026	-0.030+	-0.028
	(0.024)	(0.022)	(0.017)	(0.017)	(0.017)
G medium	-0.016	-0.007	-0.017	-0.026	-0.022
	(0.022)	(0.021)	(0.016)	(0.016)	(0.016)
Women employees	-0.014	-0.046*	0.008	-0.015	0.01
	(0.019)	(0.018)	(0.014)	(0.014)	(0.014)
Size	0.009	0.009	-0.137***	-0.135***	-0.133***
	(0.010)	(0.009)	(0.007)	(0.007)	(0.007)
MTB	-0.024**	0.007	-0.022***	-0.026***	-0.022***
	(0.009)	(0.008)	(0.006)	(0.007)	(0.006)
ROA	-0.046***	-0.102***	-0.149***	-0.155***	-0.147***
	(0.009)	(0.009)	(0.007)	(0.007)	(0.007)
Lev	0.031***	0.053***	0.068***	0.073***	0.068***
	(0.008)	(0.008)	(0.006)	(0.006)	(0.006)
Avg board tenure	-0.050***	-0.040***	-0.041***	-0.042***	-0.042***
	(0.009)	(0.008)	(0.006)	(0.006)	(0.006)
Board Size	-0.014	-0.030***	-0.047***	-0.044***	-0.043***
	(0.009)	(0.008)	(0.006)	(0.006)	(0.006)
G high xWomen employees	-0.018	0.006	-0.018	0.002	-0.023
	(0.023)	(0.022)	(0.017)	(0.017)	(0.016)
G medium xWomen employees	-0.006	-0.009	-0.035*	-0.02	-0.035*
	(0.021)	(0.020)	(0.016)	(0.016)	(0.015)
Model	FE	FE	RE	RE	RE
Num.Obs.	14931	15605	15605	15505	15505
R2	0.008	0.019	0.088	0.09	0.089
AIC	39618.6	40659	32878.8	32693.4	31848.1

This table reports the panel regression results regarding the impact of G on the gender diversity-risk relationship at the firm level for an unbalanced panel of 3718 firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. G high is a dummy variable that takes value 1 when the G score of the firm is above the 75% of the G socres distribution, and 0 othervise. G medium is a dummy variable that takes value 1 when the G score of the firm is between the 25% and the 75% of the G socres distribution, and 0 othervise. Women employees is the percentage of women employees. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. 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 17: Impact of G on the women managers-risk relationship, Total sample

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
Intercept			-0.086+	-0.053	-0.083
			(0.049)	(0.050)	(0.051)
G high	0.001	0.028	-0.024	-0.034	-0.033+
	(0.028)	(0.027)	(0.021)	(0.021)	(0.020)
G medium	-0.011	0.006	-0.022	-0.034+	-0.03
	(0.027)	(0.025)	(0.019)	(0.019)	(0.019)
Women managers	-0.032	-0.029	0.039*	0.034*	0.039*
	(0.023)	(0.021)	(0.016)	(0.017)	(0.016)
Size	0.008	0.004	-0.139***	-0.135***	-0.134***
	(0.011)	(0.011)	(0.008)	(0.008)	(0.008)
MTB	-0.028**	-0.002	-0.024**	-0.023**	-0.023**
	(0.010)	(0.010)	(0.008)	(0.008)	(0.007)
ROA	-0.044***	-0.096***	-0.130***	-0.145***	-0.129***
	(0.011)	(0.011)	(0.008)	(0.008)	(0.008)
Lev	0.031**	0.055***	0.071***	0.075***	0.072***
	(0.010)	(0.009)	(0.007)	(0.007)	(0.007)
Avg board tenure	-0.034**	-0.036***	-0.033***	-0.035***	-0.036***
	(0.010)	(0.010)	(0.008)	(0.008)	(0.007)
Board Size	-0.014	-0.034***	-0.050***	-0.050***	-0.048***
	(0.010)	(0.009)	(0.007)	(0.007)	(0.007)
G high xWomen managers	0.007	-0.015	-0.044*	-0.050*	-0.048*
	(0.027)	(0.026)	(0.020)	(0.020)	(0.019)
G medium xWomen managers	0.011	0.003	-0.057**	-0.056**	-0.055**
	(0.025)	(0.024)	(0.018)	(0.018)	(0.018)
Model	FE	RE	RE	RE	RE
Num.Obs.	10969	11526	11526	11448	11448
R2	0.007	0.017	0.081	0.087	0.083
AIC	28954.8	29830.8	23867.6	23694.7	23054.8

This table reports the panel regression results regarding the impact of G on the gender diversity-risk relationship at the firm level for an unbalanced panel of 3718 firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. G high is a dummy variable that takes value 1 when the G score of the firm is above the 75% of the G socres distribution, and 0 othervise. G medium is a dummy variable that takes value 1 when the G score of the firm is between the 25% and the 75% of the G socres distribution, and 0 othervise. Women managers is the percentage of women managers. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. 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 18: Impact of G on the board diversity-risk relationship, Total sample

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
Intercept			-0.105*		
			(0.047)		
G high	-0.017	-0.023	0.015	0.009	0.01
	(0.018)	(0.017)	(0.013)	(0.013)	(0.013)
G medium	-0.013	-0.012	-0.002	-0.013	-0.009
	(0.015)	(0.014)	(0.011)	(0.011)	(0.010)
Board diversity	-0.030**	-0.036***	-0.082***	-0.079***	-0.079***
	(0.011)	(0.011)	(0.008)	(0.008)	(0.008)
Size	-0.002	0.006	-0.165***	-0.157***	-0.160***
	(0.008)	(0.007)	(0.006)	(0.006)	(0.006)
MTB	-0.016*	0.017**	-0.011*	-0.015**	-0.012*
	(0.007)	(0.006)	(0.005)	(0.005)	(0.005)
ROA	-0.056***	-0.134***	-0.188***	-0.200***	-0.186***
	(0.006)	(0.006)	(0.005)	(0.004)	(0.004)
Lev	0.026***	0.046***	0.056***	0.061***	0.057***
	(0.006)	(0.006)	(0.005)	(0.005)	(0.005)
Avg board tenure	-0.032***	-0.034***	-0.068***	-0.072***	-0.066***
	(0.006)	(0.006)	(0.004)	(0.004)	(0.004)
Board Size	-0.01	-0.023***	-0.031***	-0.024***	-0.028***
	(0.007)	(0.007)	(0.005)	(0.005)	(0.005)
G high xBoard diversity	0.009	0.027+	0.025*	0.018	0.023+
	(0.017)	(0.016)	(0.012)	(0.012)	(0.012)
G medium xBoard diversity	0.003	-0.007	0.030**	0.019+	0.024*
	(0.014)	(0.013)	(0.010)	(0.010)	(0.010)
Model	FE	FE	RE	FE	FE
Num.Obs.	28093	28883	28883	28756	28756
R2	0.007	0.028	0.135	0.144	0.137
AIC	77243.5	76475.4	61461.9	60197.1	59538

This table reports the panel regression results regarding the impact of G on the gender diversity-risk relationship at the firm level for an unbalanced panel of 3718 firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. G high is a dummy variable that takes value 1 when the G score of the firm is above the 75% of the G socres distribution, and 0 othervise. G medium is a dummy variable that takes value 1 when the G score of the firm is between the 25% and the 75% of the G socres distribution, and 0 othervise. Board diversity is the percentage of women on board. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. 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 19: Impact of G on the MB ratio-risk relationship, Total sample

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
Intercept			-0.107*	-0.074	-0.104*
			(0.050)	(0.050)	(0.052)
G high	0.012	0.031	-0.01	-0.02	-0.02
	(0.030)	(0.028)	(0.021)	(0.022)	(0.021)
G medium	-0.004	0.014	-0.01	-0.022	-0.019
	(0.028)	(0.026)	(0.020)	(0.020)	(0.020)
M.B.	0.008	0.019	0.046***	0.046***	0.045***
	(0.019)	(0.018)	(0.014)	(0.014)	(0.013)
Size	0.007	0.003	-0.136***	-0.132***	-0.131***
	(0.011)	(0.011)	(0.008)	(0.008)	(0.008)
MTB	-0.030**	-0.007	-0.027***	-0.026***	-0.026***
	(0.010)	(0.010)	(0.008)	(0.008)	(0.007)
ROA	-0.043***	-0.093***	-0.123***	-0.138***	-0.123***
	(0.011)	(0.011)	(0.008)	(0.008)	(0.008)
Lev	0.034***	0.057***	0.071***	0.076***	0.072***
	(0.010)	(0.010)	(0.007)	(0.007)	(0.007)
Avg board tenure	-0.035**	-0.033***	-0.032***	-0.035***	-0.035***
	(0.011)	(0.010)	(0.008)	(0.008)	(0.008)
Board Size	-0.012	-0.038***	-0.051***	-0.051***	-0.048***
	(0.010)	(0.010)	(0.007)	(0.007)	(0.007)
G high xM.B	-0.014	-0.066**	-0.047*	-0.049**	-0.048**
	(0.026)	(0.024)	(0.019)	(0.019)	(0.018)
G medium xM.B	-0.018	0.001	-0.019	-0.01	-0.015
	(0.023)	(0.022)	(0.016)	(0.017)	(0.016)
Model	FE	FE	RE	RE	RE
Num.Obs.	10649	11186	11186	11110	11110
R2	0.006	0.017	0.078	0.084	0.08
AIC	28068.4	28922.9	23047.9	22895.6	22252.4

This table reports the panel regression results regarding the impact of G on the gender diversity-risk relationship at the firm level for an unbalanced panel of 3718 firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. G high is a dummy variable that takes value 1 when the G score of the firm is above the 75% of the G socres distribution, and 0 othervise. G medium is a dummy variable that takes value 1 when the G score of the firm is between the 25% and the 75% of the G socres distribution, and 0 othervise. M.B. is the ratio of women managers with respect the women on board. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. 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 20: Impact of G on the EB ratio-risk relationship, Total sample

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
Intercept		-0.048			
		(0.031)			
G high	-0.029	-0.030+	-0.022+	-0.027*	-0.025*
	(0.018)	(0.017)	(0.013)	(0.013)	(0.013)
G medium	-0.019	-0.022	-0.022+	-0.032**	-0.028*
	(0.015)	(0.014)	(0.011)	(0.011)	(0.011)
E.B.	0.013	0.015	0.041***	0.038***	0.041***
	(0.011)	(0.011)	(0.008)	(0.008)	(0.008)
Size	-0.003	0.003	-0.161***	-0.154***	-0.157***
	(0.008)	(0.008)	(0.006)	(0.006)	(0.006)
MTB	-0.019**	0.012+	-0.017***	-0.020***	-0.017***
	(0.007)	(0.006)	(0.005)	(0.005)	(0.005)
ROA	-0.057***	-0.131***	-0.183***	-0.195***	-0.182***
	(0.007)	(0.006)	(0.005)	(0.005)	(0.005)
Lev	0.030***	0.049***	0.062***	0.066***	0.063***
	(0.007)	(0.006)	(0.005)	(0.005)	(0.005)
Avg board tenure	-0.034***	-0.033***	-0.060***	-0.063***	-0.058***
	(0.006)	(0.006)	(0.004)	(0.004)	(0.004)
Board Size	-0.016*	-0.034***	-0.037***	-0.031***	-0.035***
	(0.007)	(0.007)	(0.005)	(0.005)	(0.005)
G high xE.B	-0.023	-0.047**	-0.033**	-0.033**	-0.033**
	(0.017)	(0.016)	(0.013)	(0.012)	(0.012)
G medium xE.B	-0.016	-0.012	-0.018+	-0.013	-0.019+
	(0.014)	(0.013)	(0.010)	(0.010)	(0.010)
Model	FE	RE	FE	FE	FE
Num.Obs.	25667	26422	26422	26297	26297
R2	0.007	0.027	0.123	0.13	0.125
AIC	70205.6	69956.8	56018.9	55027.6	54386.4

This table reports the panel regression results regarding the impact of G on the gender diversity-risk relationship at the firm level for an unbalanced panel of 3718 firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. G high is a dummy variable that takes value 1 when the G score of the firm is above the 75% of the G socres distribution, and 0 othervise. G medium is a dummy variable that takes value 1 when the G score of the firm is between the 25% and the 75% of the G socres distribution, and 0 othervise. E.B. is the equivalent ratio for the executive women. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. 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 21: Impact of ESG on the women employees-risk relationship, USA sample

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
ESG high	-0.105+	-0.122*	-0.193***	-0.222***	-0.190***
	(0.057)	(0.051)	(0.041)	(0.041)	(0.040)
ESG medium	-0.100+	-0.145**	-0.145***	-0.164***	-0.137***
	(0.057)	(0.050)	(0.040)	(0.040)	(0.039)
Women employees	0.067	-0.048	-0.023	-0.063	-0.015
	(0.054)	(0.048)	(0.038)	(0.039)	(0.038)
Size	-0.008	-0.082***	-0.267***	-0.250***	-0.251***
	(0.018)	(0.016)	(0.013)	(0.013)	(0.012)
MTB	-0.022+	-0.012	-0.065***	-0.064***	-0.062***
	(0.013)	(0.011)	(0.009)	(0.009)	(0.009)
ROA	-0.027*	-0.104***	-0.151***	-0.155***	-0.150***
	(0.013)	(0.012)	(0.010)	(0.010)	(0.009)
Lev	0.015	0.055***	0.083***	0.084***	0.079***
	(0.014)	(0.012)	(0.010)	(0.010)	(0.009)
Avg board tenure	-0.065***	-0.058***	-0.062***	-0.061***	-0.063***
	(0.014)	(0.012)	(0.010)	(0.010)	(0.010)
Board Size	-0.063***	-0.071***	-0.053***	-0.069***	-0.053***
	(0.019)	(0.016)	(0.013)	(0.013)	(0.013)
ESG high xWomen employees	-0.135*	0.007	0.009	0.04	-0.001
	(0.056)	(0.050)	(0.040)	(0.040)	(0.039)
ESG medium xWomen employees	-0.091	-0.003	-0.001	0.032	-0.012
	(0.056)	(0.050)	(0.040)	(0.040)	(0.039)
Model	FE	FE	FE	FE	FE
Num.Obs.	6510	6510	6510	6474	6474
R2	0.014	0.047	0.196	0.197	0.194
AIC	17797.5	16207.1	13349.5	13256.7	12923.3

This table reports the panel regression results regarding the impact of the ESG score on the gender diversity-risk relationship at the firm level for an unbalanced panel of 2326 US firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG high is a dummy variable that takes value 1 when the ESG score of the firm is above the 75% of the ESG socres distribution, and 0 othervise. ESG medium is a dummy variable that takes value 1 when the ESG score of the firm is between the 25% and the 75% of the ESG socres distribution, and 0 othervise. Women employees is the percentage of women employees. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. 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 22: Impact of ESG on the women managers-risk relationship, USA sample

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
Intercept					0.155*
					(0.077)
ESG high	-0.137	-0.11	-0.237***	-0.238***	-0.225***
	(0.085)	(0.074)	(0.059)	(0.059)	(0.057)
ESG medium	-0.142+	-0.125+	-0.175**	-0.163**	-0.158**
	(0.085)	(0.074)	(0.059)	(0.059)	(0.057)
Women managers	0.033	0.062	0.135*	0.119*	0.165**
	(0.084)	(0.074)	(0.058)	(0.059)	(0.057)
Size	-0.017	-0.090***	-0.285***	-0.262***	-0.269***
	(0.021)	(0.019)	(0.015)	(0.015)	(0.015)
MTB	-0.024	-0.023+	-0.071***	-0.066***	-0.066***
	(0.016)	(0.014)	(0.011)	(0.011)	(0.011)
ROA	-0.017	-0.100***	-0.131***	-0.142***	-0.129***
	(0.017)	(0.015)	(0.012)	(0.012)	(0.012)
Lev	0.026	0.084***	0.096***	0.096***	0.093***
	(0.017)	(0.015)	(0.012)	(0.012)	(0.011)
Avg board tenure	-0.041*	-0.043**	-0.051***	-0.057***	-0.057***
	(0.017)	(0.015)	(0.012)	(0.012)	(0.012)
Board Size	-0.065**	-0.083***	-0.045**	-0.069***	-0.049**
	(0.023)	(0.020)	(0.016)	(0.016)	(0.015)
ESG high xWomen managers	-0.078	-0.081	-0.115+	-0.105+	-0.150**
	(0.086)	(0.075)	(0.060)	(0.060)	(0.058)
ESG medium xWomen managers	-0.085	-0.078	-0.114+	-0.104+	-0.149*
	(0.086)	(0.076)	(0.060)	(0.060)	(0.058)
Model	FE	FE	FE	FE	RE
Num.Obs.	4280	4280	4280	4258	4258
R2	0.011	0.048	0.198	0.198	0.197
AIC	11583.6	10457.4	8479.4	8478.9	8326.1

This table reports the panel regression results regarding the impact of ESG on the gender diversity-risk relationship at the firm level for an unbalanced panel of 2326 US firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG high is a dummy variable that takes value 1 when the ESG score of the firm is above the 75% of the ESG socres distribution, and 0 othervise. ESG medium is a dummy variable that takes value 1 when the ESG score of the firm is between the 25% and the 75% of the ESG socres distribution, and 0 othervise. Women managers is the percentage of women managers. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. 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 23: Impact of ESG on the board diversity -risk relationship, USA sample

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
ESG high	-0.061*	-0.037	-0.086***	-0.084***	-0.087***
	(0.027)	(0.024)	(0.018)	(0.018)	(0.018)
ESG medium	-0.023	-0.052**	-0.060***	-0.060***	-0.064***
	(0.022)	(0.020)	(0.015)	(0.015)	(0.015)
Board diverstity	0.025	0.02	0.013	0.011	0.013
	(0.017)	(0.015)	(0.012)	(0.011)	(0.011)
Size	-0.028*	-0.062***	-0.240***	-0.222***	-0.228***
	(0.012)	(0.010)	(0.008)	(0.008)	(0.008)
MTB	-0.019*	-0.001	-0.038***	-0.039***	-0.036***
	(0.008)	(0.007)	(0.006)	(0.005)	(0.005)
ROA	-0.041***	-0.137***	-0.183***	-0.201***	-0.182***
	(0.008)	(0.007)	(0.005)	(0.005)	(0.005)
Lev	0.021*	0.045***	0.057***	0.060***	0.056***
	(0.008)	(0.008)	(0.006)	(0.006)	(0.006)
Avg board tenure	-0.048***	-0.064***	-0.083***	-0.080***	-0.080***
	(0.008)	(0.007)	(0.005)	(0.005)	(0.005)
Board Size	-0.025*	-0.035***	-0.048***	-0.050***	-0.047***
	(0.011)	(0.010)	(0.008)	(0.008)	(0.008)
ESG high xBoard diversity	-0.056*	-0.052*	0.001	-0.004	-0.004
	(0.026)	(0.023)	(0.017)	(0.017)	(0.017)
ESG medium xBoard diversity	-0.070***	-0.063***	-0.005	-0.011	-0.005
	(0.021)	(0.019)	(0.014)	(0.014)	(0.014)
Model	FE	FE	FE	FE	FE
Num.Obs.	17956	17957	17957	17905	17905
R2	0.01	0.045	0.202	0.214	0.202
AIC	50748.9	46674.9	36778.8	35566.3	35701.9

This table reports the panel regression results regarding the impact of ESG on the gender diversity-risk relationship at the firm level for an unbalanced panel of 2326 US firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG high is a dummy variable that takes value 1 when the ESG score of the firm is above the 75% of the ESG socres distribution, and 0 othervise. ESG medium is a dummy variable that takes value 1 when the ESG score of the firm is between the 25% and the 75% of the ESG socres distribution, and 0 othervise. Board diversity is the percentage of women on board. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. 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 24: Impact of ESG on the MB ratio-risk relationship, USA sample

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
Intercept			0.229**	0.193*	
			(0.081)	(0.081)	
ESG high	-0.194*	-0.148+	-0.299***	-0.261***	-0.273***
	(0.093)	(0.082)	(0.065)	(0.065)	(0.063)
ESG medium	-0.199*	-0.166*	-0.233***	-0.188**	-0.202**
	(0.093)	(0.082)	(0.065)	(0.065)	(0.063)
M.B.	-0.105+	-0.077	-0.023	0.004	0.005
	(0.055)	(0.048)	(0.038)	(0.038)	(0.037)
Size	-0.017	-0.090***	-0.286***	-0.266***	-0.266***
	(0.022)	(0.019)	(0.015)	(0.015)	(0.015)
MTB	-0.026	-0.025+	-0.069***	-0.064***	-0.067***
	(0.016)	(0.014)	(0.011)	(0.011)	(0.011)
ROA	-0.015	-0.101***	-0.130***	-0.142***	-0.127***
	(0.017)	(0.015)	(0.012)	(0.012)	(0.012)
Lev	0.030+	0.089***	0.098***	0.097***	0.098***
	(0.017)	(0.015)	(0.012)	(0.012)	(0.011)
Avg board tenure	-0.043*	-0.040**	-0.045***	-0.053***	-0.049***
	(0.018)	(0.015)	(0.012)	(0.012)	(0.012)
Board Size	-0.059**	-0.083***	-0.044**	-0.069***	-0.045**
	(0.023)	(0.020)	(0.016)	(0.016)	(0.015)
ESG high xM.B	0.091	0.038	-0.023	-0.057	-0.045
	(0.060)	(0.053)	(0.042)	(0.042)	(0.040)
ESG medium xM.B	0.081	0.074	0.012	-0.012	-0.014
	(0.059)	(0.052)	(0.041)	(0.041)	(0.040)
Model	FE	FE	RE	RE	FE
Num.Obs.	4209	4209	4209	4187	4187
R2	0.009	0.049	0.197	0.198	0.194
AIC	11349.1	10262.1	8426.8	8452.6	7986.7

This table reports the panel regression results regarding the impact of ESG on the gender diversity-risk relationship at the firm level for an unbalanced panel of 2326 US firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG high is a dummy variable that takes value 1 when the ESG score of the firm is above the 75% of the ESG socres distribution, and 0 othervise. ESG medium is a dummy variable that takes value 1 when the ESG score of the firm is between the 25% and the 75% of the ESG socres distribution, and 0 othervise. M.B. is the ratio of women managers with respect the women on board. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. 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 25: Impact of ESG on the EB ratio-risk relationship, USA sample

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
ESG high	-0.058*	-0.036	-0.083***	-0.081***	-0.086***
	(0.025)	(0.023)	(0.017)	(0.017)	(0.017)
ESG medium	-0.011	-0.046*	-0.062***	-0.064***	-0.067***
	(0.021)	(0.019)	(0.014)	(0.014)	(0.014)
E.B.	-0.024+	-0.027*	-0.001	0.004	0.001
	(0.014)	(0.013)	(0.010)	(0.010)	(0.010)
Size	-0.021+	-0.055***	-0.228***	-0.211***	-0.216***
	(0.012)	(0.011)	(0.008)	(0.008)	(0.008)
MTB	-0.021*	-0.005	-0.040***	-0.042***	-0.039***
	(0.009)	(0.008)	(0.006)	(0.006)	(0.006)
ROA	-0.041***	-0.133***	-0.178***	-0.195***	-0.177***
	(0.008)	(0.007)	(0.006)	(0.006)	(0.006)
Lev	0.022*	0.051***	0.060***	0.062***	0.059***
	(0.009)	(0.008)	(0.006)	(0.006)	(0.006)
Avg board tenure	-0.054***	-0.073***	-0.090***	-0.085***	-0.087***
	(0.008)	(0.007)	(0.006)	(0.005)	(0.005)
Board Size	-0.032**	-0.047***	-0.051***	-0.053***	-0.051***
	(0.012)	(0.011)	(0.008)	(0.008)	(0.008)
ESG high xE.B	0.004	-0.022	-0.022	-0.035*	-0.025
	(0.023)	(0.020)	(0.016)	(0.015)	(0.015)
ESG medium xE.B	0.019	0.021	0.01	0.000	0.006
	(0.018)	(0.016)	(0.012)	(0.012)	(0.012)
Model	FE	FE	FE	FE	FE
Num.Obs.	16272	16273	16273	16221	16221
R2	0.01	0.047	0.197	0.207	0.197
AIC	45693.7	42047.9	33188.2	32131.6	32196.8

This table reports the panel regression results regarding the impact of ESG on the gender diversity-risk relationship at the firm level for an unbalanced panel of 2326 US firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG high is a dummy variable that takes value 1 when the ESG score of the firm is above the 75% of the ESG socres distribution, and 0 othervise. ESG medium is a dummy variable that takes value 1 when the ESG score of the firm is between the 25% and the 75% of the ESG socres distribution, and 0 othervise. E.B. is the equivalent ratio for the executive women. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. 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 26: Impact of ESG on the women employees-risk relationship, European sample

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
Intercept	-0.082**		-0.112*	-0.061	-0.120*
	(0.031)		(0.047)	(0.049)	(0.049)
ESG high	0.061*	0.129***	-0.052*	-0.062**	-0.054*
	(0.031)	(0.031)	(0.023)	(0.023)	(0.022)
ESG medium	0.009	0.093***	-0.007	-0.018	-0.005
	(0.027)	(0.027)	(0.020)	(0.020)	(0.019)
Women employees	0.002	-0.059*	-0.042*	-0.052**	-0.033+
	(0.025)	(0.025)	(0.018)	(0.018)	(0.018)
Size	0.007	0.042***	-0.072***	-0.068***	-0.074***
	(0.011)	(0.012)	(0.008)	(0.009)	(0.008)
MTB	-0.026*	0.012	0.008	0.012	0.006
	(0.012)	(0.013)	(0.009)	(0.009)	(0.009)
ROA	-0.054***	-0.068***	-0.099***	-0.107***	-0.100***
	(0.013)	(0.013)	(0.010)	(0.010)	(0.009)
Lev	0.033**	0.056***	0.060***	0.066***	0.061***
	(0.011)	(0.011)	(0.008)	(0.008)	(0.008)
Avg board tenure	-0.030*	-0.025*	-0.031***	-0.023*	-0.036***
	(0.012)	(0.012)	(0.009)	(0.009)	(0.009)
Board Size	-0.005	-0.017+	-0.029***	-0.022**	-0.025***
	(0.009)	(0.009)	(0.007)	(0.007)	(0.007)
ESG high xWomen employees	-0.001	-0.006	0.014	0.023	0.009
	(0.030)	(0.030)	(0.022)	(0.022)	(0.021)
ESG medium xWomen employees	-0.022	0.006	0.029	0.03	0.02
	(0.027)	(0.027)	(0.020)	(0.020)	(0.019)
Model	RE	FE	RE	RE	RE
Num.Obs.	8421	9095	9095	9031	9031
R2	0.009	0.018	0.041	0.041	0.043
AIC	21078.4	23434.6	17875.9	17702.5	17289

This table reports the panel regression results regarding the impact of ESG on the gender diversity-risk risk relationship at the firm level for an unbalanced panel of 1392 European firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG high is a dummy variable that takes value 1 when the ESG score of the firm is above the 75% of the ESG socres distribution, and 0 othervise. ESG medium is a dummy variable that takes value 1 when the ESG score of the firm is between the 25% and the 75% of the ESG socres distribution, and 0 othervise. Women employees is the percentage of women employees. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. 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 27: Impact of ESG on the women managers-risk relationship, European sample

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
Intercept	-0.074*		-0.100*	-0.061	-0.108*
	(0.037)		(0.049)	(0.050)	(0.051)
ESG high	0.073+	0.142***	-0.058*	-0.052+	-0.062*
	(0.038)	(0.038)	(0.028)	(0.028)	(0.027)
ESG medium	-0.006	0.085*	-0.026	-0.023	-0.024
	(0.034)	(0.034)	(0.025)	(0.025)	(0.025)
Women managers	-0.002	-0.087**	-0.046*	-0.042+	-0.044+
	(0.031)	(0.031)	(0.023)	(0.023)	(0.023)
Size	0.001	0.035**	-0.077***	-0.074***	-0.078***
	(0.013)	(0.013)	(0.009)	(0.009)	(0.009)
MTB	-0.027+	0.011	0.009	0.018+	0.007
	(0.014)	(0.014)	(0.010)	(0.010)	(0.010)
ROA	-0.066***	-0.075***	-0.096***	-0.113***	-0.098***
	(0.015)	(0.015)	(0.011)	(0.011)	(0.011)
Lev	0.027*	0.039**	0.057***	0.062***	0.058***
	(0.012)	(0.012)	(0.009)	(0.009)	(0.009)
Avg board tenure	-0.022	-0.025+	-0.024*	-0.014	-0.029**
	(0.014)	(0.014)	(0.010)	(0.010)	(0.010)
Board Size	-0.005	-0.021*	-0.039***	-0.035***	-0.035***
	(0.011)	(0.011)	(0.008)	(0.008)	(0.008)
ESG high xWomen managers	0.015	0.051	0.023	0.015	0.023
	(0.037)	(0.037)	(0.027)	(0.027)	(0.027)
ESG medium xWomen managers	-0.032	0.028	0.018	0.01	0.016
	(0.034)	(0.034)	(0.025)	(0.025)	(0.025)
Model	RE	FE	RE	RE	RE
Num.Obs.	6689	7246	7246	7190	7190
R2	0.011	0.016	0.043	0.046	0.046
AIC	16769.4	18567.4	14193.1	13964.2	13687.2

This table reports the panel regression results regarding the impact of ESG on the gender diversity-risk risk relationship at the firm level for an unbalanced panel of 1392 European firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG high is a dummy variable that takes value 1 when the ESG score of the firm is above the 75% of the ESG socres distribution, and 0 othervise. ESG medium is a dummy variable that takes value 1 when the ESG score of the firm is between the 25% and the 75% of the ESG socres distribution, and 0 othervise. Women managers is the percentage of women managers. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. 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 28: Impact of ESG on the board diversity-risk relationship, European sample

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
Intercept	-0.115***		-0.161***	-0.106*	-0.164***
	(0.027)		(0.043)	(0.046)	(0.047)
ESG high	0.070*	0.121***	-0.026	-0.035	-0.034
	(0.029)	(0.030)	(0.023)	(0.022)	(0.022)
ESG medium	0.036+	0.129***	0.050*	0.034*	0.045**
	(0.022)	(0.024)	(0.021)	(0.017)	(0.016)
Board diverstity	-0.037*	-0.014	-0.100***	-0.105***	-0.097***
	(0.015)	(0.018)	(0.016)	(0.012)	(0.011)
Size	0.023*	0.071***	-0.043***	-0.038***	-0.047***
	(0.010)	(0.015)	(0.011)	(0.008)	(0.008)
MTB	-0.016	0.021	0.031*	0.035***	0.028***
	(0.011)	(0.014)	(0.012)	(0.009)	(0.008)
ROA	-0.052***	-0.066***	-0.106***	-0.111***	-0.106***
	(0.011)	(0.013)	(0.013)	(0.008)	(0.008)
Lev	0.031**	0.059***	0.064***	0.070***	0.066***
	(0.010)	(0.009)	(0.011)	(0.007)	(0.007)
Avg board tenure	-0.030**	-0.027*	-0.045***	-0.038***	-0.049***
	(0.011)	(0.013)	(0.008)	(0.008)	(0.008)
Board Size	-0.001	-0.015	-0.016*	-0.008	-0.012+
	(0.008)	(0.010)	(0.008)	(0.006)	(0.006)
ESG high xBoard diversity	0.056*	0.040+	0.080***	0.072***	0.078***
	(0.023)	(0.024)	(0.021)	(0.018)	(0.017)
ESG medium xBoard diversity	0.015	-0.014	0.033+	0.034*	0.033*
	(0.019)	(0.022)	(0.018)	(0.014)	(0.014)
Model	RE	FE	RE	RE	RE
Num.Obs.	10137	10926	10926	10851	10851
R2	0.012	0.028	0.048	0.05	0.051
AIC	25198.7	28025.9	21700.5	21679	21064

This table reports the panel regression results regarding the impact of ESG on the gender diversity-risk risk relationship at the firm level for an unbalanced panel of 1392 European firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG high is a dummy variable that takes value 1 when the ESG score of the firm is above the 75% of the ESG socres distribution, and 0 othervise. ESG medium is a dummy variable that takes value 1 when the ESG score of the firm is between the 25% and the 75% of the ESG socres distribution, and 0 othervise. Board diversity is the percentage of women on board. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. 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 29: Impact of ESG on the MB ratio-risk relationship, European sample

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
Intercept	-0.109**		-0.114*	-0.072	-0.126*
	(0.034)		(0.047)	(0.050)	(0.050)
ESG high	0.093*	0.151***	-0.056*	-0.055*	-0.056*
	(0.037)	(0.037)	(0.027)	(0.028)	(0.027)
ESG medium	0.019	0.093**	-0.005	-0.004	0.000
	(0.033)	(0.033)	(0.024)	(0.024)	(0.024)
M.B.	0.03	-0.017	0.035	0.016	0.023
	(0.032)	(0.033)	(0.024)	(0.024)	(0.024)
Size	0.016	0.056***	-0.067***	-0.061***	-0.067***
	(0.013)	(0.013)	(0.010)	(0.010)	(0.010)
MTB	-0.022	0.013	0.013	0.019+	0.012
	(0.014)	(0.014)	(0.011)	(0.011)	(0.010)
ROA	-0.065***	-0.083***	-0.086***	-0.095***	-0.086***
	(0.015)	(0.015)	(0.011)	(0.011)	(0.011)
Lev	0.017	0.037**	0.063***	0.067***	0.065***
	(0.012)	(0.012)	(0.009)	(0.009)	(0.009)
Avg board tenure	-0.030*	-0.019	-0.023*	-0.019+	-0.028**
	(0.014)	(0.014)	(0.010)	(0.010)	(0.010)
Board Size	0.000	-0.018+	-0.030***	-0.028***	-0.026***
	(0.011)	(0.011)	(0.008)	(0.008)	(0.008)
ESG high xM.B	-0.022	0.034	-0.026	0.007	-0.013
	(0.037)	(0.037)	(0.028)	(0.028)	(0.027)
ESG medium xM.B	-0.044	0.011	0.001	0.027	0.013
	(0.035)	(0.036)	(0.026)	(0.026)	(0.026)
Model	RE	FE	RE	RE	RE
Num.Obs.	6468	6977	6977	6924	6924
R2	0.012	0.02	0.037	0.038	0.039
AIC	16387	17981.7	13905.7	13818.4	13439

This table reports the panel regression results regarding the impact of ESG on the gender diversity-risk risk relationship at the firm level for an unbalanced panel of 1392 European firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG high is a dummy variable that takes value 1 when the ESG score of the firm is above the 75% of the ESG socres distribution, and 0 othervise. ESG medium is a dummy variable that takes value 1 when the ESG score of the firm is between the 25% and the 75% of the ESG socres distribution, and 0 othervise. M.B. is the ratio of women managers with respect the women on board. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. 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 30: Impact of ESG on the EB ratio-risk relationship, European sample

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
Intercept	-0.104***		-0.156***	-0.099*	-0.159***
	(0.029)		(0.045)	(0.047)	(0.047)
ESG high	0.083**	0.137***	-0.028	-0.045*	-0.034
	(0.028)	(0.029)	(0.021)	(0.021)	(0.021)
ESG medium	0.03	0.117***	0.035*	0.019	0.032+
	(0.024)	(0.024)	(0.018)	(0.018)	(0.017)
E.B.	0.028	0.036*	0.085***	0.096***	0.079***
	(0.018)	(0.018)	(0.013)	(0.013)	(0.013)
Size	0.018+	0.065***	-0.050***	-0.046***	-0.053***
	(0.011)	(0.011)	(0.008)	(0.008)	(0.008)
MTB	-0.019+	0.014	0.027**	0.030***	0.023**
	(0.011)	(0.012)	(0.009)	(0.009)	(0.009)
ROA	-0.053***	-0.064***	-0.104***	-0.110***	-0.105***
	(0.011)	(0.012)	(0.009)	(0.009)	(0.008)
Lev	0.034***	0.054***	0.061***	0.067***	0.064***
	(0.010)	(0.010)	(0.008)	(0.008)	(0.007)
Avg board tenure	-0.027*	-0.018	-0.035***	-0.028**	-0.039***
	(0.011)	(0.011)	(0.009)	(0.009)	(0.008)
Board Size	-0.003	-0.017+	-0.017*	-0.008	-0.013*
	(0.009)	(0.009)	(0.007)	(0.007)	(0.007)
ESG high xE.B	-0.049+	-0.114***	-0.104***	-0.098***	-0.094***
	(0.027)	(0.028)	(0.020)	(0.021)	(0.020)
ESG medium xE.B	-0.013	-0.023	-0.037*	-0.043*	-0.033*
	(0.022)	(0.023)	(0.017)	(0.017)	(0.016)
Model	RE	FE	RE	RE	RE
Num.Obs.	9395	10149	10149	10076	10076
R2	0.012	0.027	0.041	0.043	0.044
AIC	23285.7	25999.6	20084.8	20005.3	19480.7

This table reports the panel regression results regarding the impact of ESG on the gender diversity-risk risk relationship at the firm level for an unbalanced panel of 1392 European firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG high is a dummy variable that takes value 1 when the ESG score of the firm is above the 75% of the ESG socres distribution, and 0 othervise. ESG medium is a dummy variable that takes value 1 when the ESG score of the firm is between the 25% and the 75% of the ESG socres distribution, and 0 othervise. E.B. is the equivalent ratio for the executive women. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. 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 31: Impact of ESG on the women employees-risk relationship, Non-financial sample

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
Intercept			0.013	0.063	0.009
			(0.056)	(0.057)	(0.058)
ESG high	-0.014	0.006	-0.179***	-0.202***	-0.177***
	(0.035)	(0.034)	(0.026)	(0.026)	(0.026)
ESG medium	-0.047	-0.042	-0.148***	-0.177***	-0.145***
	(0.034)	(0.032)	(0.025)	(0.025)	(0.024)
Women employees	0.034	-0.053+	-0.036	-0.066**	-0.023
	(0.033)	(0.031)	(0.024)	(0.024)	(0.024)
Size	-0.004	-0.003	-0.129***	-0.128***	-0.126***
	(0.010)	(0.010)	(0.008)	(0.008)	(0.007)
MTB	-0.018+	0.012	-0.018*	-0.020**	-0.017*
	(0.009)	(0.009)	(0.007)	(0.007)	(0.007)
ROA	-0.052***	-0.120***	-0.162***	-0.169***	-0.161***
	(0.010)	(0.010)	(0.008)	(0.008)	(0.007)
Lev	0.025**	0.044***	0.054***	0.061***	0.053***
	(0.009)	(0.009)	(0.007)	(0.007)	(0.007)
Avg board tenure	-0.044***	-0.043***	-0.032***	-0.036***	-0.033***
	(0.009)	(0.009)	(0.007)	(0.007)	(0.007)
Board Size	-0.016+	-0.045***	-0.050***	-0.051***	-0.047***
	(0.009)	(0.009)	(0.007)	(0.007)	(0.007)
ESG high xWomen employees	-0.074*	-0.018	0.001	0.024	-0.013
	(0.035)	(0.033)	(0.026)	(0.026)	(0.025)
ESG medium xWomen employees	-0.061+	0.014	0.022	0.038	0.008
	(0.034)	(0.033)	(0.025)	(0.025)	(0.025)
Model	FE	FE	RE	RE	RE
Num.Obs.	12791	13358	13358	13278	13278
R2	0.008	0.024	0.103	0.11	0.104
AIC	33763.9	34516.7	27834.4	27608	26987.2

This table reports the panel regression results regarding the impact of ESG on the gender diversity-risk risk relationship at the firm level for an unbalanced panel of 3098 non-financial firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG high is a dummy variable that takes value 1 when the ESG score of the firm is above the 75% of the ESG socres distribution, and 0 othervise. ESG medium is a dummy variable that takes value 1 when the ESG score of the firm is between the 25% and the 75% of the ESG socres distribution, and 0 othervise. Women employees is the percentage of women employees. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. 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 32: Impact of ESG on the women managers-risk relationship, Non-financial sample

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
Intercept			0.000	0.041	0.002
			(0.056)	(0.056)	(0.057)
ESG high	0.009	0.077+	-0.128***	-0.142***	-0.134***
	(0.044)	(0.042)	(0.032)	(0.032)	(0.032)
ESG medium	-0.031	0.02	-0.099**	-0.122***	-0.105***
	(0.043)	(0.041)	(0.032)	(0.032)	(0.031)
Women managers	-0.007	-0.009	0.049	0.037	0.063*
	(0.043)	(0.041)	(0.031)	(0.031)	(0.031)
Size	0.007	0.001	-0.134***	-0.131***	-0.129***
	(0.011)	(0.011)	(0.008)	(0.008)	(0.008)
MTB	-0.028**	-0.001	-0.025**	-0.023**	-0.024**
	(0.010)	(0.010)	(0.008)	(0.008)	(0.007)
ROA	-0.045***	-0.097***	-0.128***	-0.144***	-0.128***
	(0.011)	(0.011)	(0.008)	(0.008)	(0.008)
Lev	0.031**	0.054***	0.070***	0.075***	0.071***
	(0.010)	(0.009)	(0.007)	(0.007)	(0.007)
Avg board tenure	-0.034**	-0.035***	-0.033***	-0.035***	-0.036***
	(0.010)	(0.010)	(0.008)	(0.008)	(0.007)
Board Size	-0.016	-0.039***	-0.048***	-0.048***	-0.045***
	(0.010)	(0.009)	(0.007)	(0.007)	(0.007)
ESG high xWomen managers	-0.01	-0.023	-0.049	-0.046	-0.064*
	(0.045)	(0.043)	(0.033)	(0.033)	(0.032)
ESG medium xWomen managers	-0.025	-0.026	-0.060+	-0.051	-0.075*
	(0.044)	(0.042)	(0.032)	(0.032)	(0.032)
Model	FE	FE	RE	RE	RE
Num.Obs.	9410	9877	9877	9816	9816
R2	0.007	0.022	0.093	0.101	0.095
AIC	24675.8	25284.9	20151.4	19988.3	19512.4

This table reports the panel regression results regarding the impact of ESG on the gender diversity-risk risk relationship at the firm level for an unbalanced panel of 3098 non-financial firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG high is a dummy variable that takes value 1 when the ESG score of the firm is above the 75% of the ESG socres distribution, and 0 othervise. ESG medium is a dummy variable that takes value 1 when the ESG score of the firm is between the 25% and the 75% of the ESG socres distribution, and 0 othervise. Women managers is the percentage of women managers. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. 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 33:Impact of ESG on the board diversity -risk relationship, Non-financial sample

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
ESG high	-0.066**	-0.058*	-0.136***	-0.117***	-0.141***
	(0.022)	(0.024)	(0.025)	(0.016)	(0.016)
ESG medium	-0.063***	-0.068***	-0.109***	-0.102***	-0.113***
	(0.018)	(0.018)	(0.020)	(0.013)	(0.013)
Board diverstity	-0.004	-0.021	-0.028*	-0.033***	-0.025**
	(0.013)	(0.015)	(0.012)	(0.010)	(0.010)
Size	-0.008	-0.003	-0.156***	-0.151***	-0.152***
	(0.009)	(0.012)	(0.011)	(0.006)	(0.006)
MTB	-0.017*	0.01	-0.015	-0.019***	-0.015**
	(0.007)	(0.013)	(0.010)	(0.005)	(0.005)
ROA	-0.054***	-0.143***	-0.198***	-0.212***	-0.197***
	(0.007)	(0.013)	(0.014)	(0.005)	(0.005)
Lev	0.028***	0.046***	0.040***	0.047***	0.040***
	(0.007)	(0.011)	(0.010)	(0.005)	(0.005)
Avg board tenure	-0.033***	-0.037***	-0.059***	-0.065***	-0.057***
	(0.007)	(0.011)	(0.007)	(0.005)	(0.005)
Board Size	-0.018*	-0.044***	-0.044***	-0.043***	-0.041***
	(0.008)	(0.008)	(0.006)	(0.005)	(0.005)
ESG high xBoard diversity	-0.005	0.017	-0.009	-0.009	-0.01
	(0.020)	(0.019)	(0.017)	(0.014)	(0.014)
ESG medium xBoard diversity	-0.032*	-0.027+	-0.021	-0.016	-0.022+
	(0.016)	(0.015)	(0.013)	(0.012)	(0.011)
Model	FE	FE	FE	FE	FE
Num.Obs.	23400	24025	24025	23923	23923
R2	0.009	0.036	0.165	0.177	0.168
AIC	64224.2	63009.8	50658.9	49394.5	49206.4

This table reports the panel regression results regarding the impact of ESG on the gender diversity-risk risk relationship at the firm level for an unbalanced panel of 3098 non-financial firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG high is a dummy variable that takes value 1 when the ESG score of the firm is above the 75% of the ESG socres distribution, and 0 othervise. ESG medium is a dummy variable that takes value 1 when the ESG score of the firm is between the 25% and the 75% of the ESG socres distribution, and 0 othervise. Board diversity is the percentage of women on board. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. 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 34: Impact of ESG on the MB ratio-risk relationship, Non-financial sample

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
Intercept					-0.053
					(0.053)
ESG high	-0.021	-0.032	-0.100***	-0.101***	-0.118***
	(0.037)	(0.036)	(0.028)	(0.027)	(0.027)
ESG medium	-0.048	-0.086*	-0.088***	-0.098***	-0.102***
	(0.035)	(0.034)	(0.026)	(0.026)	(0.025)
M.B.	0.019	0.015	0.003	0.005	0.000
	(0.033)	(0.032)	(0.025)	(0.025)	(0.024)
Size	-0.001	-0.001	-0.125***	-0.126***	-0.121***
	(0.012)	(0.011)	(0.009)	(0.009)	(0.008)
MTB	-0.018	0.01	-0.01	-0.008	-0.008
	(0.011)	(0.011)	(0.008)	(0.008)	(0.008)
ROA	-0.061***	-0.126***	-0.166***	-0.185***	-0.168***
	(0.012)	(0.012)	(0.009)	(0.009)	(0.009)
Lev	0.028*	0.050***	0.038***	0.046***	0.040***
	(0.011)	(0.011)	(0.008)	(0.008)	(0.008)
Avg board tenure	-0.027*	-0.034**	-0.035***	-0.039***	-0.037***
	(0.011)	(0.011)	(0.008)	(0.008)	(0.008)
Board Size	-0.018+	-0.058***	-0.054***	-0.057***	-0.052***
	(0.011)	(0.010)	(0.008)	(0.008)	(0.008)
ESG high xM.B	-0.032	-0.005	-0.004	-0.006	-0.007
	(0.037)	(0.036)	(0.027)	(0.027)	(0.027)
ESG medium xM.B	-0.012	-0.012	0.013	0.003	0.011
	(0.036)	(0.035)	(0.027)	(0.027)	(0.027)
Model	FE	FE	FE	FE	RE
Num.Obs.	9138	9565	9565	9504	9504
R2	0.007	0.026	0.107	0.12	0.112
AIC	23718.2	24587.3	19491.9	19276.1	18981.3

This table reports the panel regression results regarding the impact of ESG on the gender diversity-risk risk relationship at the firm level for an unbalanced panel of 3098 non-financial firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG high is a dummy variable that takes value 1 when the ESG score of the firm is above the 75% of the ESG socres distribution, and 0 othervise. ESG medium is a dummy variable that takes value 1 when the ESG score of the firm is between the 25% and the 75% of the ESG socres distribution, and 0 othervise. M.B. is the ratio of women managers with respect the women on board. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. 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 35:Impact of ESG on the EB ratio-risk relationship, Non-financial sample

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
Intercept	0.027		-0.016		
	(0.030)		(0.048)		
ESG high	-0.072***	-0.063**	-0.155***	-0.141***	-0.159***
	(0.021)	(0.020)	(0.015)	(0.015)	(0.015)
ESG medium	-0.067***	-0.088***	-0.121***	-0.118***	-0.125***
	(0.018)	(0.016)	(0.013)	(0.012)	(0.012)
E.B.	-0.007	0.005	0.021*	0.016+	0.022*
	(0.012)	(0.011)	(0.009)	(0.009)	(0.008)
Size	-0.010	-0.006	-0.151***	-0.145***	-0.146***
	(0.009)	(0.008)	(0.006)	(0.006)	(0.006)
MTB	-0.017*	0.005	-0.018***	-0.022***	-0.019***
	(0.007)	(0.007)	(0.005)	(0.005)	(0.005)
ROA	-0.054***	-0.139***	-0.194***	-0.207***	-0.194***
	(0.007)	(0.007)	(0.005)	(0.005)	(0.005)
Lev	0.026***	0.050***	0.042***	0.049***	0.042***
	(0.007)	(0.007)	(0.005)	(0.005)	(0.005)
Avg board tenure	-0.036***	-0.038***	-0.053***	-0.057***	-0.050***
	(0.007)	(0.006)	(0.005)	(0.005)	(0.005)
Board Size	-0.023**	-0.055***	-0.050***	-0.049***	-0.048***
	(0.008)	(0.008)	(0.006)	(0.006)	(0.006)
ESG high xE.B	-0.009	-0.048**	-0.034*	-0.031*	-0.034*
	(0.019)	(0.018)	(0.014)	(0.013)	(0.013)
ESG medium xE.B	0.007	0.001	0.001	0.004	-0.001
	(0.015)	(0.014)	(0.011)	(0.011)	(0.011)
Model	RE	FE	RE	FE	FE
Num.Obs.	21243	21839	21839	21738	21738
R2	0.009	0.035	0.154	0.164	0.157
AIC	58197.9	57080.1	46143.2	44863.9	44669.8

This table reports the panel regression results regarding the impact of ESG on the gender diversity-risk risk relationship at the firm level for an unbalanced panel of 3098 non-financial firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG high is a dummy variable that takes value 1 when the ESG score of the firm is above the 75% of the ESG socres distribution, and 0 othervise. ESG medium is a dummy variable that takes value 1 when the ESG score of the firm is between the 25% and the 75% of the ESG socres distribution, and 0 othervise. E.B. is the equivalent ratio for the executive women. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. 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 36: Impact of ESG on the women employees-risk relationship, Financial sample

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
Intercept	0.119				
	(0.088)				
ESG high	-0.196*	-0.229*	-0.181	-0.042	-0.165
	(0.097)	(0.107)	(0.122)	(0.119)	(0.124)
ESG medium	-0.193*	-0.177+	-0.111	0.019	-0.098
	(0.094)	(0.103)	(0.117)	(0.114)	(0.119)
Women employees	0.039	0.195*	0.285**	0.223*	0.279**
	(0.073)	(0.086)	(0.098)	(0.096)	(0.100)
Size	0.108***	-0.032	0.063	0.04	0.061
	(0.031)	(0.049)	(0.056)	(0.057)	(0.059)
MTB	-0.040+	-0.060*	-0.008	-0.032	-0.03
	(0.023)	(0.029)	(0.033)	(0.033)	(0.034)
ROA	0.012	0.048	0.119***	0.122***	0.124***
	(0.028)	(0.030)	(0.035)	(0.034)	(0.036)
Lev	0.015	0.093**	0.054	0.062+	0.061
	(0.025)	(0.032)	(0.036)	(0.036)	(0.037)
Avg board tenure	-0.056*	-0.006	-0.045	-0.049	-0.051
	(0.027)	(0.037)	(0.042)	(0.041)	(0.043)
Board Size	-0.02	-0.087*	0.002	-0.001	0.001
	(0.029)	(0.035)	(0.040)	(0.040)	(0.042)
ESG high xWomen employees	-0.033	-0.210*	-0.286**	-0.252*	-0.283**
	(0.080)	(0.092)	(0.105)	(0.102)	(0.107)
ESG medium xWomen employees	-0.072	-0.245**	-0.256*	-0.189+	-0.250*
	(0.078)	(0.088)	(0.100)	(0.097)	(0.102)
Model	RE	FE	FE	FE	FE
Num.Obs.	2140	2247	2247	2227	2227
R2	0.017	0.018	0.014	0.014	0.015
AIC	5798.3	4454.2	5043	4866.7	5080.6

This table reports the panel regression results regarding the impact of ESG on the gender diversity-risk relationship at the firm level for an unbalanced panel of 620 financial firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG high is a dummy variable that takes value 1 when the ESG score of the firm is above the 75% of the ESG socres distribution, and 0 othervise. ESG medium is a dummy variable that takes value 1 when the ESG score of the firm is between the 25% and the 75% of the ESG socres distribution, and 0 othervise. Women employees is the percentage of women employees. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. 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 37: Impact of ESG on the women managers-risk relationship, Financial sample

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
Intercept	-0.032				
	(0.131)				
ESG high	-0.026	-0.159	-0.182	-0.038	-0.21
	(0.138)	(0.170)	(0.194)	(0.187)	(0.198)
ESG medium	-0.017	-0.049	-0.104	0.03	-0.122
	(0.137)	(0.166)	(0.189)	(0.182)	(0.193)
Women managers	-0.091	0.142	0.429*	0.389+	0.480*
	(0.128)	(0.191)	(0.218)	(0.210)	(0.222)
Size	0.115**	-0.113+	0.065	0.022	0.061
	(0.036)	(0.061)	(0.070)	(0.069)	(0.073)
MTB	-0.037	-0.101**	-0.031	-0.06	-0.052
	(0.027)	(0.038)	(0.043)	(0.043)	(0.045)
ROA	-0.007	0.086*	0.171***	0.170***	0.167***
	(0.034)	(0.043)	(0.049)	(0.048)	(0.050)
Lev	0.003	0.156***	0.095*	0.124**	0.108*
	(0.028)	(0.041)	(0.047)	(0.046)	(0.049)
Avg board tenure	-0.048	-0.028	-0.057	-0.049	-0.07
	(0.033)	(0.050)	(0.057)	(0.056)	(0.059)
Board Size	-0.015	-0.084+	-0.039	-0.061	-0.048
	(0.033)	(0.044)	(0.050)	(0.050)	(0.052)
ESG high xWomen managers	0.131	-0.101	-0.440*	-0.401+	-0.487*
	(0.133)	(0.193)	(0.220)	(0.212)	(0.224)
ESG medium xWomen managers	0.051	-0.064	-0.335	-0.244	-0.357
	(0.132)	(0.190)	(0.217)	(0.208)	(0.220)
Model	RE	FE	FE	FE	FE
Num.Obs.	1559	1649	1649	1632	1632
R2	0.021	0.026	0.019	0.026	0.022
AIC	4272.8	3243.9	3682.6	3512.5	3699.2

This table reports the panel regression results regarding the impact of ESG on the gender diversity-risk relationship at the firm level for an unbalanced panel of 620 financial firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG high is a dummy variable that takes value 1 when the ESG score of the firm is above the 75% of the ESG socres distribution, and 0 othervise. ESG medium is a dummy variable that takes value 1 when the ESG score of the firm is between the 25% and the 75% of the ESG socres distribution, and 0 othervise. Women managers is the percentage of women managers. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. 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 38: Impact of ESG on the board diversity-risk relationship, Financial sample

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
Intercept	-0.015			0.028	
	(0.041)			(0.043)	
ESG high	-0.048	-0.122*	-0.019	0.056	0.004
	(0.058)	(0.055)	(0.057)	(0.054)	(0.061)
ESG medium	0.021	0.011	0.024	0.061	0.04
	(0.043)	(0.042)	(0.043)	(0.040)	(0.045)
Board diverstity	-0.065*	-0.056+	0.096**	0.074*	0.094**
	(0.031)	(0.034)	(0.030)	(0.029)	(0.034)
Size	0.053+	-0.104**	0.108**	0.041	0.107**
	(0.029)	(0.037)	(0.034)	(0.030)	(0.041)
MTB	-0.041*	-0.078***	-0.021	0.000	-0.025
	(0.019)	(0.020)	(0.018)	(0.019)	(0.023)
ROA	-0.032+	0.012	0.107***	0.078***	0.110***
	(0.019)	(0.017)	(0.018)	(0.018)	(0.020)
Lev	0.001	0.136***	0.047*	0.068**	0.053*
	(0.021)	(0.025)	(0.022)	(0.021)	(0.027)
Avg board tenure	-0.029	0.03	0.044+	-0.024	0.04
	(0.021)	(0.023)	(0.024)	(0.021)	(0.026)
Board Size	0.022	-0.016	0.016	0.032	0.027
	(0.024)	(0.027)	(0.026)	(0.024)	(0.029)
ESG high xBoard diversity	0.034	0.117**	-0.024	-0.023	-0.023
	(0.047)	(0.045)	(0.045)	(0.044)	(0.049)
ESG medium xBoard diversity	0.01	0.03	0.025	0.005	0.024
	(0.038)	(0.039)	(0.035)	(0.035)	(0.039)
Model	RE	FE	FE	RE	FE
Num.Obs.	4693	4858	4858	4833	4833
R2	0.009	0.016	0.018	0.015	0.018
AIC	12675.3	10769.2	11759	12057	11850.7

This table reports the panel regression results regarding the impact of ESG on the gender diversity-risk relationship at the firm level for an unbalanced panel of 620 financial firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG high is a dummy variable that takes value 1 when the ESG score of the firm is above the 75% of the ESG socres distribution, and 0 othervise. ESG medium is a dummy variable that takes value 1 when the ESG score of the firm is between the 25% and the 75% of the ESG socres distribution, and 0 othervise. Board diversity is the percentage of women on board. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. 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 39: Impact of ESG on the MB ratio-risk relationship, Financial sample

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
Intercept	-0.03				
	(0.148)				
ESG high	-0.033	-0.033	-0.001	0.103	-0.022
	(0.153)	(0.163)	(0.186)	(0.179)	(0.190)
ESG medium	-0.012	0.053	0.071	0.153	0.052
	(0.153)	(0.159)	(0.182)	(0.176)	(0.186)
M.B.	-0.096	0.224+	0.033	-0.011	0.034
	(0.084)	(0.118)	(0.135)	(0.130)	(0.138)
Size	0.118***	-0.093	0.074	0.039	0.077
	(0.036)	(0.061)	(0.070)	(0.069)	(0.073)
MTB	-0.034	-0.085*	-0.031	-0.062	-0.055
	(0.028)	(0.038)	(0.044)	(0.044)	(0.046)
ROA	-0.009	0.081+	0.166**	0.169***	0.159**
	(0.035)	(0.045)	(0.051)	(0.050)	(0.053)
Lev	-0.001	0.145***	0.087+	0.104*	0.094+
	(0.028)	(0.042)	(0.048)	(0.047)	(0.050)
Avg board tenure	-0.042	-0.018	-0.05	-0.052	-0.063
	(0.033)	(0.051)	(0.059)	(0.058)	(0.061)
Board Size	-0.011	-0.071	-0.025	-0.04	-0.024
	(0.033)	(0.045)	(0.051)	(0.051)	(0.053)
ESG high xM.B	0.103	-0.250*	-0.049	0.003	-0.058
	(0.087)	(0.120)	(0.138)	(0.133)	(0.140)
ESG medium xM.B	0.075	-0.199+	-0.033	0.037	-0.037
	(0.088)	(0.118)	(0.135)	(0.130)	(0.138)
Model	RE	FE	FE	FE	FE
Num.Obs.	1533	1621	1621	1605	1605
R2	0.021	0.024	0.013	0.016	0.013
AIC	4204.3	3195.5	3631.3	3474.7	3654.8

This table reports the panel regression results regarding the impact of ESG on the gender diversity-risk relationship at the firm level for an unbalanced panel of 620 financial firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG high is a dummy variable that takes value 1 when the ESG score of the firm is above the 75% of the ESG socres distribution, and 0 othervise. ESG medium is a dummy variable that takes value 1 when the ESG score of the firm is between the 25% and the 75% of the ESG socres distribution, and 0 othervise. M.B. is the ratio of women managers with respect the women on board. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. 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 40: Impact of ESG on the EB ratio-risk relationship, Financial sample

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
Intercept	-0.01				
	(0.041)				
ESG high	-0.079	-0.132**	0.061	0.110+	0.083
	(0.054)	(0.051)	(0.057)	(0.056)	(0.059)
ESG medium	0.021	-0.019	0.073	0.099*	0.087+
	(0.043)	(0.040)	(0.045)	(0.045)	(0.046)
E.B.	0.000	0.044	-0.019	0.002	-0.012
	(0.033)	(0.032)	(0.036)	(0.036)	(0.037)
Size	0.057+	-0.119**	0.124**	0.135**	0.125**
	(0.030)	(0.037)	(0.042)	(0.042)	(0.043)
MTB	-0.034+	-0.083***	-0.011	-0.02	-0.017
	(0.020)	(0.020)	(0.023)	(0.023)	(0.024)
ROA	-0.035+	0.002	0.105***	0.120***	0.110***
	(0.020)	(0.018)	(0.020)	(0.020)	(0.021)
Lev	0.013	0.143***	0.037	0.033	0.043
	(0.022)	(0.024)	(0.027)	(0.027)	(0.028)
Avg board tenure	-0.018	0.027	0.013	0.012	0.01
	(0.021)	(0.024)	(0.027)	(0.026)	(0.027)
Board Size	0.025	-0.024	0.005	0.004	0.017
	(0.024)	(0.026)	(0.030)	(0.029)	(0.031)
ESG high xE.B	-0.05	-0.173***	-0.003	0.016	-0.005
	(0.054)	(0.050)	(0.056)	(0.055)	(0.058)
ESG medium xE.B	0.016	-0.064+	-0.006	-0.008	-0.013
	(0.038)	(0.035)	(0.040)	(0.039)	(0.040)
Model	RE	FE	FE	FE	FE
Num.Obs.	4424	4583	4583	4559	4559
R2	0.008	0.018	0.01	0.014	0.011
AIC	11863.7	10056.6	11181.5	10932	11265.6

This table reports the panel regression results regarding the impact of ESG on the gender diversity-risk relationship at the firm level for an unbalanced panel of 620 financial firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG high is a dummy variable that takes value 1 when the ESG score of the firm is above the 75% of the ESG socres distribution, and 0 othervise. ESG medium is a dummy variable that takes value 1 when the ESG score of the firm is between the 25% and the 75% of the ESG socres distribution, and 0 othervise. E.B. is the equivalent ratio for the executive women. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. 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 41: Impact of ESG on the women employees-risk relationship, Covid period

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
Intercept		-0.100*	-0.142**		-0.151**
		(0.042)	(0.048)		(0.050)
ESG high	-0.021	0.025	-0.160***	-0.174***	-0.158***
	(0.033)	(0.031)	(0.024)	(0.025)	(0.024)
ESG medium	-0.053+	-0.027	-0.123***	-0.143***	-0.121***
	(0.031)	(0.030)	(0.023)	(0.023)	(0.023)
Women employees	0.032	-0.052+	-0.041+	-0.064**	-0.027
	(0.032)	(0.030)	(0.023)	(0.024)	(0.023)
Size	0.008	0.004	-0.129***	-0.127***	-0.125***
	(0.010)	(0.009)	(0.007)	(0.007)	(0.007)
MTB	-0.024**	0.008	-0.023***	-0.027***	-0.022***
	(0.009)	(0.008)	(0.006)	(0.007)	(0.006)
ROA	-0.045***	-0.104***	-0.145***	-0.152***	-0.144***
	(0.009)	(0.009)	(0.007)	(0.007)	(0.007)
Lev	0.031***	0.050***	0.068***	0.074***	0.068***
	(0.008)	(0.008)	(0.006)	(0.006)	(0.006)
Avg board tenure	-0.050***	-0.039***	-0.042***	-0.043***	-0.043***
	(0.009)	(0.008)	(0.006)	(0.006)	(0.006)
Board Size	-0.015+	-0.034***	-0.041***	-0.039***	-0.038***
	(0.009)	(0.008)	(0.006)	(0.006)	(0.006)
Women employeesxCovid	0.010	(0.006)	0.017	0.003	0.013
	(0.019)	(0.018)	(0.014)	(0.014)	(0.014)
ESG high xWomen employees	-0.062+	0.002	0.022	0.045+	0.009
	(0.033)	(0.031)	(0.024)	(0.024)	(0.024)
ESG medium xWomen employees	-0.063*	0.008	0.02	0.041+	0.007
	(0.032)	(0.031)	(0.024)	(0.024)	(0.023)
Model	FE	RE	RE	FE	RE
Num.Obs.	14931	15605	15605	15505	15505
R2	0.008	0.02	0.094	0.093	0.094
AIC	39611.8	40858.2	32855	32512.5	31825

This table reports the panel regression results regarding the impact of ESG on the gender diversity- risk relationship at the firm level for an unbalanced panel of 3718 firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG high is a dummy variable that takes value 1 when the ESG score of the firm is above the 75% of the ESG socres distribution, and 0 othervise. ESG medium is a dummy variable that takes value 1 when the ESG score of the firm is between the 25% and the 75% of the ESG socres distribution, and 0 othervise. Women employees is the percentage of women employees. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. It is also included the interaction of the gender variable with the covid variable, that is a dummy that takes value 1 for 2020, 2021 and 2022, and 0 otherwise.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 42: Impact of ESG on the women managers-risk relationship, Covid period

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
Intercept			-0.159**		-0.161**
			(0.052)		(0.054)
ESG high	0.008	0.076+	-0.128***	-0.142***	-0.134***
	(0.044)	(0.042)	(0.032)	(0.032)	(0.032)
ESG medium	-0.033	0.019	-0.098**	-0.121***	-0.105***
	(0.043)	(0.041)	(0.032)	(0.032)	(0.031)
Women managers	0.006	-0.002	0.039	0.036	0.056+
	(0.044)	(0.042)	(0.032)	(0.032)	(0.031)
Size	0.007	0.001	-0.134***	-0.131***	-0.129***
	(0.011)	(0.011)	(0.008)	(0.008)	(0.008)
MTB	-0.028**	-0.001	-0.025**	-0.024**	-0.024**
	(0.010)	(0.010)	(0.008)	(0.008)	(0.007)
ROA	-0.045***	-0.097***	-0.128***	-0.143***	-0.127***
	(0.011)	(0.011)	(0.008)	(0.008)	(0.008)
Lev	0.031**	0.054***	0.070***	0.075***	0.071***
	(0.010)	(0.009)	(0.007)	(0.007)	(0.007)
Avg board tenure	-0.034**	-0.035***	-0.033***	-0.035***	-0.036***
	(0.010)	(0.010)	(0.008)	(0.008)	(0.007)
Board Size	-0.015	-0.039***	-0.047***	-0.047***	-0.045***
	(0.010)	(0.009)	(0.007)	(0.007)	(0.007)
Women managersxCovid	-0.027	-0.016	0.018	0.001	0.013
	(0.020)	(0.019)	(0.015)	(0.015)	(0.014)
ESG high xWomen managers	-0.01	-0.024	-0.049	-0.046	-0.064*
	(0.045)	(0.043)	(0.033)	(0.033)	(0.032)
ESG medium xWomen managers	-0.027	-0.027	-0.059+	-0.05	-0.074*
	(0.044)	(0.042)	(0.032)	(0.032)	(0.032)
Model	FE	FE	RE	FE	RE
Num.Obs.	10969	11526	11526	11448	11448
R2	0.008	0.018	0.087	0.087	0.088
AIC	28949.5	29822.4	23870.1	23550.7	23054.7

This table reports the panel regression results regarding the impact of ESG on the gender diversity- risk relationship at the firm level for an unbalanced panel of 3718 firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG high is a dummy variable that takes value 1 when the ESG score of the firm is above the 75% of the ESG socres distribution, and 0 othervise. ESG medium is a dummy variable that takes value 1 when the ESG score of the firm is between the 25% and the 75% of the ESG socres distribution, and 0 othervise. Women managers is the percentage of women managers. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. It is also included the interaction of the gender variable with the covid variable, that is a dummy that takes value 1 for 2020, 2021 and 2022, and 0 otherwise. 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 43: Impact of ESG on the board diversity-risk relationship, Covid period

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
Intercept			-0.182***		-0.188***
			(0.054)		(0.056)
ESG high	-0.01	0.071	-0.112**	-0.119***	-0.114***
	(0.048)	(0.045)	(0.035)	(0.035)	(0.034)
ESG medium	-0.054	0.007	-0.089**	-0.106**	-0.092**
	(0.047)	(0.044)	(0.034)	(0.034)	(0.033)
Board diversity	-0.039	-0.023	0.008	0.008	0.017
	(0.038)	(0.036)	(0.028)	(0.028)	(0.027)
Size	0.006	0.001	-0.131***	-0.128***	-0.126***
	(0.011)	(0.011)	(0.008)	(0.008)	(0.008)
MTB	-0.030**	-0.007	-0.028***	-0.027***	-0.027***
	(0.010)	(0.010)	(0.008)	(0.008)	(0.007)
ROA	-0.044***	-0.096***	-0.122***	-0.137***	-0.122***
	(0.011)	(0.011)	(0.008)	(0.008)	(0.008)
Lev	0.033***	0.055***	0.070***	0.076***	0.072***
	(0.010)	(0.010)	(0.007)	(0.007)	(0.007)
Avg board tenure	-0.034**	-0.033***	-0.033***	-0.036***	-0.037***
	(0.011)	(0.010)	(0.008)	(0.008)	(0.008)
Board Size	-0.015	-0.043***	-0.047***	-0.049***	-0.045***
	(0.010)	(0.010)	(0.007)	(0.007)	(0.007)
Board diversityxCovid	(0.022)	-0.036+	0.024	0.005	0.022
	(0.020)	(0.019)	(0.015)	(0.015)	(0.015)
ESG high xBoard diversity	0.06	0.043	0.005	0.017	-0.001
	(0.039)	(0.038)	(0.029)	(0.029)	(0.028)
ESG medium xBoard diversity	0.033	0.038	0.012	0.022	0.003
	(0.038)	(0.037)	(0.028)	(0.028)	(0.028)
Model	FE	FE	RE	FE	RE
Num.Obs.	28093	28883	28883	28756	28756
R2	0.007	0.028	0.139	0.15	0.142
AIC	77231.4	76461.4	61163.5	60277.8	59391.2

This table reports the panel regression results regarding the impact of ESG on the gender diversity- risk relationship at the firm level for an unbalanced panel of 3718 firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG high is a dummy variable that takes value 1 when the ESG score of the firm is above the 75% of the ESG socres distribution, and 0 othervise. ESG medium is a dummy variable that takes value 1 when the ESG score of the firm is between the 25% and the 75% of the ESG socres distribution, and 0 othervise. Board diversity is the percentage of women on board. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. It is also included the interaction of the gender variable with the covid variable, that is a dummy that takes value 1 for 2020, 2021 and 2022, and 0 otherwise. 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 44: Impact of ESG on the MB ratio-risk relationship, Covid period

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
Intercept				-0.202***	
				(0.045)	
ESG high	-0.054*	-0.02	-0.136***	-0.133***	-0.141***
	(0.022)	(0.021)	(0.016)	(0.016)	(0.016)
ESG medium	-0.034+	-0.030+	-0.091***	-0.093***	-0.096***
	(0.019)	(0.018)	(0.014)	(0.013)	(0.013)
M.B.	-0.021	-0.045*	0.037*	0.051**	0.038*
	(0.022)	(0.021)	(0.016)	(0.016)	(0.016)
Size	0.005	0.009	-0.145***	-0.140***	-0.140***
	(0.008)	(0.008)	(0.006)	(0.006)	(0.006)
MTB	-0.017*	0.013+	-0.014**	-0.017***	-0.014**
	(0.007)	(0.006)	(0.005)	(0.005)	(0.005)
ROA	-0.054***	-0.129***	-0.179***	-0.191***	-0.178***
	(0.007)	(0.006)	(0.005)	(0.005)	(0.005)
Lev	0.029***	0.051***	0.060***	0.063***	0.060***
	(0.007)	(0.006)	(0.005)	(0.005)	(0.005)
Avg board tenure	-0.037***	-0.037***	-0.063***	-0.064***	-0.060***
	(0.006)	(0.006)	(0.005)	(0.004)	(0.004)
Board Size	-0.013+	-0.030***	-0.032***	-0.027***	-0.030***
	(0.007)	(0.007)	(0.005)	(0.005)	(0.005)
MBxCovid	-0.030*	-0.043***	-0.086***	-0.099***	-0.083***
	(0.013)	(0.012)	(0.009)	(0.009)	(0.009)
ESG high xM.B	0.053*	0.064**	-0.001	-0.003	-0.004
	(0.024)	(0.023)	(0.017)	(0.017)	(0.017)
ESG medium xM.B	0.003	0.031	-0.006	-0.011	-0.012
	(0.023)	(0.021)	(0.017)	(0.016)	(0.016)
Model	FE	FE	FE	RE	FE
Num.Obs.	10649	11186	11186	11110	11110
R2	0.007	0.018	0.084	0.084	0.085
AIC	28060.4	28919.2	23052.8	22758.5	22259.1

This table reports the panel regression results regarding the impact of ESG on the gender diversity- risk relationship at the firm level for an unbalanced panel of 3718 firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG high is a dummy variable that takes value 1 when the ESG score of the firm is above the 75% of the ESG socres distribution, and 0 othervise. ESG medium is a dummy variable that takes value 1 when the ESG score of the firm is between the 25% and the 75% of the ESG socres distribution, and 0 othervise. M.B. is the ratio of women managers with respect the women on board. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. It is also included the interaction of the gender variable with the covid variable, that is a dummy that takes value 1 for 2020, 2021 and 2022, and 0 otherwise. 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 45: Impact of ESG on the EB ratio-risk relationship, Covid period

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
Intercept		-0.022		-0.209***	
		(0.033)		(0.044)	
ESG high	-0.056**	-0.043*	-0.129***	-0.119***	-0.132***
	(0.019)	(0.018)	(0.014)	(0.014)	(0.014)
ESG medium	-0.047**	-0.055***	-0.087***	-0.085***	-0.091***
	(0.016)	(0.015)	(0.011)	(0.011)	(0.011)
E.B.	-0.004	0.012	0.026**	0.022**	0.027**
	(0.012)	(0.011)	(0.008)	(0.008)	(0.008)
Size	0.001	0.005	-0.147***	-0.142***	-0.143***
	(0.008)	(0.008)	(0.006)	(0.006)	(0.006)
MTB	-0.019**	0.013*	-0.016**	-0.019***	-0.016***
	(0.007)	(0.006)	(0.005)	(0.005)	(0.005)
ROA	-0.055***	-0.130***	-0.178***	-0.191***	-0.178***
	(0.007)	(0.006)	(0.005)	(0.005)	(0.005)
Lev	0.029***	0.048***	0.061***	0.064***	0.062***
	(0.007)	(0.006)	(0.005)	(0.005)	(0.005)
Avg board tenure	-0.036***	-0.035***	-0.065***	-0.067***	-0.063***
	(0.006)	(0.006)	(0.005)	(0.004)	(0.004)
Board Size	-0.014+	-0.032***	-0.032***	-0.026***	-0.030***
	(0.007)	(0.007)	(0.005)	(0.005)	(0.005)
EBxCovid	(0.006)	-0.024*	0.018+	0.019*	0.016+
	(0.013)	(0.012)	(0.009)	(0.009)	(0.009)
ESG high xE.B	-0.012	-0.055***	-0.035**	-0.030*	-0.034**
	(0.017)	(0.016)	(0.013)	(0.013)	(0.012)
ESG medium xE.B	0.015	0.01	0.000	0.002	-0.002
	(0.014)	(0.013)	(0.010)	(0.010)	(0.010)
Model	FE	RE	FE	RE	FE
Num.Obs.	25667	26422	26422	26297	26297
R2	0.008	0.028	0.126	0.135	0.129
AIC	70198.8	69961.2	55927.8	55118.4	54290.3

This table reports the panel regression results regarding the impact of ESG on the gender diversity- risk relationship at the firm level for an unbalanced panel of 3718 firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG high is a dummy variable that takes value 1 when the ESG score of the firm is above the 75% of the ESG socres distribution, and 0 othervise. ESG medium is a dummy variable that takes value 1 when the ESG score of the firm is between the 25% and the 75% of the ESG socres distribution, and 0 othervise. E.B. is the equivalent ratio for the executive women. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. It is also included the interaction of the gender variable with the covid variable, that is a dummy that takes value 1 for 2020, 2021 and 2022, and 0 otherwise. 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 46: Impact of ESG on the women employees-risk relationship

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
Intercept		-0.103**	0.022	0.062	0.017
		(0.038)	(0.051)	(0.052)	(0.053)
ESG high	-0.021	0.023	-0.158***	-0.174***	-0.156***
	(0.033)	(0.031)	(0.024)	(0.024)	(0.024)
ESG medium	-0.054+	-0.031	-0.124***	-0.146***	-0.122***
	(0.031)	(0.030)	(0.023)	(0.023)	(0.023)
Women employees Shan.Indx.	0.024	-0.093***	-0.069***	-0.092***	-0.057**
	(0.028)	(0.027)	(0.021)	(0.021)	(0.020)
Size	0.007	0.004	-0.129***	-0.127***	-0.126***
	(0.010)	(0.009)	(0.007)	(0.007)	(0.007)
MTB	-0.024**	0.01	-0.019**	-0.022***	-0.019**
	(0.009)	(0.008)	(0.006)	(0.007)	(0.006)
ROA	-0.045***	-0.103***	-0.146***	-0.153***	-0.145***
	(0.009)	(0.009)	(0.007)	(0.007)	(0.007)
Lev	0.032***	0.050***	0.068***	0.074***	0.068***
	(0.008)	(0.008)	(0.006)	(0.006)	(0.006)
Avg board tenure	-0.051***	-0.042***	-0.045***	-0.047***	-0.045***
	(0.009)	(0.008)	(0.006)	(0.006)	(0.006)
Board Size	-0.014	-0.032***	-0.041***	-0.039***	-0.037***
	(0.009)	(0.008)	(0.006)	(0.006)	(0.006)
ESG highxWomen employees Shan.Indx.	-0.066*	0.022	0.002	0.022	-0.008
	(0.030)	(0.029)	(0.022)	(0.023)	(0.022)
ESG mediumxWomen employees Shan.Indx.	-0.048+	0.064*	0.031	0.043*	0.021
	(0.029)	(0.028)	(0.022)	(0.022)	(0.021)
Model	FE	RE	RE	RE	RE
Num.Obs.	14931	15605	15605	15505	15505
R2	0.009	0.021	0.094	0.097	0.094
AIC	39605.8	40857.4	32783	32574.8	31756.2

This table reports the panel regression results regarding the impact of ESG on the gender diversity- risk relationship at the firm level for an unbalanced panel of 3718 firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG highis a dummy variable that takes value 1 when the ESG score of the firm is above the 75% of the ESG socres distribution, and 0 othervise. ESG medium is a dummy variable that takes value 1 when the ESG score of the firm is between the 25% and the 75% of the ESG socres distribution, and 0 othervise. Women employees Shan.Indx. is the Shannon Index calculated for the women employees category. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. 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 47: Impact of ESG on the women managers-risk relationship

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
Intercept			-0.001	0.039	0.001
			(0.056)	(0.057)	(0.058)
ESG high	0.008	0.078+	-0.128***	-0.141***	-0.134***
	(0.044)	(0.042)	(0.032)	(0.032)	(0.032)
ESG medium	-0.036	0.017	-0.102**	-0.125***	-0.108***
	(0.043)	(0.041)	(0.032)	(0.032)	(0.031)
Women managers Shan.Indx.	0.008	-0.017	0.021	0.000	0.027
	(0.036)	(0.033)	(0.025)	(0.025)	(0.025)
Size	0.008	0.003	-0.132***	-0.128***	-0.127***
	(0.011)	(0.011)	(0.008)	(0.008)	(0.008)
MTB	-0.027**	0.000	-0.021**	-0.019*	-0.021**
	(0.010)	(0.010)	(0.008)	(0.008)	(0.007)
ROA	-0.045***	-0.096***	-0.129***	-0.145***	-0.129***
	(0.011)	(0.011)	(0.008)	(0.008)	(0.008)
Lev	0.032***	0.056***	0.070***	0.075***	0.071***
	(0.010)	(0.009)	(0.007)	(0.007)	(0.007)
Avg board tenure	-0.035***	-0.037***	-0.033***	-0.035***	-0.036***
	(0.010)	(0.010)	(0.008)	(0.008)	(0.007)
Board Size	-0.015	-0.038***	-0.047***	-0.047***	-0.044***
	(0.010)	(0.009)	(0.007)	(0.007)	(0.007)
ESG highxWomen managers Shan.Indx.	-0.037	-0.021	-0.055*	-0.047+	-0.062*
	(0.038)	(0.036)	(0.027)	(0.027)	(0.027)
ESG mediumxWomen managers Shan.Indx.	-0.051	-0.029	-0.064*	-0.049+	-0.066*
	(0.037)	(0.035)	(0.027)	(0.027)	(0.026)
Model	FE	FE	RE	RE	RE
Num.Obs.	10969	11526	11526	11448	11448
R2	0.008	0.019	0.084	0.09	0.086
AIC	28942.8	29813.9	23827.5	23639.7	23014.2

This table reports the panel regression results regarding the impact of ESG on the gender diversity- risk relationship at the firm level for an unbalanced panel of 3718 firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG highis a dummy variable that takes value 1 when the ESG score of the firm is above the 75% of the ESG socres distribution, and 0 othervise. ESG medium is a dummy variable that takes value 1 when the ESG score of the firm is between the 25% and the 75% of the ESG socres distribution, and 0 othervise. Women managers Shan.Indx. is the Shannon Index calculated for the women managers category. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. 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 48: Impact of ESG on the board diversity-risk relationship

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
ESG high	-0.058**	-0.051**	-0.102***	-0.085***	-0.106***
	(0.020)	(0.019)	(0.015)	(0.014)	(0.014)
ESG medium	-0.049**	-0.047**	-0.074***	-0.069***	-0.077***
	(0.016)	(0.015)	(0.011)	(0.011)	(0.011)
Board diversity Shan.Indx.	0.002	-0.011	-0.038***	-0.043***	-0.037***
	(0.010)	(0.009)	(0.007)	(0.007)	(0.007)
Size	0.000	0.006	-0.151***	-0.146***	-0.147***
	(0.008)	(0.007)	(0.006)	(0.006)	(0.006)
MTB	-0.016*	0.016**	-0.011*	-0.014**	-0.011*
	(0.007)	(0.006)	(0.005)	(0.005)	(0.005)
ROA	-0.055***	-0.134***	-0.184***	-0.197***	-0.183***
	(0.006)	(0.006)	(0.005)	(0.005)	(0.004)
Lev	0.027***	0.047***	0.056***	0.060***	0.057***
	(0.006)	(0.006)	(0.005)	(0.005)	(0.005)
Avg board tenure	-0.031***	-0.032***	-0.068***	-0.072***	-0.066***
	(0.006)	(0.006)	(0.004)	(0.004)	(0.004)
Board Size	-0.009	-0.022**	-0.026***	-0.020***	-0.023***
	(0.007)	(0.007)	(0.005)	(0.005)	(0.005)
ESG highxBoard diversity Shan.Indx.	-0.005	0.029	-0.019	-0.027*	-0.019
	(0.019)	(0.018)	(0.014)	(0.014)	(0.014)
ESG mediumxBoard diversity Shan.Indx.	-0.027*	-0.026*	-0.01	-0.012	-0.011
	(0.013)	(0.013)	(0.010)	(0.010)	(0.009)
Model	FE	FE	FE	FE	FE
Num.Obs.	28093	28883	28883	28756	28756
R2	0.007	0.027	0.136	0.144	0.138
AIC	77243.8	76479.8	61284.9	60183.1	59515.5

This table reports the panel regression results regarding the impact of ESG on the gender diversity- risk relationship at the firm level for an unbalanced panel of 3718 firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG highis a dummy variable that takes value 1 when the ESG score of the firm is above the 75% of the ESG socres distribution, and 0 othervise. ESG medium is a dummy variable that takes value 1 when the ESG score of the firm is between the 25% and the 75% of the ESG socres distribution, and 0 othervise. Board diversity Shan.Indx. is the Shannon Index calculated for the women on boards category. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. 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 49: Impact of ESG on the MB ratio-risk relationship

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
Intercept			-0.021	0.015	-0.023
			(0.057)	(0.058)	(0.059)
ESG high	-0.008	0.073	-0.112**	-0.119***	-0.114***
	(0.048)	(0.045)	(0.035)	(0.035)	(0.034)
ESG medium	-0.052	0.008	-0.089**	-0.106**	-0.092**
	(0.047)	(0.045)	(0.034)	(0.034)	(0.033)
M.B Shan.Indx.	-0.047	-0.042	0.023	0.013	0.03
	(0.037)	(0.036)	(0.027)	(0.027)	(0.026)
Size	0.060	0.048	-0.008	0.007	-0.013
	(0.039)	(0.038)	(0.029)	(0.029)	(0.028)
MTB	0.034	0.045	0.003	0.015	-0.006
	(0.039)	(0.037)	(0.029)	(0.029)	(0.028)
ROA	0.006	0.000	-0.132***	-0.129***	-0.127***
	(0.011)	(0.011)	(0.008)	(0.008)	(0.008)
Lev	-0.030**	-0.007	-0.028***	-0.027***	-0.027***
	(0.010)	(0.010)	(0.008)	(0.008)	(0.007)
Avg board tenure	-0.044***	-0.096***	-0.123***	-0.138***	-0.123***
	(0.011)	(0.011)	(0.008)	(0.008)	(0.008)
Board Size	0.034***	0.056***	0.070***	0.076***	0.072***
	(0.010)	(0.010)	(0.007)	(0.007)	(0.007)
ESG highxM.B Shan.Indx.	-0.035**	-0.034***	-0.032***	-0.035***	-0.036***
	(0.011)	(0.010)	(0.008)	(0.008)	(0.008)
ESG mediumxM.B Shan.Indx.	-0.015	-0.042***	-0.048***	-0.049***	-0.046***
	(0.010)	(0.010)	(0.007)	(0.007)	(0.007)
Model	FE	FE	RE	RE	RE
Num.Obs.	10649	11186	11186	11110	11110
R2	0.007	0.017	0.079	0.084	0.08
AIC	28060.5	28921	23044.7	22894	22249.7

This table reports the panel regression results regarding the impact of ESG on the gender diversity- risk relationship at the firm level for an unbalanced panel of 3718 firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG highis a dummy variable that takes value 1 when the ESG score of the firm is above the 75% of the ESG socres distribution, and 0 othervise. ESG medium is a dummy variable that takes value 1 when the ESG score of the firm is between the 25% and the 75% of the ESG socres distribution, and 0 othervise. M.B Shan.Indx. is the Shannon Index calculated for the women managers over women on boards category ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. 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 50: Impact of ESG on the EB ratio-risk relationship

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
Intercept		-0.028			
		(0.029)			
ESG high	-0.055**	-0.042*	-0.130***	-0.119***	-0.133***
	(0.019)	(0.018)	(0.014)	(0.014)	(0.014)
ESG medium	-0.047**	-0.056***	-0.089***	-0.086***	-0.092***
	(0.016)	(0.015)	(0.011)	(0.011)	(0.011)
E.B Shan.Indx.	-0.005	0.008	0.035***	0.030***	0.034***
	(0.011)	(0.010)	(0.008)	(0.008)	(0.008)
Size	0.001	0.005	-0.147***	-0.142***	-0.143***
	(0.008)	(0.008)	(0.006)	(0.006)	(0.006)
MTB	-0.019**	0.013+	-0.016**	-0.019***	-0.016***
	(0.007)	(0.006)	(0.005)	(0.005)	(0.005)
ROA	-0.055***	-0.130***	-0.178***	-0.191***	-0.178***
	(0.007)	(0.006)	(0.005)	(0.005)	(0.005)
Lev	0.029***	0.048***	0.061***	0.065***	0.062***
	(0.007)	(0.006)	(0.005)	(0.005)	(0.005)
Avg board tenure	-0.036***	-0.035***	-0.065***	-0.067***	-0.063***
	(0.006)	(0.006)	(0.005)	(0.004)	(0.004)
Board Size	-0.014+	-0.032***	-0.032***	-0.026***	-0.030***
	(0.007)	(0.007)	(0.005)	(0.005)	(0.005)
ESG highxE.B Shan.Indx.	-0.011	-0.058***	-0.038**	-0.031*	-0.036**
	(0.017)	(0.016)	(0.013)	(0.012)	(0.012)
ESG mediumxE.B Shan.Indx.	0.016	0.008	-0.003	0.000	-0.005
	(0.014)	(0.013)	(0.010)	(0.010)	(0.010)
Model	FE	RE	FE	FE	FE
Num.Obs.	25667	26422	26422	26297	26297
R2	0.008	0.027	0.126	0.132	0.129
AIC	70196.8	69968	55926.7	54953.6	54288.7

This table reports the panel regression results regarding the impact of ESG on the gender diversity- risk relationship at the firm level for an unbalanced panel of 3718 firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG highis a dummy variable that takes value 1 when the ESG score of the firm is above the 75% of the ESG socres distribution, and 0 othervise. ESG medium is a dummy variable that takes value 1 when the ESG score of the firm is between the 25% and the 75% of the ESG socres distribution, and 0 othervise. E.B Shan.Indx. is the Shannon Index calculated for the women executives over women on boards category. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. 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 51: Impact of ESG on the women employees-risk relationship

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
Intercept		-0.103**	0.022	0.062	0.017
		(0.038)	(0.051)	(0.052)	(0.053)
ESG high	-0.021	0.023	-0.158***	-0.174***	-0.156***
	(0.033)	(0.031)	(0.024)	(0.024)	(0.024)
ESG medium	-0.054+	-0.031	-0.124***	-0.146***	-0.122***
	(0.031)	(0.030)	(0.023)	(0.023)	(0.023)
Women employees Blau.Index.	0.024	-0.093***	-0.069***	-0.092***	-0.057**
	(0.028)	(0.027)	(0.021)	(0.021)	(0.020)
Size	0.007	0.004	-0.129***	-0.127***	-0.126***
	(0.010)	(0.009)	(0.007)	(0.007)	(0.007)
MTB	-0.024**	0.01	-0.019**	-0.022***	-0.019**
	(0.009)	(0.008)	(0.006)	(0.007)	(0.006)
ROA	-0.045***	-0.103***	-0.146***	-0.153***	-0.145***
	(0.009)	(0.009)	(0.007)	(0.007)	(0.007)
Lev	0.032***	0.050***	0.068***	0.074***	0.068***
	(0.008)	(0.008)	(0.006)	(0.006)	(0.006)
Avg board tenure	-0.051***	-0.042***	-0.045***	-0.047***	-0.045***
	(0.009)	(0.008)	(0.006)	(0.006)	(0.006)
Board Size	-0.014	-0.032***	-0.041***	-0.039***	-0.037***
	(0.009)	(0.008)	(0.006)	(0.006)	(0.006)
ESG highxWomen employees Blau.Index.	-0.066*	0.022	0.002	0.022	-0.008
	(0.030)	(0.029)	(0.022)	(0.023)	(0.022)
ESG mediumxWomen employees Blau.Index.	-0.048+	0.064*	0.031	0.043*	0.021
	(0.029)	(0.028)	(0.022)	(0.022)	(0.021)
Model	FE	RE	RE	RE	RE
Num.Obs.	14931	15605	15605	15505	15505
R2	0.009	0.021	0.094	0.097	0.094
AIC	39605.8	40857.4	32783	32574.8	31756.2

This table reports the panel regression results regarding the impact of ESG on the gender diversity- risk relationship at the firm level for an unbalanced panel of 3718 firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG highis a dummy variable that takes value 1 when the ESG score of the firm is above the 75% of the ESG socres distribution, and 0 othervise. ESG medium is a dummy variable that takes value 1 when the ESG score of the firm is between the 25% and the 75% of the ESG socres distribution, and 0 othervise. Women employees Blau.Index. is the Blau Index calculated for the women employees category. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. 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 52: Impact of ESG on the women managers-risk relationship

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
Intercept			-0.001	0.039	0.001
			(0.056)	(0.057)	(0.058)
ESG high	0.008	0.078+	-0.128***	-0.141***	-0.134***
	(0.044)	(0.042)	(0.032)	(0.032)	(0.032)
ESG medium	-0.036	0.017	-0.102**	-0.125***	-0.108***
	(0.043)	(0.041)	(0.032)	(0.032)	(0.031)
Women managers Blau.Index.	0.008	-0.017	0.021	0.000	0.027
	(0.036)	(0.033)	(0.025)	(0.025)	(0.025)
Size	0.008	0.003	-0.132***	-0.128***	-0.127***
	(0.011)	(0.011)	(0.008)	(0.008)	(0.008)
MTB	-0.027**	0.000	-0.021**	-0.019*	-0.021**
	(0.010)	(0.010)	(0.008)	(0.008)	(0.007)
ROA	-0.045***	-0.096***	-0.129***	-0.145***	-0.129***
	(0.011)	(0.011)	(0.008)	(0.008)	(0.008)
Lev	0.032***	0.056***	0.070***	0.075***	0.071***
	(0.010)	(0.009)	(0.007)	(0.007)	(0.007)
Avg board tenure	-0.035***	-0.037***	-0.033***	-0.035***	-0.036***
	(0.010)	(0.010)	(0.008)	(0.008)	(0.007)
Board Size	-0.015	-0.038***	-0.047***	-0.047***	-0.044***
	(0.010)	(0.009)	(0.007)	(0.007)	(0.007)
ESG highxWomen managers Blau.Index.	-0.037	-0.021	-0.055*	-0.047+	-0.062*
	(0.038)	(0.036)	(0.027)	(0.027)	(0.027)
ESG mediumxWomen managers Blau.Index.	-0.051	-0.029	-0.064*	-0.049+	-0.066*
	(0.037)	(0.035)	(0.027)	(0.027)	(0.026)
Model	FE	FE	RE	RE	RE
Num.Obs.	10969	11526	11526	11448	11448
R2	0.008	0.019	0.084	0.09	0.086
AIC	28942.8	29813.9	23827.5	23639.7	23014.2

This table reports the panel regression results regarding the impact of ESG on the gender diversity- risk relationship at the firm level for an unbalanced panel of 3718 firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG highis a dummy variable that takes value 1 when the ESG score of the firm is above the 75% of the ESG socres distribution, and 0 othervise. ESG medium is a dummy variable that takes value 1 when the ESG score of the firm is between the 25% and the 75% of the ESG socres distribution, and 0 othervise. Women managers Blau.Index. is the Blau Index calculated for the women managers category. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. 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 53: Impact of ESG on the board diversity-risk relationship

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
ESG high	-0.058**	-0.051**	-0.102***	-0.085***	-0.106***
	(0.020)	(0.019)	(0.015)	(0.014)	(0.014)
ESG medium	-0.049**	-0.047**	-0.074***	-0.069***	-0.077***
	(0.016)	(0.015)	(0.011)	(0.011)	(0.011)
Board diversity Blau.Index.	0.002	-0.011	-0.038***	-0.043***	-0.037***
	(0.010)	(0.009)	(0.007)	(0.007)	(0.007)
Size	0.000	0.006	-0.151***	-0.146***	-0.147***
	(0.008)	(0.007)	(0.006)	(0.006)	(0.006)
MTB	-0.016*	0.016**	-0.011*	-0.014**	-0.011*
	(0.007)	(0.006)	(0.005)	(0.005)	(0.005)
ROA	-0.055***	-0.134***	-0.184***	-0.197***	-0.183***
	(0.006)	(0.006)	(0.005)	(0.005)	(0.004)
Lev	0.027***	0.047***	0.056***	0.060***	0.057***
	(0.006)	(0.006)	(0.005)	(0.005)	(0.005)
Avg board tenure	-0.031***	-0.032***	-0.068***	-0.072***	-0.066***
	(0.006)	(0.006)	(0.004)	(0.004)	(0.004)
Board Size	-0.009	-0.022**	-0.026***	-0.020***	-0.023***
	(0.007)	(0.007)	(0.005)	(0.005)	(0.005)
ESG highxBoard diversity Blau.Index.	-0.005	0.029	-0.019	-0.027*	-0.019
	(0.019)	(0.018)	(0.014)	(0.014)	(0.014)
ESG mediumxBoard diversity Blau.Index.	-0.027*	-0.026*	-0.01	-0.012	-0.011
	(0.013)	(0.013)	(0.010)	(0.010)	(0.009)
Model	FE	FE	FE	FE	FE
Num.Obs.	28093	28883	28883	28756	28756
R2	0.007	0.027	0.136	0.144	0.138
AIC	77243.8	76479.8	61284.9	60183.1	59515.5

This table reports the panel regression results regarding the impact of ESG on the gender diversity- risk relationship at the firm level for an unbalanced panel of 3718 firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG highis a dummy variable that takes value 1 when the ESG score of the firm is above the 75% of the ESG socres distribution, and 0 othervise. ESG medium is a dummy variable that takes value 1 when the ESG score of the firm is between the 25% and the 75% of the ESG socres distribution, and 0 othervise. Board diversity Blau.Index. is the Blau Index calculated for the women on boards category. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. 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 54: Impact of ESG on the MB ratio-risk relationship

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
Intercept			-0.02	0.015	-0.023
			(0.057)	(0.058)	(0.059)
ESG high	-0.008	0.074	-0.112**	-0.120***	-0.114***
	(0.048)	(0.045)	(0.035)	(0.035)	(0.034)
ESG medium	-0.053	0.009	-0.090**	-0.107**	-0.093**
	(0.047)	(0.045)	(0.034)	(0.034)	(0.033)
M.B Blau.Index.	-0.05	-0.041	0.021	0.012	0.028
	(0.036)	(0.035)	(0.027)	(0.027)	(0.026)
Size	0.065+	0.051	-0.003	0.013	-0.007
	(0.039)	(0.037)	(0.029)	(0.029)	(0.028)
MTB	0.036	0.044	0.007	0.018	-0.002
	(0.038)	(0.037)	(0.028)	(0.028)	(0.027)
ROA	0.006	0.000	-0.132***	-0.128***	-0.127***
	(0.011)	(0.011)	(0.008)	(0.008)	(0.008)
Lev	-0.030**	-0.007	-0.028***	-0.027***	-0.027***
	(0.010)	(0.010)	(0.008)	(0.008)	(0.007)
Avg board tenure	-0.044***	-0.096***	-0.123***	-0.138***	-0.123***
	(0.011)	(0.011)	(0.008)	(0.008)	(0.008)
Board Size	0.034***	0.056***	0.070***	0.076***	0.072***
	(0.010)	(0.010)	(0.007)	(0.007)	(0.007)
ESG highxM.B Blau.Index.	-0.035**	-0.034***	-0.032***	-0.035***	-0.036***
	(0.011)	(0.010)	(0.008)	(0.008)	(0.008)
ESG mediumxM.B Blau.Index.	-0.014	-0.042***	-0.049***	-0.049***	-0.046***
	(0.010)	(0.010)	(0.007)	(0.007)	(0.007)
Model	FE	FE	RE	RE	RE
Num.Obs.	10649	11186	11186	11110	11110
R2	0.007	0.017	0.079	0.084	0.081
AIC	28059.8	28920.7	23043	22890.5	22248

This table reports the panel regression results regarding the impact of ESG on the gender diversity- risk relationship at the firm level for an unbalanced panel of 3718 firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG highis a dummy variable that takes value 1 when the ESG score of the firm is above the 75% of the ESG socres distribution, and 0 othervise. ESG medium is a dummy variable that takes value 1 when the ESG score of the firm is between the 25% and the 75% of the ESG socres distribution, and 0 othervise. M.B Blau.Index. is the Blau Index calculated for the women managers over women on boards category ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. 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 55: Impact of ESG on the EB ratio-risk relationship

	Tailbeta	*Downsidebeta*	*LPM*	*VaR*	ES
Intercept		-0.028			
		(0.029)			
ESG high	-0.055**	-0.042*	-0.130***	-0.119***	-0.133***
	(0.019)	(0.018)	(0.014)	(0.014)	(0.014)
ESG medium	-0.047**	-0.056***	-0.089***	-0.086***	-0.092***
	(0.016)	(0.015)	(0.011)	(0.011)	(0.011)
E.B Blau.Index.	-0.005	0.008	0.035***	0.030***	0.034***
	(0.011)	(0.010)	(0.008)	(0.008)	(0.008)
Size	0.001	0.005	-0.147***	-0.142***	-0.143***
	(0.008)	(0.008)	(0.006)	(0.006)	(0.006)
MTB	-0.019**	0.013+	-0.016**	-0.019***	-0.016***
	(0.007)	(0.006)	(0.005)	(0.005)	(0.005)
ROA	-0.055***	-0.130***	-0.178***	-0.191***	-0.178***
	(0.007)	(0.006)	(0.005)	(0.005)	(0.005)
Lev	0.029***	0.048***	0.061***	0.065***	0.062***
	(0.007)	(0.006)	(0.005)	(0.005)	(0.005)
Avg board tenure	-0.036***	-0.035***	-0.065***	-0.067***	-0.063***
	(0.006)	(0.006)	(0.005)	(0.004)	(0.004)
Board Size	-0.014+	-0.032***	-0.032***	-0.026***	-0.030***
	(0.007)	(0.007)	(0.005)	(0.005)	(0.005)
ESG highxE.B Blau.Index.	-0.011	-0.058***	-0.038**	-0.031*	-0.036**
	(0.017)	(0.016)	(0.013)	(0.012)	(0.012)
ESG mediumxE.B Blau.Index.	0.016	0.008	-0.003	0.000	-0.005
	(0.014)	(0.013)	(0.010)	(0.010)	(0.010)
Model	FE	RE	FE	FE	FE
Num.Obs.	25667	26422	26422	26297	26297
R2	0.008	0.027	0.126	0.132	0.129
AIC	70196.8	69968	55926.7	54953.6	54288.7

This table reports the panel regression results regarding the impact of ESG on the gender diversity- risk relationship at the firm level for an unbalanced panel of 3718 firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the avg market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. ESG highis a dummy variable that takes value 1 when the ESG score of the firm is above the 75% of the ESG socres distribution, and 0 othervise. ESG medium is a dummy variable that takes value 1 when the ESG score of the firm is between the 25% and the 75% of the ESG socres distribution, and 0 othervise. E.B Blau.Index. is the Blau Index calculated for the women executives over women on boards category. ROA is the return on assets ratio. Lev is the leverage ratio, measured as the debt-to-assets ratio. Size is the size of the firm, calculated as the log of the total assets. Marke-to-book (MTB) is measured as the stock market capitalization of the firm divided by the total equity of the firm. avg board tenure is the avg number of years each board member has been on the board. Board size is the total number of board members at the end of the fiscal year. The interactions between each of the dummies and the independent variable are also inlcuded in the model. 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. □

3

Does Biodiversity Risk Affect Financial Risk? Evidence from U.S. Firms.

Abstract

This study examines the relationship between biodiversity risk and financial risk using a panel of 1,993 U.S. firms from 2010 to 2022. It analyses how multiple biodiversity proxies influence eight dimensions of financial risk, including systematic, idiosyncratic, downside, and extreme risks. The findings show that stronger environmental (E) performance is consistently associated with lower financial risk, underscoring the role of environmental practices in shaping the biodiversity–financial risk nexus. Among the biodiversity measures considered, indicators of biodiversity-related concern emerge as the most influential factor, displaying the strongest association with firms' financial risk profiles. Firms disclosing concerns about biodiversity loss or subject to biodiversity-related regulation exhibit distinct risk patterns, particularly in downside and extreme risk measures. The results further indicate that firms' dependency on and impact within ecosystems—reflecting the double materiality principle—modulate the magnitude of these relationships. The conclusions remain robust under instrumental variable estimation and alternative biodiversity risk specifications. Overall, the study provides empirical evidence and a framework to assess how biodiversity-related exposures affect financial stability and inform sustainable investment and financing strategies.

Keywords: biodiversity risk. financial risk, resource use, double materiality.

JEL classification: C33, G32, M14.

1. Introduction

Biodiversity encompasses the variety of life on Earth—including genes, species, and ecosystems—and the ecological interactions that sustain them (Ma et al., 2024). It underpins the resilience and functionality of ecosystems, which provide essential services such as pollination, water purification, climate regulation, and soil fertility, all of which are foundational to human well-being and economic activity. The World Economic Forum (2020) estimates that USD 44 trillion of global GDP—over half the world's economy—is moderately or highly dependent on nature.

Biodiversity entered the global development agenda in 2015 through the Sustainable Development Goals (SDGs), prominently within SDG 14 (Life Below Water) and SDG 15 (Life on Land). It also contributes to a wide range of social and economic objectives, including SDG 1 (No Poverty), SDG 2 (Zero Hunger), SDG 3 (Good Health and Well-being), SDG 6 (Clean Water and Sanitation), and SDG 13 (Climate Action), illustrating its cross-cutting relevance beyond environmental domains (BIOFIN, 2018). While unsustainable economic growth has contributed to the degradation of natural ecosystems, biodiversity loss itself poses a direct threat to economic activity (Hutchinson & Lucey, 2024). Reflecting its systemic implications, biodiversity loss ranks as the third most severe global risk in the Global Risks Report (WEF, 2024), underscoring its emergence as a global priority alongside climate change (Karoly & Tobin de la Puente, 2023; Pörtner et al., 2021).

Biodiversity loss and climate change are deeply interconnected and mutually reinforcing. Deforestation and ecosystem collapse release stored carbon, intensifying climate risks, while rising temperatures and extreme weather events accelerate biodiversity degradation (Giglio et al., 2024). Despite these linkages, biodiversity loss constitutes a distinct source of environmental and financial vulnerability compared to climate risk (Giglio et al., 2023). Its close interdependence with climate processes, combined with its multifaceted and spatially heterogeneous nature, makes assessing firms' exposure to biodiversity-related risks an exceptionally complex task.

Biodiversity risk exposure—the degree to which a firm's operations, supply chains, or financial activities are vulnerable to the adverse impacts of biodiversity loss and ecosystem degradation—has significant implications at the firm level. Ecosystem degradation caused by habitat destruction, resource depletion, pollution, or regulatory interventions directly threatens the availability of inputs and increases production costs, particularly in biodiversity-dependent industries such as agriculture, forestry, and fisheries (Dasgupta, 2021; IPBES, 2019; OECD, 2019). From a financial perspective, depletion of natural resources can reduce revenues and

compel firms to replace ecosystem services with costly artificial substitutes, leading to a higher cost of capital, greater cash flow volatility, and increased exposure to downside and extreme risks (Berg et al., 2022; Giglio et al., 2021; UNEP FI, 2020).

Investor behaviour is also evolving, as environmental considerations become increasingly integrated into portfolio decisions. This shift influences stock valuations and access to finance, particularly for firms with poor biodiversity performance (Karolyi & Tobin de la Puente, 2022). Regulatory developments, such as the Taskforce on Nature-related Financial Disclosures (TNFD, 2023), further impose compliance costs and shape strategic decisions. Moreover, firms perceived as biodiversity-negative face reputational costs, including diminished ESG ratings, reduced investor sentiment, and adverse consumer responses (Friede et al., 2015; Peloza et al., 2012). Beyond risk mitigation, biodiversity represents a vital source of innovation—especially in pharmaceuticals and biomaterials—meaning that biodiversity loss can constrain long-term competitiveness and limit opportunities for sustainable product development (Chivian & Bernstein, 2008).

Despite its importance, the impact of biodiversity loss on firm performance and risk remains underexplored in the economic and financial literature (Ahmad & Karpuz, 2024). Flammer et al. (2025) attribute this gap to methodological ambiguities in evaluating biodiversity-related risks and returns, which hinder private investment. Giglio et al. (2023) identify biodiversity loss as a source of corporate and financial-system risk with potential implications for financial stability and economic growth. Svartzman et al. (2021) show that 42% of the asset portfolios of French financial institutions depend highly on ecosystem services, yet biodiversity risks remain undervalued within the financial system. Similarly, Carvalho et al. (2023) report that, by 2018, only 29% of firms had integrated biodiversity into their policies and practices.

The challenge of quantifying biodiversity risk stems from the inherent complexity of biodiversity itself (Giglio et al., 2023). Unlike climate change—where greenhouse gas (GHG) emissions offer a consistent benchmark—biodiversity spans diverse ecosystems, species, and ecological dependencies, making aggregation into financially relevant indicators particularly difficult (Global Canopy, 2024; Stepping & Meijer, 2018). The absence of standardized corporate disclosure, the local and context-dependent nature of biodiversity exposure, and the need to account for both firms' impacts on and dependencies upon ecosystems make biodiversity risks more complex to assess than climate-related risks (AXA IM Core, 2024).

Against this backdrop, this study examines whether biodiversity risk constitutes a measurable and material source of firm-level financial risk. Specifically, we analyse how firms' exposure to biodiversity loss—captured through textual indicators from 10-K filings and firm-

level biodiversity mitigation disclosures—relates to eight dimensions of financial risk. By integrating novel biodiversity exposure measures with a comprehensive risk framework, we provide new empirical evidence on the financial materiality of nature-related factors.

This study contributes to the emerging literature on the economic implications of biodiversity by analysing the link between biodiversity risk and firm-level financial risk. We offer a new perspective on how biodiversity risk translates into financial volatility and tail exposure by examining its relationship with eight measures of financial risk: Total risk (SD), Systematic risk (Beta), Idiosyncratic risk (IDS), Lower Partial Moment (LPM), Downside beta (Downsidebeta), Tail beta (Tailbeta), Value-at-Risk (VaR), and Expected Shortfall (ES). To capture biodiversity risk, we employ two complementary approaches: textual indicators from firms' 10-K filings developed by Giglio et al. (2023) and indicators reflecting firms' biodiversity-loss mitigation initiatives. To address the concept of double materiality, we incorporate both biodiversity impacts and dependencies using industry-level indicators from the WWF Biodiversity Risk Filter. Our analysis of 1,993 U.S.-listed firms from 2010–2022 employs panel regressions with firm-level controls.

The results reveal a clear relationship between biodiversity concern indicators and firms' financial risk profiles, underscoring the materiality of biodiversity-related exposure. Firms expressing concern about biodiversity loss or facing biodiversity-related regulatory pressures exhibit distinct financial risk patterns. This differentiation is more pronounced among firms that actively disclose initiatives to reduce environmental impacts—such as mitigating effects on owned or managed land and reducing natural resource use. These firms experience measurable variations in downside and tail risk metrics, suggesting that biodiversity-related disclosures are financially significant.

This work adds to a growing body of research linking biodiversity-related issues to corporate performance. Huang et al. (2024) find that biodiversity risk affects profitability and stock returns, while Kalhoro and Kyaw (2024) document abnormal returns around biodiversity-related events such as the Kunming Declaration and TNFD launch. Ahmad and Karpuz (2024) show that biodiversity exposure prompts higher corporate cash holdings, and Adamolekun (2024) finds that it increases the likelihood of financial distress. Yet evidence on biodiversity risk and firm-level financial risk remains scarce. Xin et al. (2023), using MSCI biodiversity-related environmental scores, find no effect on systematic or idiosyncratic risk. Our study fills this gap by offering the first comprehensive examination of biodiversity risk exposure across multiple financial risk dimensions.

The remainder of the paper is structured as follows. Section 2 presents the literature review. Section 3 describes the data used in the analysis. Section 4 presents the main results. Section 5 provides robustness checks. Finally, Section 6 concludes.

2. Conceptual Framework

2.1. From climate risk to biodiversity risk

While climate risk has dominated sustainability discussions (Benkraiem et al., 2025; García-Jorcano et al., 2025, 2023; Boubaker et al., 2024; Ginglinger & Moreau, 2023; Bolton & Kacperczyk, 2020–2023a, 2023b; Zhu & Hou, 2022; Engle et al., 2020), biodiversity-related risks have recently emerged as a critical concern for economic and financial stability (Flammer et al., 2025; Kopnina et al., 2024). Biodiversity affects both firms' dependence on ecosystem services and their impact on those services (Giglio et al., 2023; OECD, 2023), creating operational, regulatory, and reputational challenges.

The climate system and the biosphere are tightly interconnected. Climate change accelerates biodiversity loss through rising temperatures, ocean acidification, and extreme weather events that destroy habitats and push species beyond tolerance thresholds (Pörtner et al., 2021; IPBES, 2019). Conversely, ecosystem degradation weakens nature's climate-regulating capacity. Deforestation, wetland drainage, and soil degradation reduce carbon sinks, diminish greenhouse gas absorption, and erode natural defenses against storms and coastal erosion, amplifying climate risks.

Giglio et al. (2025) extend these insights to finance through the "Twin-Crises Multiplier," a framework integrating biodiversity into financial risk models. It highlights how biodiversity degradation and climate instability reinforce each other, amplifying physical, transition, and market risks across global systems. These risks are not only environmental but also directly affect firm-level financial exposures, demonstrating the systemic and interdependent nature of biodiversity risk.

Both climate change and biodiversity loss generate significant financial risks for firms, investors, and lenders. Climate-related risks arise from GHG emissions, including asset damage from acute events and chronic effects such as rising sea levels (physical risks), as well as transition risks associated with shifts to a low-carbon economy (He et al., 2025; Shan et al., 2024; Ginglinger & Moreau, 2023). Similarly, biodiversity-related risks emerge from firms' dependencies on and impacts upon nature. Physical biodiversity risks include operational disruptions due to pollinator decline, water scarcity, or soil degradation, while transition risks

encompass compliance costs, market regulation, and reputational harm from habitat destruction (He et al., 2025). For example, apparel and food firms may face consumer backlash linked to deforestation in their supply chains.

A key challenge is distinguishing biodiversity risk from climate risk. While climate change drives biodiversity loss, biodiversity risk is broader and multifaceted (Giglio et al., 2023). It arises from interacting pressures such as land-use change, pollution, and overexploitation. Its financial impacts are local, ecosystem-specific, and difficult to standardize. Unlike climate risk, which can be proxied by CO_2-equivalent metrics, biodiversity lacks a single global measure (Global Canopy, 2024).

Moreover, biodiversity loss can generate systemic financial instability. Correlated exposures across industries amplify aggregate shocks to asset values and credit quality (NGFS, 2022; Svartzman et al., 2021). Ecosystem collapse in sectors reliant on pollination or freshwater basins can cascade through markets, threatening macro-financial stability. These dynamics create reinforcing cycles: biodiversity loss disrupts supply chains, raises operational costs, influences investor behavior, and reduces firms' incentives to invest in sustainability, which in turn accelerates ecosystem degradation. Biodiversity risk is therefore material and interconnected—comparable to climate risk, yet distinct in mechanism, spatial scale, and dynamic effects.

From a financial perspective, biodiversity-related shocks can alter firms' systematic risk and expected returns, while extreme ecological events translate into higher extreme and downside risks. Incorporating these considerations embeds biodiversity risk within established financial risk management frameworks while capturing its unique ecological and systemic characteristics. Thus, incorporating biodiversity-related shocks into asset pricing models or multi-factor frameworks enables quantification of biodiversity's contribution to risk, aligning ecological dynamics with established financial risk measurement tools.

2.2. Biodiversity risk impact on financial risk: theory and empirical evidence.

Biodiversity risk refers to the adverse financial consequences firms face when biodiversity degradation undermines profitability, cash flow stability, and long-term viability (OECD, 2023). These risks manifest as physical risks, such as reduced agricultural yields or resource scarcity, and transition risks, including regulatory, policy, and stakeholder pressures (Giglio et al., 2023). Firms also face reputational risks from consumer backlash, investor divestment, and public scrutiny (WWF, 2022), and market risks from input price volatility and supply chain instability. Because biodiversity-related shocks—such as ecosystem collapse—are systemic and non-

diversifiable, they threaten market stability, asset pricing, and portfolio resilience. Moreover, firm-level biodiversity exposures can aggregate into sectoral and systemic financial risks through correlated asset shocks and credit deterioration, highlighting the need to integrate biodiversity metrics into both micro- and macroprudential risk assessment frameworks.

Recognizing biodiversity as a financial risk is essential for accurate risk assessment and capital allocation. Firms that fail to integrate biodiversity into strategy face operational, regulatory, and reputational vulnerabilities, whereas proactive management enhances stakeholder trust, secures a social license to operate, and supports competitive advantage (Adler et al., 2017). Nearly half of the world's largest firms now reference biodiversity in annual reports, and roughly one-third have explicit biodiversity commitments, improving transparency and reducing information asymmetry (Addison et al., 2019; Smith et al., 2019).

Several theories explain how firms perceive and respond to biodiversity challenges. The Stakeholder Theory explains why firms address biodiversity challenges. The theory posits that companies operate within a network of relationships -including investors, regulators, employees, and local communities (Freeman, 1984). When a firm harms ecosystems, it faces negative repercussions from these groups, such as community opposition, regulatory sanctions, or investor divestment. This mechanism directly drives the Cost of Capital Channel: companies highly exposed to physical and transition biodiversity risks are perceived as riskier by stakeholders (especially investors). This increased risk perception ultimately translates into higher borrowing costs and equity financing rates (He et al., 2025; Bach et al., 2025; Zhou et al., 2025; Adamolekun, 2024; Liang et al., 2024).

The Agency Theory explains the conflict between managers' short-term incentives and shareholders' long-term interests (Jensen & Meckling, 1976). Managers often prioritize immediate financial results and may underinvest in biodiversity protection, as the benefits are often long-term or difficult to quantify. This behavior creates a misalignment that increases long-term exposure to regulatory, operational, and reputational risks. This dynamic supports the Default Risk Channel, which suggests that when managers and shareholders are not aligned on long-term environmental planning, the firm's overall chance of default and its financial instability increase.

Finally, there are two other theories that explain how ecosystem health directly translates into operational financial risk. The Resource Dependence Theory (RDT) (Pfeffer & Salancik, 1978) asserts that firms rely on vital, external ecosystem resources, such as freshwater, fertile soil, and pollination, for core operations. When these resources degrade, operational vulnerability increases, leading to supply chain disruptions and higher input costs.

Similarly, the Natural Capital Theory (NCT) (Dasgupta, 2021; Costanza et al., 1997) conceptualizes biodiversity and ecosystem services as a form of capital essential for economic activity. Because this capital is often unpriced, its depletion creates hidden liabilities and reduces a firm's long-term productive capacity and resilience. In alignment with Giglio et al., (2023, 2024), both RDT and NCT support the Productivity Channel. This channel links a firm's biodiversity involvement to financial risk because the loss of natural capital and ecosystem services disrupts operations and directly increases input costs, thereby affecting potential growth.

Despite growing awareness, investors continue to underprice biodiversity risk, even though evidence links it to higher bankruptcy likelihood, stock crashes, reduced dividends, and elevated capital costs (Zhou et al., 2025; Adamolekun, 2024; Liang et al., 2024). Strong governance and transparent biodiversity disclosures reduce financing costs and enhance resilience (He et al., 2025; Bach et al., 2025), while neglecting biodiversity exposes firms to escalating regulatory, reputational, and systemic vulnerabilities. This framework extends prior sustainability-finance research by systematically integrating ecological interdependencies and financial risk theory, offering a multidimensional lens to assess biodiversity-related financial exposure and its propagation through firm-level and systemic channels.

Based on this conceptual framework, it is proposed that firms with greater exposure to biodiversity-related risk may exhibit higher financial risk (H1). Firms that implement measures to manage and reduce their impact on biodiversity are expected to display lower financial risk than those that do not adopt such practices (H2). Finally, strong overall environmental performance is anticipated to mitigate the impact of biodiversity risk on financial outcomes (H3).

3. Research Design

3.1. Methodology

To analyse the biodiversity risk exposure on financial risk, we specify a panel data model in which all explanatory variables are lagged one period to establish a clearer causal link and avoid reverse causality (García-Sanz et al., 2024):[1]

$$Y_{iT} = \mu_0 + \mu_1 \text{Bio}_{i,T-1} + \mu_2 \text{EnvPerf}_{i,T-1} + \mu_3 (\text{Bio}_{i,T-1} \times \text{EnvPerf}_{i,T-1}) + \mu_4 \text{IndBio}_i + \mathbf{X}'_{i,T-1}\gamma + \grave{o}_{iT} \quad (1)$$

where Y_{iT} is the measure of financial risk for firm i at year T and $\grave{o}_{iT}$ is the idiosyncratic error

[1] Equation (1) is also estimated using Instrumental Variables to address the endogeneity concerns for checking the robustness of the results.

term. $\text{Bio}_{i,T-1}$ is the proxy for the firm's biodiversity exposure, the core explanatory variable. A positive and statistically significant μ_1 would mean that, after controlling for other factors, firms with higher exposure to biodiversity risk exhibit greater financial risk.

In order to disentangle the effect of biodiversity risk from other environmental concerns, we include the variable $\text{EnvPerf}_{i,T-1}$ that captures the environmental performance of firm *i* at year T. The coefficient measures the direct impact of the environmental performance on financial risk, and it is expected to be negative. With the same end, we also include the interaction term, $(\text{Bio}_{i,T-1} \times \text{EnvPerf}_{i,T-1})$, to capture the extent to which the environmental performance could moderate the impact of biodiversity loss on financial risk.

The variable IndBio_i proxies for the impact/dependence of the industry at which firm *i* belongs. It aims to control for the fact that some industries (e.g., agriculture, mining, utilities) are systemically more exposed to biodiversity risk than others (e.g., software, finance). Operating in a high-impact or high-dependency industry is expected to be associated with higher financial risk, even after accounting for a firm's individual characteristics. We include it to capture the sector-wide exposure to biodiversity physical and transition risks that affects all firms in that industry.

Finally, to ensure the validity of the findings, the model includes a set of control variables, included in vector $X'_{i,T-1}$. Specifically, these variables are firm size, leverage, profitability, and growth opportunities, are known to be significant determinants of a firm's financial risk. By incorporating them into the model, we account for their influence and prevent omitted variable bias, helping to isolate the effect of biodiversity risk on financial risk.

3.2. Variables description

The following subsections detail the construction of all variables employed in our empirical analysis. We begin by defining the financial risk measures we analyse and then describe the definition and computation of our key independent variables: the firm-level biodiversity risk, the firm's environmental profile, and the industry-level impact measure. Subsequently, we outline the standard firm-level control variables used to prevent omitted variable bias.

3.2.1. Financial risk measures

We investigate the financial implications of biodiversity loss for firms by analyzing three complementary dimensions of risk. Our framework uses conventional measures for a general risk profile, downside risk measures to specifically assess potential losses, and extreme risk measures

to capture exposure to extreme events. This approach provides a detailed view of how biodiversity translates into corporate financial risk.

In the conventional risk measures set, we consider unconditional Total return volatility (SD), as well as Systematic risk (Beta) and Idiosyncratic risk (IDS), which we compute using the CAPM pricing model. All these measures capture the variability of returns across the entire return distribution and are useful for asset pricing, long-term evaluation, and as benchmark references. However, they may understate the impact of extreme negative events.

In the downside risk set, we consider three measures that focus specifically on losses relative to a reference point. First, Lower Partial Moments (LPM) formally quantify the dispersion of returns that fall below a specified minimum acceptable return (the mean, in our case), thereby capturing the magnitude of undesirable outcomes. Additionally, Downside beta (Downsidebeta) formally measures a firm's systematic risk exclusively during periods of negative market returns, indicating its sensitivity to market downturns. For the most extreme scenarios, Tail beta (Tailbeta) formally assesses a firm's sensitivity to the market during periods of severe market stress, calculated using only the returns that fall into the lowest quantile of the market's distribution (10th percentile in our case). Collectively, these measures provide practical value for risk management by highlighting how negative shocks—potentially linked to biodiversity exposure—affect firms differently than the overall variance captured by unconditional measures.

For the extreme risk set we include Value-at-Risk (VaR) and Expected Shortfall (ES), which identify extreme negative outcomes that exceed normal market fluctuations. Value-at-Risk (VaR) formally estimates the maximum potential loss a firm could experience over a specific time horizon at a given confidence level (5% in our case). Complementing this, Expected Shortfall (ES) formally calculates the expected value of losses that exceed the VaR threshold, thus quantifying the average severity of these extreme tail events. These measures are particularly valuable for contingency planning and portfolio insurance, capturing unlikely but severe losses that could threaten a firm's financial stability in scenarios involving biodiversity-related shocks.

Table 1 provides the definition and a brief description of the financial risk measures outlined above. All risk measures are computed on an annual basis; that is, for each firm and for each year in our sample, a single value for the risk measure is calculated using the full series of daily excess returns from that specific year. Appendix I offers a more detailed explanation of their definitions and calculations.

[Insert table 1 about here]

3.2.2. Biodiversity measures and environmental score

The primary challenge we face in analysing the biodiversity risk exposure of firms is to get reliable disclosed data on a firm's effective impact and dependence on nature. To overcome this difficulty, our study adopts a pragmatic approach by utilizing various and complementary sources. We use the firm-level indicators developed by Giglio et al. (2023) based on textual analysis of firms' 10-K statements.[2] These indicators measure the degree of biodiversity awareness and engagement exhibited by firms through their public disclosures. Specifically, they capture how frequently and substantively firms discuss biodiversity-related topics, signalling their recognition of and response to nature-related risks and responsibilities, serving as a proxy for their exposure to biodiversity, physical, and transition risks.[3] Specifically, the first textual indicator, which we call BioConcern, is a dummy variable that takes the value 1 when the 10-K statement contains at least two biodiversity-related sentences, and 0 otherwise. The second is BioRegulation, a dummy variable that takes the value of 1 if the 10-K statement contains at least two biodiversity risk sentences, at least one of which is related to biodiversity regulation risk, and 0 otherwise.

We complement these indicators with two additional measures from the LSEG Refinitiv Eikon database that reflect firms' resource use and biodiversity management practices. The Land Impact variable captures the firm's direct operational footprint, while the Policy Reduction variable indicates the presence of initiatives aimed at mitigating biodiversity impacts. Both measures are derived from firms' publicly disclosed sustainability information. Conceptually, these indicators are highly relevant because they capture two of the main corporate mechanisms contributing to biodiversity loss: unsustainable resource use and land degradation (OECD, 2023; IPBES, 2019). Policy reduction is a dummy variable that reflects whether a firm has adopted explicit policies to reduce natural resource consumption or minimize its environmental footprint, indicating a formal and strategic commitment to biodiversity-sensitive practices or not (it takes value 1 or 0 respectively). Land impact is a dummy variable that captures initiatives related to land management or not (it takes value 1 or 0 respectively), which is particularly important given

[2] 10-K statement is a report filed annually by publicly listed companies with the U.S. Securities and Exchange Commission (SEC). It provides a detailed overview of a company's performance, including both structured financial metrics and unstructured textual information, such as management's discussion and analysis, business overview, and risk facts.

[3] The methodology used by Giglio et al. (2023) to build the indicators implies: (1) building a comprehensive "biodiversity dictionary" with numerous biodiversity-related keywords; (2) using algorithms to scan firms' 10-K annual reports for different years, counting the occurrences of these terms. To ensure comparability across reports of different lengths, this raw count is normalized by the total word count of the document. The final output is a standardized index that quantifies the salience of biodiversity in a firm's formal risk disclosures over time.

that land-use change is among the most significant drivers of biodiversity decline. From a methodological standpoint, these variables offer a standardized, firm-level measure of biodiversity-related practices that can be consistently compared across companies and industries.

To measure a firm's environmental performance (EnvPerf), we use the LSEG Refinitiv Environmental score (E), which evaluates corporate resource use, emissions, and innovation. The score ranges from 0 to 100, with higher values indicating a stronger environmental profile.[4] The choice of LSEG Refinitiv scores is motivated by their widespread adoption in academic research (e.g., García et al., 2025; Dyck et al., 2019) due to their extensive global coverage, methodological transparency, and deep historical data. Furthermore, they align with major reporting frameworks such as the Global Reporting Initiative (GRI) and the Sustainability Accounting Standards Board (SASB). While ESG ratings can differ across providers, recent studies show a growing convergence in their assessments (Berg et al., 2022).

3.2.3. Industry dependency/impact

We compute several indicators to capture firms' dependency and impact on biodiversity, reflecting the principle of double materiality. This concept acknowledges that firms are both affected by biodiversity loss and contributors to ecosystem degradation. An explicit consideration of double materiality thus integrates two complementary perspectives. From the outside-in perspective, firms depend on ecosystem services—such as water availability, soil fertility, and pollination—so their deterioration directly exposes firms to operational and financial risks, consistent with Resource Dependence Theory and Natural Capital Theory. From the inside-out perspective, firms' activities can adversely affect biodiversity, generating reputational, regulatory, and market risks, in line with Stakeholder Theory. Overall, double materiality connects ecological dependencies and impacts to financial performance, underscoring the need for integrated approaches to governance, disclosure, and risk management.

We gather data from the World Wide Fund for Nature (WWF)[5] biodiversity risk filter, which provides industry-level indicators that capture both *industry dependency on biodiversity* and their *impact on ecosystems*. These indicators are weighted averages of the underlying factors

[4] 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).

[5] WWF is one of the world's largest organizations dedicated to the conservation of nature, with headquarters in more than 100 countries. Its mission is to halt the environmental degradation of the planet and build a future in which humans live in harmony with nature, through the protection and conservation of biodiversity and the reduction of the ecological footprint.

within each category[6], considering only the *direct dependencies or impacts* relevant to production processes.

To compute our indicators, we first match the Global Industry Classification Standard (GICS) used by WWF to the Industry Classification Benchmark (ICB) used in LSGE Refinitiv DataStream. For each industry, we compute the indicator as the weighted average across different categories. So, the Dependency indicator is the weighted average of the categories Water availability, Air quality, Wildfire hazard, Landslides, Tropical cyclones, and Extreme heat. For biodiversity impact, we compute Biodiversity impact as the average of Land, Freshwater, and Sea use change, Tree cover loss, Invasive species, and Pollution.

To consider the interdependence between biodiversity and environmental health (IPBES, 2019; Cardinale et al., 2012), we also compute the Environmental impact indicator, as the average of Protected and conserved areas, Key biodiversity areas, and Other significant delineated areas, ecosystem condition, and species rarity. Also, we define the Reputational impact indicator as the average of Media scrutiny, Political context, Sites of international interest, and Preparedness for biodiversity-related risks. This indicator considers that firms in industries that negatively impact biodiversity face increasing reputational risks, which can result in boycotts, divestment campaigns, and greater regulatory oversight (Karolyi & Tobin-de la Puente, 2022; Addison et al., 2019; Smith et al., 2019).

We build the set of dummy variables based on those indicators that are included in different versions of Model (1); High dependency, equal to 1 for firms in industries with the Dependency indicator equal to 4 or 5 (classified as high or very high dependency according to WWF standards), and 0 otherwise; High biodiversity impact takes the value of 1 for firms in an industry with Biodiversity impact equal to 4 or 5, and 0 otherwise; High environmental impact is equal to 1 for firms with Environmental impact equal to 4 or 5, and 0 otherwise; and High reputational impact as 1 for firms in an industry with Reputational impact equal to 4 or 5, and 0 otherwise.

3.2.4. Control variables

Additionally, we control for firm characteristics that may covariate with the financial risks following the main literature (Fandella et al., 2023; Maxfield & Wang, 2021; Eliwa et al., 2021; Benlemlih & Gired-Potin, 2017, among others). Size ($Size_{i,T-1}$), measured as the log of total

[6] WWF BRF uses over 50 global data layers to build 33 distinct indicators, whose values range from 1 (low level) to 5 (high level), to measure dependency and impact. The primary data sources are the ENCORE (Exploring Natural Capital Opportunities, Risks and Exposure) tool and the Science Based Targets Network (SBTN) Sectoral Materiality Tool (see https://riskfilter.org/biodiversity/home for details). The data used for the baseline assessment generally range from 2020 to 2023.

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 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 biodiversity measures, and Panel B shows the covariates.

[Insert table 2 about here]

3.3. Data and preliminary analysis

We select the set of 2481 US firms that belong to the LSEG Refinitiv DataStream US index for the period 2010-2022. We filter out firms that are not covered by the biodiversity risk indicators by Giglio et al. (2023), being the final number of firms in the sample equal to 1993. We classify firms in different industries according to the ICB, that is, Energy, Materials, Industrials, Consumer Discretionary and Staples, Health care, Financials, Information Technology, Real Estate, Communication Services and Utilities.

We compute the risk measures from firms' daily excess returns defined as $R_{it} = r_{it} - r_{ft}$, where r_{it} are the log returns of firm *i*, defined as r_{it}=ln (P_{it}/P_{it-1}), and r_{ft} is the daily risk-free rate proxied by the 3-month US daily Treasury bill rate. Market excess returns it is also calculated. It is used to compute conditional risk measures based on the CAPM pricing model, as Systematic risk (Beta), Downside beta (Downsidebeta) and Tail beta (Tailbeta) (see Appendix I).

Table 3 displays the descriptive statistics for risk measures. The mean value for beta is

1.174, indicating that our sample of firms display a beta higher than the market, meaning that such a sample is more volatile than the market. The mean value for Downsidebeta is 1.146 and for Tailbeta is 1.096, meaning that, for our sample of firms, the investment performance during market downturns is positive. Moreover, these data means that the average Downsidebeta of the sample is greater than the average Tailbeta. This indicates that, in mean, assets are more sensitive to moderate market declines than to extreme negative events, as Downsidebeta captures the responsiveness of the assets to negative market movements, and Tailbeta isolates only the most severe market losses. Therefore, this suggests that assets exhibit stronger reactions during typical downturns, but they are relatively more resilient during extreme market shocks. This distinction has important implications for risk management, as it highlights that the assets may experience substantial risk in routine negative conditions while being less exposed to catastrophic market events.

Finally, the average Value-at-Risk (VaR) is 3.5%, indicating that, with a 5% probability, the expected loss for our subsample is 3.5%. In contrast, the average Expected Shortfall (ES) is 5.4%, which represents the mean loss among the worst 5% of outcomes—i.e., the expected return in the tail of the distribution for the most adverse scenarios.

[Insert table 3 about here]

Table 4 displays the descriptive statistics for independent and control variables. Mean value for BioConcern indicates that only around 4% of firms express concerns about biodiversity in their 10K-statements. Additionally, only 3% of firms that demonstrated concerns about biodiversity in the 10K-statements, also show concerns about BioRegulation. Moreover, only around 5% of firms report on initiatives to reduce the environmental impact on land owned, leased or managed for production activities. In contrast, 65% of firms have a policy for reducing the use of natural resources or to lessen the environmental impact.

[Insert table 4 about here]

Table A1 in Appendix II presents the correlation matrix between all the variables. Some correlations between risk measures are high, as expected, for instance, IDS and SD, and VaR and ES. Moreover, it is also expected to have a high correlation between BioConcern and BioRegulation, as one is dependent on the other. While at the same time, the high correlation between E score and Policy reduction means that having a policy for reducing the use of natural resources leads to a higher E score. Finally, the correlation between biodiversity measures is low.

4. Biodiversity Risk Impact on Financial Risks

We consider different versions of Model (1) depending on the different risk dimensions analysed, the specific biodiversity risk measure, and the industry impact/dependency proxies used to control for double materiality. The tables we present in this section are built as follows. Each table presents the results for all models estimated for a single biodiversity risk proxy. The columns of each table represent the different dependent variables, specifically each of the eight distinct measures of financial risk. The tables contain four panels that present the models estimated for each proxy of the firm industry's dependency/impact on biodiversity. This table structure facilitates the four-panel comparison to determine whether the effect of the key variables remains stable. To save space and highlight the key findings, the results for the firm-specific control variables are not displayed. The full version of each table, including all controls, can be found in Appendix III.

For each model, we formally test for fixed or random effects to determine the better specification, using the Breusch-Pagan and Hausman tests. This approach is preferable to mechanically applying fixed effects, as it allows us to retain efficiency and exploit both within- and between-entity variation when the random effect assumptions are valid. 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 2.5 (see Table A2 in Appendix II).

4.1. Biodiversity concerns and financial risk

Table 5 provides a summary of the results for the impact of BioConcern on risks. The main finding points to a complex relationship between biodiversity and risk, when biodiversity disclosures can signal both firm-specific vulnerabilities and strong governance, while strong environmental performance consistently acts as a powerful risk mitigator.

[Insert table 5 about here]

Consistent with our first hypothesis, we find that biodiversity is a critical determinant of its financial risk. For Beta (systematic risk), the estimated coefficient is negative and significant (e.g., -0.032 in Panel 2 and -0.059 in Panel 3, which controls for high impact on biodiversity and environment of the industry, respectively) but insignificant in Panels 1 and 4. This aligns with literature suggesting disclosure reduces information asymmetry (He et al., 2025; Smith et al.,

2019). The market appears to interpret high levels of disclosure as a signal of superior governance and proactive management, rewarding these firms with lower sensitivity to market-wide shocks.

In contrast, for measures of total (SD), firm-specific (IDS), downside (LPM), and extreme risk (VaR, ES), the coefficient is consistently positive and significant (e.g., 0.068 for IDS and 0.052 for SD in Panel 1). This suggests that high biodiversity disclosure also serves as a warning sign for investors, indicating that the firm has specific vulnerabilities and a higher likelihood of experiencing significant, negative events.

Our second hypothesis—that proactive management and strong environmental performance mitigate biodiversity risk—finds robust support in the data. The role of E, the firm's environmental performance score – EnvPerf in Model (1)- is clear and consistent. Its coefficient is negative and almost always statistically significant across all eight risk measures. This result highlights that stronger environmental performance is robustly associated with lower financial risk, both systematic and firm specific. This result aligns with the main literature on the impact of the ESG profile of firms on financial risks (see, e.g., García-Sanz et al., 2024).

The interaction term E x BioConcern also has a consistently negative and significant coefficient. This important finding indicates that the positive, risk-increasing effect of BioConcern on idiosyncratic risk is mitigated by its strong environmental performance. Simultaneously, the risk-reducing effect of BioConcern on systematic risk is amplified. It mitigates the firm-specific risks that disclosure reveals while amplifying the positive governance signal. This supports the literature (e.g., Zhou et al., 2025; Bach et al., 2025), highlighting that a firm's internal strategy is essential for navigating external environmental pressures.

Examining the industry context variables, we observe that being in a highly dependent industry is associated with a statistically significant reduction in nearly all forms of financial risk (Panel 1, Table 5). For systematic risk (Beta, Downsidebeta, Tailbeta), the coefficients are large, negative, and highly significant (e.g., -0.661 for Beta). This means the market views firms in high-dependency industries as highly defensive. They are significantly less sensitive to overall market movements, particularly during downturns and extreme crashes. For idiosyncratic, downside, and extreme risk (IDS, SD, LPM, VaR, ES), the coefficients are also consistently negative and significant (e.g., -0.308 for SD), indicating that these firms are perceived as having lower firm-specific volatility and a smaller probability of experiencing large, catastrophic losses. The market does not price high dependency as a risk. Instead, these results suggest that firms whose business models are fundamentally reliant on nature have developed conservative risk management strategies.

In contrast, being in a high biodiversity impact industry is linked to lower systematic risk but higher idiosyncratic risk (Panel 2, Table 5). For systematic risk (Beta, Downsidebeta, Tailbeta), the coefficients are negative and significant (e.g., -0.066 for Beta). Like high-dependency firms, these companies appear to be more defensive and less vulnerable to market-wide shocks. For idiosyncratic, total, downside, and extreme risks (IDS, SD, LPM, VaR, ES), the coefficients are positive and significant (e.g., 0.094 for SD), suggesting that the market views them as having higher firm-specific volatility and a greater risk of large, negative operational events. These findings show that being in an industry with a significant impact on biodiversity separates a firm's risk profile from the overall economy. While less exposed to market crashes, these companies are seen as having their own unique operational risks that could lead to substantial losses.

Remarkably, the results reveal a strong, positive, and significant impact of operating in an industry with high environmental impact on nearly every risk measure (Panel 3, Table 5). For systematic risk, the coefficients for Beta (0.523) and Downsidebeta (0.316) are both large and positive. This indicates that firms with a high environmental impact are highly sensitive to market downturns. For idiosyncratic and downside risk, the coefficients are also large and positive (e.g., 0.558 for SD, 0.740 for VaR). This suggests these firms also exhibit high firm-specific volatility and a greater likelihood of severe losses. Based on these findings, the market appears to clearly penalize firms in industries with high environmental impact (likely related to pollution and emissions). This serves as a source of risk across all dimensions, making these firms more vulnerable to both market-wide shocks and company-specific negative events.

Finally, being in an industry with high reputational impact is linked to lower systematic risk but does not influence idiosyncratic risk (Panel 4, Table 5). For systematic risk (Beta, Downsidebeta, Tailbeta), the coefficients are negative and highly significant (e.g., 0.388 for Beta), indicating that firms under intense reputational scrutiny are more defensive and resilient to market-wide shocks. For idiosyncratic, total, downside, and extreme risk, the results are mixed. While it significantly reduces some downside risk measures (SD, LPM), it has no significant impact on others (IDS, VaR). Thus, the main effect of high reputational risk is to decrease a firm's systematic risk. The intense public and investor scrutiny likely compels these companies to adopt more conservative and robust strategies, making them less volatile in response to market-wide events.

[Insert table 6 about here]

Table 6 provides a summary of the results for the impact of BioRegulation on risks. Consistent with our first hypothesis, we find that biodiversity regulation is a critical determinant

of its financial risk. For systematic risk (Beta), the estimated coefficient is negative and significant (e.g., -0.016 in Panel 2 and -0.049 in Panel 3, which controls for high impact on biodiversity and environment of the industry, respectively) but insignificant in Panel 1 and positive and significant in Panel 4. In contrast, for measures of firm-specific, total, downside, and extreme risk (IDS, SD, LPM, VaR, ES), the coefficient is consistently positive and significant (e.g., 0.069 for IDS and 0.051 for SD in Panel 1). This may indicate that in some contexts biodiversity regulation is perceived more as a cost driver than a risk mitigant, particularly in regions or industries where compliance requirements are high but market mechanisms for valuing biodiversity benefits are still underdeveloped (OECD, 2021; Krüger, 2015). This duality aligns with prior findings that ESG and environmental regulations can either reduce risk via improved stakeholder trust or increase risk if they are primarily viewed as costly compliance burdens (Bolton & Kacperczyk, 2021a; Godfrey, 2005).

Our second hypothesis—that proactive management and strong environmental performance mitigate biodiversity risk—finds robust support in the data. The role of E -EnvPef in Model (1)-, the firm's environmental performance score, is clear and consistent. Its coefficient is negative and almost always statistically significant across all eight risk measures. This result highlights that stronger environmental performance is robustly associated with lower financial risk, both systematic and firm specific. This result aligns with the main literature on the impact of the ESG profile of firms on financial risks (see, e.g., García-Sanz et al., 2024).

The interaction term E x BioRegulation also has a consistently negative and significant coefficient. This important finding indicates that the positive, risk-increasing effect of BioRegulation is mitigated by its strong environmental performance. Simultaneously, the risk-reducing effect of BioRegulation on systematic risk is amplified. While it mitigates the firm-specific, downside and extreme risks. This supports the literature (e.g., Zhou et al., 2025; Bach et al., 2025), highlighting that a firm's internal strategy is essential for navigating external environmental pressures.

Examining the industry context variables, we observe that being in a highly dependent industry is associated with a statistically significant reduction in nearly all forms of financial risk (Panel 1, Table 6). For systematic risk (Beta, Downsidebeta, Tailbeta), the coefficients are large, negative, and highly significant (e.g., -0.663 for Beta). This means the market views firms in high-dependency industries as highly defensive. They are significantly less sensitive to overall market movements, particularly during downturns and extreme crashes. For idiosyncratic, total, downside, and extreme risk (IDS, SD, LPM, VaR, ES), the coefficients are also consistently negative and significant (e.g., -0.308 for SD), indicating that these firms are perceived as having

lower firm-specific volatility and a smaller probability of experiencing large losses. The market does not price high dependency as a risk. Instead, these results suggest that firms whose business models are fundamentally reliant on nature have developed conservative risk management and regulatory strategies.

In contrast, being in a high biodiversity impact industry is linked to lower systematic risk but higher idiosyncratic risk (Panel 2, Table 6). For systematic risk (Beta, Downsidebeta, Tailbeta), the coefficients are negative and significant (e.g., -0.073 for Beta). Like high-dependency firms, these companies appear to be more defensive and less vulnerable to market-wide shocks. For idiosyncratic, total, downside, and extreme risks (IDS, SD, LPM, VaR, ES), the coefficients are positive and significant (e.g., 0.091 for SD), suggesting that the market views them as having higher firm-specific volatility and a greater risk of large, negative regulatory changes.

As previously, the results reveal a strong, positive, and significant impact of operating in an industry with high environmental impact on every risk measure (Panel 3, Table 6). For systematic risk, the coefficients for Beta (0.523) and Downsidebeta (0.317) are both large and positive. This indicates that firms with a high environmental impact are highly sensitive to market downturns. For idiosyncratic, total, and downside risk, the coefficients are also large and positive (e.g., 0.560 for SD, 0.734 for VaR). This suggests these firms also exhibit high firm-specific volatility and a greater likelihood of severe losses. Based on these findings, the market appears to clearly penalize firms in industries with high environmental impact (likely related to pollution and emissions). This serves as a source of risk across all dimensions, making these firms more vulnerable to both market-wide shocks and company-specific regulatory changes.

Finally, being in an industry with high reputational impact is linked to lower systematic risk but does not influence idiosyncratic risk (Panel 4, Table 6). For systematic risk (Beta, Downsidebeta, Tailbeta), the coefficients are negative and highly significant (e.g., 0.397 for Beta), indicating that firms under intense reputational scrutiny are more defensive and resilient to market-wide shocks. For idiosyncratic, downside, and extreme risk, the results are mixed. While it significantly reduces downside risk measures (LPM), it has no significant impact on others (IDS). Thus, the main effect of high reputational risk is to decrease a firm's systematic risk. The intense public and investor scrutiny likely compels these companies to adopt more conservative and robust strategies, making them less volatile in response to market-wide regulatory changes.

4.2. *Active approach towards biodiversity preservation and financial risk*

We carried out an analysis where we replace BioConcern and BioRegulation to use Policy reduction and Land impact. Table 7 provides a summary of the results for the impact of Policy reduction on risks, while Table 8 provides a summary of the results for the impact of Land Impact.

[Insert table 7 about here]

Consistent with our first hypothesis, we find that firms that proactively manage and mitigate their biodiversity resources consumption exhibit different levels of financial risk than those that do not do it. For systematic risk (Beta), the estimated coefficient is negative and significant (e.g., -0.036 in Panel 3, which controls for high impact on environment of the industry) but insignificant in Panels 1, 3, and 4. The market appears to interpret having policies to reduce the use of resources as a signal of superior governance and proactive management, rewarding these firms with lower sensitivity to market-wide shocks.

In contrast, for measures of firm-specific, downside, and extreme risk (IDS, SD, LPM, VaR, ES), the coefficient is consistently positive and significant (e.g., 0.071 for IDS and 0.072 for SD in Panel 1). This suggests that having policies to reduce the use of resources also serves as a warning sign for investors, indicating that the firm has specific vulnerabilities and a higher likelihood of experiencing significant, negative events.

Our second hypothesis—that proactive management and strong environmental performance mitigate biodiversity risk—finds robust support in the data. The role of E, the firm's environmental performance score -EnvPerf in Model (1)-, is clear and consistent. Its coefficient is negative and almost always statistically significant across all eight risk measures. This result highlights that stronger environmental performance is robustly associated with lower financial risk, both systematic and firm specific. This result aligns with the main literature on the impact of the ESG profile of firms on financial risks (see, e.g., García-Sanz et al., 2024).

The interaction term E x Policy reduction also has a consistently negative and significant coefficient for Beta and Downsidebeta. This finding indicates that the risk-mitigating effect of Policy reduction on them is reinforced by its strong environmental performance. Contrary, the risk-increasing effect of Policy reduction on firm-specific, total, downside and extreme risks (IDS, SD, LPM, VaR, ES) is amplified. These findings align with prior literature emphasizing that firms' internal strategies and sustainability integration shape how they respond to external regulatory or environmental pressures (Zhou et al., 2025; Bach et al., 2025; Bolton & Kacperczyk, 2021a; Krüger, 2015; Cheng et al., 2014). In particular, environmental leaders may reduce exposure to market-wide risks but face higher operational and compliance costs when policy tightening interacts with already ambitious environmental commitments (Haque & Ntim, 2020; Li et al., 2018).

Examining the industry context variables, we observe that being in a highly dependent industry is associated with a statistically significant reduction in nearly all forms of financial risk (Panel 1, Table 7). For systematic risk (Beta, Downsidebeta, Tailbeta), the coefficients are large, negative, and highly significant (e.g., -0.674 for Beta). This means the market views firms in high-dependency industries as highly defensive. They are significantly less sensitive to overall market movements, particularly during downturns and extreme crashes. For idiosyncratic, total, downside, and extreme risk (IDS, SD, LPM, VaR, ES), the coefficients are also consistently negative and significant (e.g., -0.296 for SD), indicating that these firms are perceived as having lower firm-specific volatility and a smaller probability of experiencing large, catastrophic losses. The market does not price high dependency as a risk. Instead, these results suggest that firms whose business models are fundamentally reliant on nature have developed conservative risk management strategies.

In contrast, being in a high biodiversity impact industry is linked to lower systematic risk but higher idiosyncratic risk (Panel 2, Table 7). For systematic risk (Beta, Downsidebeta, Tailbeta), the coefficients are negative and significant (e.g., -0.077 for Beta). Like high-dependency firms, these companies appear to be more defensive and less vulnerable to market-wide shocks. For idiosyncratic, total, downside, and extreme risks (IDS, SD, LPM, VaR, ES), the coefficients are positive and significant (e.g., 0.102 for SD), suggesting that the market views them as having higher firm-specific volatility and a greater risk of large, negative operational events. These findings show that being in an industry with a significant impact on biodiversity separates a firm's risk profile from the overall economy. While less exposed to market crashes, these companies are seen as having their own unique operational risks that could lead to substantial losses.

Remarkably, the results reveal a strong, positive, and significant impact of operating in an industry with high environmental impact on nearly every risk measure (Panel 3, Table 7). For systematic risk, the coefficients for Beta (0.468) and Downsidebeta (0.276) are both large and positive. This indicates that firms with a high environmental impact are highly sensitive to market downturns. For idiosyncratic and downside risk, the coefficients are also large and positive (e.g., 0.571 for SD, 0.761 for VaR). This suggests these firms also exhibit high firm-specific volatility and a greater likelihood of severe losses. Based on these findings, the market appears to clearly penalize firms in industries with high environmental impact (likely related to pollution and emissions). This serves as a source of risk across all dimensions, making these firms more vulnerable to both market-wide shocks and company-specific negative events.

Finally, being in an industry with high reputational impact is linked to lower systematic risk (Panel 4, Table 7). For systematic risk (Beta, Downsidebeta, Tailbeta), the coefficients are negative and highly significant (e.g., -0.400 for Beta), indicating that firms under intense reputational scrutiny are more defensive and resilient to market-wide shocks. For idiosyncratic, total, downside, and extreme risk, the results are mixed. While it significantly increases idiosyncratic risk, reduces downside risk measure (LPM), and it has no significant impact on others (VaR). Thus, the main effect of high reputational risk is to decrease a firm's systematic risk. The intense public and investor scrutiny likely compels these companies to adopt more conservative and robust strategies, making them less volatile in response to market-wide events.

[Insert tables 8 about here]

Consistent with our first hypothesis, we find that firms that proactively manage their land impact exhibit different levels of financial risk than those that do not do it. For systematic risk (Beta), the estimated coefficient is negative and significant (e.g., -0.026 in Panel 3, which controls for high impact on environment of the industry) but insignificant in Panel 2, and positive and significant for panels 1 and 4. This duality aligns with prior findings that ESG and environmental regulations can either reduce risk via improved stakeholder trust or increase risk if they are primarily viewed as costly compliance burdens (Bolton & Kacperczyk, 2021a; Godfrey, 2005).

In contrast, for measures of firm-specific, downside, and extreme risk (IDS, SD, LPM, VaR, ES), the coefficient is consistently positive and significant (e.g., 0.079 for IDS and 0.069 for SD in Panel 1). This suggests that having initiatives to manage the land use also serves as a warning sign for investors, indicating that the firm has specific vulnerabilities and a higher likelihood of experiencing significant, negative events.

Our second hypothesis—that proactive management and strong environmental performance mitigate biodiversity risk—finds robust support in the data. The role of E, the firm's environmental performance score – EnvPerf in Model (1)-, is clear and consistent. Its coefficient is negative and almost always statistically significant across all eight risk measures. This result highlights that stronger environmental performance is robustly associated with lower financial risk, both systematic and firm specific. This result aligns with the main literature on the impact of the ESG profile of firms on financial risks (see, e.g., García-Sanz et al., 2024).

The interaction term E x Land impact also has a consistently negative and significant coefficient across the risk measures. Thus, the risk-increasing effect of Land impact is mitigated. These findings align with prior literature emphasizing that firms' internal strategies and sustainability integration shape how they respond to external regulatory or environmental

pressures (Zhou et al., 2025; Bach et al., 2025; Bolton & Kacperczyk, 2021a; Krüger, 2015; Cheng et al., 2014). In particular, environmental leaders may reduce exposure to market-wide risks but face higher operational and compliance costs when policy tightening interacts with already ambitious environmental commitments (Haque & Ntim, 2020; Li et al., 2018).

Examining the industry context variables, we observe that being in a highly dependent industry is associated with a statistically significant reduction in nearly all forms of financial risk (Panel 1, Table 8). For systematic risk (Beta, Downsidebeta, Tailbeta), the coefficients are large, negative, and highly significant (e.g., -0.669 for Beta). This means the market views firms in high-dependency industries as highly defensive. They are significantly less sensitive to overall market movements, particularly during downturns and extreme crashes. For idiosyncratic, total, downside, and extreme risk (IDS, SD, LPM, VaR, ES), the coefficients are also consistently negative and significant (e.g., -0.305 for SD), indicating that these firms are perceived as having lower firm-specific volatility and a smaller probability of experiencing large, catastrophic losses. The market does not price high dependency as a risk. Instead, these results suggest that firms whose business models are fundamentally reliant on nature have developed conservative risk management strategies.

In contrast, being in a high biodiversity impact industry is linked to lower systematic risk but higher idiosyncratic risk (Panel 2, Table 8). For systematic risk (Beta, Downsidebeta, Tailbeta), the coefficients are negative and significant (e.g., -0.067 for Beta). Like high-dependency firms, these companies appear to be more defensive and less vulnerable to market-wide shocks. For idiosyncratic, total, downside, and extreme risks (IDS, SD, LPM, VaR, ES), the coefficients are positive and significant (e.g., 0.086 for SD), suggesting that the market views them as having higher firm-specific volatility and a greater risk of large, negative operational events. These findings show that being in an industry with a significant impact on biodiversity separates a firm's risk profile from the overall economy. While less exposed to market crashes, these companies are seen as having their own unique operational risks that could lead to substantial losses.

Remarkably, the results reveal a strong, positive, and significant impact of operating in an industry with high environmental impact on nearly every risk measure (Panel 3, Table 8). For systematic risk, the coefficients for Beta (0.543) and Downsidebeta (0.325) are both large and positive. This indicates that firms with a high environmental impact are highly sensitive to market downturns. For idiosyncratic, total and downside risk, the coefficients are also large and positive (e.g., 0.556 for SD, 0.740 for VaR). This suggests these firms also exhibit high firm-specific volatility and a greater likelihood of severe losses. Based on these findings, the market appears

to clearly penalize firms in industries with high environmental impact (likely related to pollution and emissions). This serves as a source of risk across all dimensions, making these firms more vulnerable to both market-wide shocks and company-specific negative events.

Finally, being in an industry with high reputational impact is linked to lower systematic risk (Panel 4, Table 8). For systematic risk (Beta, Downsidebeta, Tailbeta), the coefficients are negative and highly significant (e.g., -0.406 for Beta), indicating that firms under intense reputational scrutiny are more defensive and resilient to market-wide shocks. For idiosyncratic, downside, and extreme risk, the results are mixed. While it has no significant impact on idiosyncratic risk, it reduces downside risk (LPM) and extreme risks (VaR, ES). Thus, the main effect of high reputational risk is to decrease a firm's risk. The intense public and investor scrutiny likely compels these companies to adopt more conservative and robust strategies, making them less volatile in response to market-wide events.

5. Robustness

5.1. Endogeneity concerns

This study employs panel data models and incorporates lagged E, biodiversity, and control variables. This methodology is commonly used to address persistent endogeneity issues related to simultaneity and reverse causality (García-Sanz, et al., 2024; Maxfield & Wang, 2021). However, some unavoidable concerns may still remain, potentially biasing the results (Bouslah et al., 2013). In this line, firms with stronger financial results may have more available resources to allocate toward sustainability initiatives, suggesting that financial strength drives sustainability engagement and biodiversity protection rather than sustainability and biodiversity performances leading to improved financial outcomes. Similar issue has been consistently discussed in prior studies (e.g., Albuquerque et al., 2019).

To analyze 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 the endogenous variable), and exogenous (that is, independent of the error term). Following the literature, we use the leave-one-out sector-average approach, calculated excluding the *i-th* firm (Martielli et al., 2024; El Ghoul et al., 2019) as instrumental variable for each of the potential endogenous variables, that is, the E score from LSEG Refinitiv DataStream, and each of the biodiversity variables (Count, Regulation, Policy reduction, and Land impact). Firms operating in the same sector face similar challenges and regulations, and common sustainability patterns and standards are likely to develop. Excluding the *i-th* firm to compute the

average removes the direct contamination from the specific firm's own value, while capturing the relevant influence of the peer group sector.

[Insert table 9 about here]

The results presented in this section are structured as follows. The columns of the Table 9 correspond to the different dependent variables, specifically the eight distinct measures of financial risk. Also, Table 9 is divided into five panels, which report the estimated coefficient for each variable of interest, including two specification diagnostics too. The first is the weak instrument test, which evaluates the predictive power of the instrument—the leave-one-out sector average—on the endogenous variable. The null hypothesis states that the instrument is weak. As reported, the p-values of the first-stage statistics strongly reject the null across all models, confirming that the chosen instruments are valid and relevant predictors.

The second diagnostic is the Wu–Hausman (WH) test for endogeneity, which compares the coefficients obtained from the baseline fixed effects (FE) model with those from the IV specification. The null hypothesis is that the variable of interest is exogenous, in which case the more efficient FE estimator is consistent and appropriate. The test results show that, for most estimated models, the null of exogeneity cannot be rejected at conventional significance levels. In the few cases where exogeneity is rejected, the sign and significance of the coefficients remain consistent with those from the baseline FE model, reinforcing the robustness of the findings.

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.

5.2. Alternative measure

To test the robustness of our results, we employ an alternative measure of land impact using a broader definition, also sourced from LSGE Refinitiv DataStream. The variable Biodiversity impact reduction -BioIR- captures whether a firm discloses information either on its impact on biodiversity or on initiatives aimed at mitigating this impact. This includes actions related to native ecosystems, species preservation, and the protection of sensitive or legally protected biodiversity areas. Table 10 provides a summary of the results. Overall, the result with this alternative proxy maintains, reinforcing our previous results.

[Insert table 10 about here]

Consistent with our first hypothesis, we find that firms that proactively discloses about their land impact exhibit different levels of financial risk than those that do not do it. For systematic risk (Beta), the estimated coefficient is negative and significant (e.g., -0.159 in Panel 2, and -0.224 in Panel 3 which controls for high impact on biodiversity and environment of the industry, respectively) but insignificant in Panel 1. This result suggests that disclosing information about firms' land impact act as a signal of superior governance and proactive management, rewarding these firms with lower sensitivity to market-wide shocks.

In contrast, for measures of firm-specific, total, downside, and extreme risk (IDS, SD, LPM, VaR, ES), the coefficient is positive and significant (e.g., 0.152 for IDS and 0.136 for SD in Panel 1). This suggests that disclosing about initiatives to manage the land use also serves as a warning sign for investors, indicating that the firm has specific vulnerabilities and a higher likelihood of experiencing significant, negative events.

Our second hypothesis—that proactive management and strong environmental performance mitigate biodiversity risk—also finds support in the data. The role of E, the firm's environmental performance score –EnvPerf in Model (1)-, is negative and statistically significant across risk measures and panels. This result highlights that stronger environmental performance is associated with lower financial risk. This result aligns with the main literature on the impact of the ESG profile of firms on financial risks (see, e.g., García-Sanz et al., 2024).

The interaction term E x BioIR also has a consistently negative and significant coefficient across the risk measures. Thus, the risk-increasing effect of BioIR is mitigated. These findings align with prior literature emphasizing that firms' internal strategies and sustainability integration shape how they respond to external regulatory or environmental pressures (Zhou et al., 2025; Bach et al., 2025; Bolton & Kacperczyk, 2021a; Krüger, 2015; Cheng et al., 2014), highlighting that a firm's internal strategy is essential for navigating external environmental pressures.

Examining the industry context variables, we observe that being in a highly dependent industry is associated with a statistically significant reduction in nearly all forms of financial risk (Panel 1, Table 8). For systematic risk (Beta, Downsidebeta, Tailbeta), the coefficients are large, negative, and highly significant (e.g., -0.648 for Beta). This means the market views firms in high-dependency industries as highly defensive. They are significantly less sensitive to overall market movements, particularly during downturns and extreme crashes. For idiosyncratic, total, downside, and extreme risk (IDS, SD, LPM, VaR, ES), the coefficients are also consistently negative and significant (e.g., -0.302 for SD), indicating that these firms are perceived as having lower firm-specific volatility and a smaller probability of experiencing large, catastrophic losses. The market does not price high dependency as a risk. Instead, these results suggest that firms

whose business models are fundamentally reliant on nature have developed conservative risk management strategies.

In contrast, being in a high biodiversity impact industry is linked to lower systematic risk but higher idiosyncratic risk (Panel 2, Table 10). For systematic risk (Beta, Downsidebeta, Tailbeta), the coefficients are negative and significant (e.g., -0.067 for Beta). Like high-dependency firms, these companies appear to be more defensive and less vulnerable to market-wide shocks. For idiosyncratic, total, downside, and extreme risks (IDS, SD, LPM, VaR, ES), the coefficients are positive and significant (e.g., 0.108 for SD), suggesting that the market views them as having higher firm-specific volatility and a greater risk of large, negative operational events. These findings show that being in an industry with a significant impact on biodiversity separates a firm's risk profile from the overall economy. While less exposed to market crashes, these companies are seen as having their own unique operational risks that could lead to substantial losses.

Remarkably, the results reveal a strong, positive, and significant impact of operating in an industry with high environmental impact on nearly every risk measure (Panel 3, Table 10). For systematic risk, the coefficients for Beta (0.515) and Downsidebeta (0.308) are both large and positive. This indicates that firms with a high environmental impact are highly sensitive to market downturns. For idiosyncratic and downside risk, the coefficients are also large and positive (e.g., 0.593 for SD, 0.798 for VaR). This suggests these firms also exhibit high firm-specific volatility and a greater likelihood of severe losses. Based on these findings, the market appears to clearly penalize firms in industries with high environmental impact (likely related to pollution and emissions). This serves as a source of risk across all dimensions, making these firms more vulnerable to both market-wide shocks and company-specific negative events.

Finally, being in an industry with high reputational impact is linked to lower systematic risk (Panel 4, Table 10). For systematic risk (Beta, Downsidebeta, Tailbeta), the coefficients are negative and highly significant (e.g., -0.368 for Beta), indicating that firms under intense reputational scrutiny are more defensive and resilient to market-wide shocks. For idiosyncratic, downside, and extreme risk, the results are mixed. While it has positive impact on idiosyncratic risk, it also reduces downside risk (LPM), and it has no significant impact on extreme risks (VaR, ES). Overall, the main effect of high reputational risk is to decrease a firm's risk. The intense public and investor scrutiny likely compels these companies to adopt more conservative and robust strategies, making them less volatile in response to market-wide events.

6. Final Remarks

The relevance of firms' biodiversity risk in shaping financial risk remains largely unexplored. This study addresses this gap by examining a comprehensive set of financial risk measures and providing evidence on the effects of biodiversity risks on financial risk. By considering conventional measures for general risk, downside, and extreme risk, our findings confirm that the impact of biodiversity risk varies across financial risk measures. Results that demonstrate being robust under alternative procedures and proxies.

We find clear differences in how firms' biodiversity risk influences their financial risk exposure. Overall, strong environmental performance—as captured by the environmental score—consistently mitigates financial risks. In line with this, our results further highlight the reinforcing role of a robust environmental profile in shaping the relationship between biodiversity risk and financial risk, strengthening firms' ability to buffer against nature-related vulnerabilities. Furthermore, our results indicate that whether demonstrate biodiversity concerns, biodiversity-regulatory concerns, or implementing policies aimed at reducing biodiversity impact and resource use consumption, results are mixed over financial risks.

Our findings carry several implications for practice and policy. For corporate risk managers, biodiversity exposure should be incorporated into risk assessment frameworks, with attention to its differentiated effects across return-based and covariance-based risk measures. Moreover, regulators may benefit from promoting standardized biodiversity risk disclosures to enhance transparency and comparability. While policymakers could design targeted incentives for firms to adopt broad biodiversity protection strategies, as these appear to influence financial risks differently than narrow measures like land reduction. Finally, for academia, the results highlight a largely untapped research domain linking biodiversity to specific dimensions of financial risk, inviting further sector-specific and methodological exploration.

Our study contributes to a better understanding of how financial risks are influenced by firms' exposure to biodiversity-related factors. The findings can help stakeholders design more targeted strategies at both firm and national levels to support the transition toward a greener economy that protects biodiversity. Furthermore, this research provides a framework to quantify the impact of biodiversity risk on financial outcomes, assess its potential economic consequences, and inform investment and financing decisions.

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Tables

Table 1: Risk measures

Variable	*Definition*	*Description*	*Source*
Beta	$\beta_i = \frac{Cov(R_i, R_M)}{Var(R_M)}$	It measures the expected change in the return of an individual risky asset following changes in the market return.	Own elaboration using data from LSGE Refinitiv DataStream
IDS	$IDS_i = \sqrt{\frac{\sum_{i=1}^{n} \widehat{\varepsilon_i^2}}{n-k}}$	Idiosyncratic risk represents the factors that affect individually each stock or firm.	Own elaboration using data from LSGE Refinitiv DataStream
SD	$SD_i = \sqrt{\frac{\sum_{i=1}^{n}(R_i - \bar{R_i})}{n-1}}$	Total risk represents the whole set of risks factors that affect an organization, internal and external.	Own elaboration using data from LSGE Refinitiv DataStream
Downside beta	$Downsidebeta_i = \frac{Cov\,(R_i, R_M \mid R_M < \mu_M)}{VaR(R_M < \mu_M)}$	It focuses only on downside movements in the market, that is, when the market return is below a certain benchmark.	Own elaboration using data from LSGE Refinitiv DataStream
LPM	$LPM_i = \int_{-\infty}^{h} (h - R)^m f_i(R) dr$	It captures downside risk, focusing only on returns that fall below a specific target or threshold.	Own elaboration using data from LSGE Refinitiv DataStream
Tail beta	$Tailbeta_i = \frac{\mathrm{Cov}\,(R_i, R_M \mid R_M < P10_M)}{VaR(R_M < P10_M)}$	It measures how much an asset's returns tend to move with the market's returns during the worst market periods, defined by a percentile threshold.	Own elaboration using data from LSGE Refinitiv DataStream
VaR	$VaR_\alpha(R) = -inf\,\{x \in \mathbb{R} \mid F(x) > \alpha\}$	It estimates the maximum expected loss over a given time period, at a specified confidence level, under normal market conditions.	Own elaboration using data from LSGE Refinitiv DataStream
ES	$ES_\alpha(R_{t+1}) = -E\big(R_{t+1} < q_\alpha(R_{t+1})\big)$	It captures the average loss in the tail beyond the VaR threshold.	Own elaboration using data from LSGE Refinitiv DataStream

Table 2: Biodiversity measures and control variables

Panel A: Biodiversity variables

Variable	*Definition*	*Description*	*Source*
Environmental score (E, EnvPerf)	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.	Data from LSGE Refinitiv DataStream
BioConcern	Dummy variable that takes value 1 when the 10-K statement contains at least two biodiversity-related sentences, and 0 otherwise.	It is a firm-level measure of biodiversity risk exposure based on textual analysis of firms' 10-K statements.	Giglio et al. (20223)
BioRegulation	Dummy variable that takes value 1 if the 10-K statement of a company contains at least two biodiversity risk sentences and at least one of them is a biodiversity regulation risk sentence, and 0 otherwise.	It is a firm-level measure of biodiversity risk exposure based on textual analysis of firms' 10-K statements.	Giglio et al. (20223)
Policy reduction	Dummy variable equal to 1 when the firm has a policy for reducing the use of natural resources or to lessen the environmental impact, and 0 otherwise.	It is a variable from Thomson Reuters related to the use of environmental resources.	Data from LSGE Refinitiv DataStream
Land impact	Land impact is a dummy variable that takes value 1 when the firm reports on initiatives to reduce the environmental impact on land owned, leased or managed for production activities, and 0 otherwise.	It is a variable from Thomson Reuters related to the use of environmental resources.	Data from LSGE Refinitiv DataStream

Panel B: Control variables

Variable	***Definition***	***Description***	***Source***
Dependency high	Dummy variable that takes value 1 when the average dependency indicator of the industry is 4 or 5 (following WWF 4 or 5 means high or very high dependency), and 0 otherwise.	WWF Biodiversity Risk Filter	Own elaboration using data from WWF
Biodiversity impact high	Dummy variable, that takes value 1 when the average biodiversity impact indicator of the industry is 4 or 5, and 0 otherwise.	WWF Biodiversity Risk Filter (WWF BRF)	Own elaboration using data from WWF
Environmental impact high	Dummy variable, that takes value 1 when the environmental impact indicator of the firm is above the average environmental impact indicator of the industry, and 0 otherwise	WWF Biodiversity Risk Filter (WWF BRF)	Own elaboration using data from WWF
Reputational impact high	Dummy variable that takes value 1 when the reputational impact indicator of the industry is 4 or 5, and 0 otherwise	WWF Biodiversity Risk Filter (WWF BRF)	Own elaboration using data from WWF
Size	$\text{Size} = \log(Total\ Assets_i)$	The size of the firm	Own elaboration using data from LSGE Refinitiv DataStream
MTB	$\text{MTB} = \frac{Market\ capitalization_i}{Total\ equity_i}$	Market to book ratio compares the firm's book value to its market value.	Data from LSGE Refinitiv DataStream
ROA	$\text{ROA} = \log\left(\frac{Net\ Income_i}{Total\ Assets_i}\right)$	Return on assets ratio measures the profitability of a business in relation to its total assets.	Data from LSGE Refinitiv DataStream
Lev	$\text{Lev} = \frac{Total\ Debt_i}{Total\ Assets_i}$	Leverage ratio indicates how the company's assets and business operations are financed (using debt or equity).	Data from LSGE Refinitiv DataStream
Liq	$\text{Liq} = \frac{Total\ shares\ traded_i}{Total\ shares\ outstanding_i}$	Stock market liquidity represents the percentage of a stock that has been replaced in a given year.	Own elaboration using data from LSGE Refinitiv DataStream

Table 3: Descriptive statistics of risk measures

	N obs.	*Mean*	*Median*	*St.D.*	*Min*	*Max*	*Skew*	*Kurt*
Beta	17704	1.174	1.122	0.449	-2.055	2.850	0.722	1.889
IDS	17704	2.028	1.711	1.153	0.476	8.538	2.229	8.793
SD	18278	0.024	0.021	0.013	0.006	0.056	1.934	6.627
Downsidebeta	18439	1.146	1.101	0.555	-4.032	2.077	1.369	25.741
LPM	18278	0.025	0.021	0.014	0.003	0.057	2.182	10.704
Tailbeta	18439	1.096	1.031	2.088	-48.963	3.684	-0.694	58.816
VaR	17704	0.035	0.031	0.017	0.005	0.114	1.428	2.631
ES	17704	0.054	0.046	0.029	0.008	0.202	1.762	4.966

This table reports the descriptive statistics of risk measures at the firm level for an unbalanced panel of 1993 US firms and a period of 12 years (2010-2022). The variables in the table are defined as follows: Beta and IDS are the systematic and idiosyncratic risks, estimated form the CAPM; SD is the total risk. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the average market excess return during the past year. LPM measures losses relative to a reference point and ignores gains exceeding such a reference point. To this case, LPM is equivalent to the semivariance, as the reference point is the mean of stock's return distribution. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. VaR measures how much the value of an investment declines over a given time period with a given probability (5%). The ES is the expected return on the portfolio in the worst q % of cases (5%). Variables are measured using yearly basis and winsorized at 5%.

Table 4: Descriptive statistics of independent variables

	N obs.	*Mean*	*Median*	*St.D.*	*Min*	*Max*	*Skew*	*Kurt*
BioConcern	18439	0.041	0.000	0.198	0.000	1.000	4.644	19.568
BioRegulation	18439	0.030	0.000	0.172	0.000	1.000	5.463	27.849
Land impact	14622	0.049	0.000	0.215	0.000	1.000	4.201	15.651
Policy reduction	14709	0.65	1.000	0.477	0.000	1.000	-0.625	-1.610
E	14710	30.77	24.015	27.748	0.000	98.070	0.534	-0.971
Size	18265	15.052	14.927	1.770	9.020	22.043	0.360	0.119
MTB	17825	2.684	2.330	101.113	-10985.110	1947.770	-73.627	7927.053
ROA	18116	3.301	4.865	16.233	-517.050	259.940	-4.308	92.133
Lev	18401	71.435	50.930	2312.459	-220228.600	96050.000	-42.667	4847.482
Liq	17151	1.744	0.999	65.553	0.000	6489.250	93.207	8735.976

This table reports the descriptive statistics of independent and control variables at the firm level for an unbalanced panel of 1993 US firms and a period of 12 years (2010-2022). The variables in the table are defined as follows: BioConcern is a dummy variable that takes value 1 when the 10K statement of firm mentions biodiversity-related terms, and 0 otherwise. BioRegulation is a variable that takes value 1 when the 10K statement of the firms show at least one sentence related to regulation risk, and 0 otherwise. Land impact is a dummy variable that takes value 1 when the firm reports on initiatives to reduce the environmental impact on land owned, leased or managed for production activities, and 0 otherwise. Policy reduction is a dummy variable that thakes value 1 when the firm has a policy for reducing the use of natural resources or to lessen the environmental impact, and 0 otherwise. E is the Thomson Reuters environmetnal score, that takes value 0-100. Size is the size of the firm, calculated as the log of the total assets. 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. Variables are measured using yearly basis, and winsorized at 5%.

Table 5: Biodiversity impact: firms' biodiversity concers

	Beta	*IDS*	*SD*	*Downsidebeta*	*LPM*	*Tailbeta*	*VaR*	*ES*
E	-0.003	-0.023**	-0.008	-0.011	-0.008	-0.018	-0.027***	-0.015*
	(0.010)	(0.008)	(0.008)	(0.010)	(0.008)	(0.011)	(0.008)	(0.008)
BioConcern	-0.006	0.068***	0.052***	-0.012	0.050***	-0.019*	0.066***	0.049***
	(0.008)	(0.007)	(0.007)	(0.008)	(0.007)	(0.009)	(0.006)	(0.006)
ExBioConcern	-0.024**	-0.020**	-0.016*	-0.010	-0.014*	0.005	-0.021**	-0.014*
	(0.008)	(0.007)	(0.007)	(0.008)	(0.007)	(0.009)	(0.006)	(0.006)
Dependency high	-0.661***	-0.213***	-0.308***	-0.573***	-0.285***	-0.195***	-0.299***	-0.269***
	(0.023)	(0.019)	(0.019)	(0.024)	(0.019)	(0.025)	(0.018)	(0.018)
E	-0.045***	-0.048***	-0.034***	-0.043***	-0.033***	-0.023*	-0.058***	-0.041***
	(0.010)	(0.008)	(0.008)	(0.010)	(0.008)	(0.011)	(0.008)	(0.008)
BioConcern	-0.032***	0.050***	0.034***	-0.031***	0.033***	-0.021*	0.045***	0.031***
	(0.009)	(0.007)	(0.007)	(0.009)	(0.007)	(0.009)	(0.007)	(0.007)
ExBioConcern	-0.040***	-0.020**	-0.022**	-0.026**	-0.019**	-0.002	-0.023***	-0.018**
	(0.009)	(0.007)	(0.007)	(0.009)	(0.007)	(0.009)	(0.006)	(0.006)
Biodiversity impact high	-0.066**	0.184***	0.094***	-0.120***	0.093***	-0.149***	0.173***	0.125***
	(0.024)	(0.019)	(0.018)	(0.024)	(0.019)	(0.025)	(0.018)	(0.018)
E	-0.050***	-0.039***	-0.030***	-0.050***	-0.028***	-0.030**	-0.050***	-0.035***
	(0.010)	(0.008)	(0.008)	(0.010)	(0.008)	(0.011)	(0.008)	(0.008)
BioConcern	-0.059***	0.028***	0.013+	-0.051***	0.013+	-0.024**	0.018**	0.009
	(0.009)	(0.007)	(0.007)	(0.009)	(0.007)	(0.009)	(0.006)	(0.007)
ExBioConcern	-0.028***	-0.011	-0.012+	-0.017*	-0.010	-0.001	-0.012+	-0.008
	(0.008)	(0.007)	(0.007)	(0.009)	(0.007)	(0.009)	(0.006)	(0.006)
Environmental impact high	0.523***	0.657***	0.558***	0.316***	0.536***	-0.085*	0.740***	0.584***
	(0.039)	(0.031)	(0.030)	(0.039)	(0.031)	(0.041)	(0.029)	(0.030)
E	-0.021*	-0.040***	-0.023**	-0.024*	-0.023**	-0.018+	-0.047***	-0.031***
	(0.010)	(0.008)	(0.008)	(0.010)	(0.008)	(0.011)	(0.008)	(0.008)
BioConcern	0.000	0.057***	0.046***	-0.003	0.044***	-0.011	0.055***	0.041***
	(0.009)	(0.007)	(0.007)	(0.009)	(0.007)	(0.009)	(0.007)	(0.007)
ExBioConcern	-0.038***	-0.024***	-0.023***	-0.022**	-0.020**	0.001	-0.027***	-0.020**
	(0.008)	(0.007)	(0.007)	(0.008)	(0.007)	(0.009)	(0.006)	(0.006)
Reputational impact high	-0.388***	0.023	-0.081***	-0.370***	-0.069***	-0.186***	-0.023	-0.046**
	(0.022)	(0.017)	(0.017)	(0.022)	(0.017)	(0.023)	(0.017)	(0.017)
Model	RE	RE	RE	RE	RE	RE	RE	RE
Num.Obs.	13182	13182	13642	13687	13642	13687	13182	13182
Max. R2	0.131	0.308	0.256	0.076	0.216	0.01	0.266	0.238
Min. R2	0.079	0.285	0.239	0.038	0.200	0.006	0.231	0.216

This table summarizes the panel regression results regarding the impact of biodiversity-related terms on firm risk for a set of 1993 US firms and a period of 12 years (2010-2022). Each panel corresponds to the regressión results for each of the WWF control variables (dependency, biodiversity impact, environmental impact, reputational impact). All variables are standarized, and data are annual and winsorized at 5% and winsorized at 5%. Independent variables are lagged by one year. Beta and IDS are the systematic and idiosyncratic risks, estimated form the CAPM; SD is the total risk. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the average market excess return during the past year. LPM measures losses relative to a reference point and ignores gains exceeding such a reference point. To this case, LPM is equivalent to the semivariance, as the reference point is the mean of stock's return distribution. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. VaR measures how much the value of an investment declines over a given time period with a given probability (5%). The ES is the expected return on the portfolio in the worst q % of cases (5%). E is the Thomson Reuters Environmental scores, that takes values 0 to 100. BioConcern is a dummy variable that takes value 1 when the 10K statement of firm mentions biodiversity-related terms, and 0 otherwise. ExBioConcern is the interaction variable between the Environmental pillar score and the BioConcern dummy variable. Dependency high is a dummy variable that takes value 1 when the average depdendency indicator of the industryis 4 or 5, and 0 otherwise. Same methodology applies for the cases of the biodiversity impact high, environmental impact high and reputational impact high. 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: Biodiversity impact: firms' BioRegulation concerns

	Beta	*IDS*	*SD*	*Downsidebeta*	*LPM*	*Tailbeta*	*VaR*	*ES*
E	-0.004	-0.022**	-0.007	-0.012	-0.008	-0.018+	-0.027***	-0.015+
	(0.010)	(0.008)	(0.008)	(0.010)	(0.008)	(0.011)	(0.008)	(0.008)
BioRegulation	0.007	0.069***	0.053***	-0.003	0.054***	-0.015+	0.074***	0.055***
	(0.008)	(0.007)	(0.007)	(0.008)	(0.007)	(0.009)	(0.007)	(0.007)
ExBioRegulation	-0.043***	-0.018**	-0.017*	-0.029***	-0.018**	-0.001	-0.026***	-0.020**
	(0.009)	(0.007)	(0.007)	(0.009)	(0.007)	(0.009)	(0.007)	(0.007)
Dependency high	-0.663***	-0.212***	-0.308***	-0.572***	-0.284***	-0.195***	-0.300***	-0.269***
	(0.023)	(0.019)	(0.018)	(0.024)	(0.019)	(0.025)	(0.018)	(0.018)
E	-0.046***	-0.047***	-0.033***	-0.044***	-0.032***	-0.023*	-0.057***	-0.040***
	(0.010)	(0.008)	(0.008)	(0.010)	(0.008)	(0.011)	(0.008)	(0.008)
BioRegulation	-0.016+	0.051***	0.036***	-0.019*	0.037***	-0.015+	0.053***	0.037***
	(0.009)	(0.007)	(0.007)	(0.009)	(0.007)	(0.009)	(0.007)	(0.007)
ExBioRegulation	-0.058***	-0.017*	-0.021**	-0.044***	-0.022**	-0.009	-0.027***	-0.022***
	(0.009)	(0.007)	(0.007)	(0.009)	(0.007)	(0.009)	(0.007)	(0.007)
Biodiversity impact high	-0.073**	0.182***	0.091***	-0.125***	0.089***	-0.151***	0.167***	0.120***
	(0.024)	(0.019)	(0.019)	(0.024)	(0.019)	(0.025)	(0.018)	(0.018)
E	-0.051***	-0.039***	-0.029***	-0.051***	-0.028***	-0.031**	-0.050***	-0.035***
	(0.010)	(0.008)	(0.008)	(0.010)	(0.008)	(0.011)	(0.008)	(0.008)
BioRegulation	-0.049***	0.024***	0.010	-0.043***	0.013+	-0.019*	0.021**	0.012+
	(0.009)	(0.007)	(0.007)	(0.009)	(0.007)	(0.009)	(0.007)	(0.007)
ExBioRegulation	-0.045***	-0.009	-0.012+	-0.034***	-0.013+	-0.007	-0.016*	-0.014*
	(0.009)	(0.007)	(0.007)	(0.009)	(0.007)	(0.009)	(0.007)	(0.007)
Environmental impact high	0.523***	0.657***	0.560***	0.317***	0.534***	-0.086*	0.734***	0.580***
	(0.040)	(0.031)	(0.030)	(0.039)	(0.031)	(0.041)	(0.030)	(0.030)
E	-0.021*	-0.039***	-0.023**	-0.024*	-0.022**	-0.018+	-0.046***	-0.030***
	(0.010)	(0.008)	(0.008)	(0.010)	(0.008)	(0.011)	(0.008)	(0.008)
BioRegulation	0.018*	0.059***	0.049***	0.009	0.049***	-0.006	0.065***	0.049***
	(0.009)	(0.007)	(0.007)	(0.009)	(0.007)	(0.009)	(0.007)	(0.007)
ExBioRegulation	-0.056***	-0.022**	-0.024***	-0.041***	-0.024***	-0.005	-0.031***	-0.026***
	(0.009)	(0.007)	(0.007)	(0.009)	(0.007)	(0.009)	(0.007)	(0.007)
Reputational impact high	-0.397***	0.020	-0.084***	-0.375***	-0.073***	-0.188***	-0.031+	-0.051**
	(0.022)	(0.017)	(0.017)	(0.022)	(0.017)	(0.023)	(0.017)	(0.017)
Model	RE	RE	RE	RE	RE	RE	RE	RE
Num.Obs.	13182	13182	13642	13687	13642	13687	13182	13182
Max. R2	0.132	0.308	0.256	0.076	0.216	0.01	0.266	0.238
Min. R2	0.079	0.285	0.239	0.038	0.201	0.006	0.232	0.217

This table summarizes the panel regression results regarding the impact of biodiversity-related terms on firm risk for a set of 1993 US firms and a period of 12 years (2010-2022). Each panel corresponds to the regressión results for each of the WWF control variables (dependency, biodiversity impact, environmental impact, reputational impact). All variables are standarized, and data are annual and winsorized at 5% and winsorized at 5%. Independent variables are lagged by one year. Beta and IDS are the systematic and idiosyncratic risks, estimated form the CAPM; SD is the total risk. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the average market excess return during the past year. LPM measures losses relative to a reference point and ignores gains exceeding such a reference point. To this case, LPM is equivalent to the semivariance, as the reference point is the mean of stock's return distribution. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. VaR measures how much the value of an investment declines over a given time period with a given probability (5%). The ES is the expected return on the portfolio in the worst q % of cases (5%). E is the Thomson Reuters Environmental score, that takes values 0 to 100. BioRegulation dummy variable that takes value 1 if the 10-K statement of a company contains at least two biodiversity risk sentences and at least one of them is a biodiversity BioRegulation risk sentence, and 0 otherwise. ExBioRegulation is the interaction variable between the Environmental pillar score and the BioRegulation dummy variable. Dependency high is a dummy variable that takes value 1 when the average depdendency indicator of the industryis 4 or 5, and 0 otherwise. Same methodology applies for the cases of the biodiversity impact high, environmental impact high and reputational impact high. 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 7: Biodiversity impact: firms' use natural resources

	Beta	*IDS*	*SD*	*Downsidebeta*	*LPM*	*Tailbeta*	*VaR*	*ES*
E	0.006	-0.074***	-0.057***	0.040*	-0.057***	0.008	-0.056***	-0.056***
	(0.016)	(0.013)	(0.013)	(0.016)	(0.013)	(0.017)	(0.013)	(0.013)
Policy reduction	-0.003	0.071***	0.072***	-0.066***	0.072***	-0.039*	0.044**	0.060***
	(0.018)	(0.014)	(0.014)	(0.018)	(0.015)	(0.019)	(0.014)	(0.014)
ExPolicy reduction	-0.050**	0.078***	0.059***	-0.083***	0.056***	-0.019	0.039**	0.053***
	(0.018)	(0.015)	(0.015)	(0.019)	(0.015)	(0.020)	(0.014)	(0.014)
Dependency high	-0.674***	-0.193***	-0.296***	-0.579***	-0.273***	-0.198***	-0.281***	-0.257***
	(0.023)	(0.019)	(0.018)	(0.023)	(0.019)	(0.025)	(0.018)	(0.018)
E	-0.022	-0.087***	-0.072***	0.017	-0.071***	0.003	-0.073***	-0.071***
	(0.017)	(0.013)	(0.013)	(0.017)	(0.013)	(0.017)	(0.013)	(0.013)
Policy reduction	-0.028	0.053***	0.055***	-0.082***	0.056***	-0.039*	0.022	0.042**
	(0.018)	(0.014)	(0.014)	(0.018)	(0.015)	(0.019)	(0.014)	(0.014)
ExPolicy reduction	-0.061**	0.071***	0.052***	-0.090***	0.050**	-0.02	0.031*	0.046**
	(0.019)	(0.015)	(0.015)	(0.019)	(0.015)	(0.020)	(0.014)	(0.014)
Biodiversity impact high	-0.077**	0.201***	0.102***	-0.125***	0.100***	-0.151***	0.189***	0.134***
	(0.024)	(0.019)	(0.018)	(0.024)	(0.019)	(0.025)	(0.018)	(0.018)
E	-0.024	-0.082***	-0.069***	0.015	-0.068***	-0.001	-0.069***	-0.067***
	(0.017)	(0.013)	(0.013)	(0.017)	(0.013)	(0.017)	(0.012)	(0.012)
Policy reduction	-0.036*	0.056***	0.054***	-0.092***	0.055***	-0.046*	0.025+	0.043**
	(0.018)	(0.014)	(0.014)	(0.018)	(0.014)	(0.019)	(0.014)	(0.014)
ExPolicy reduction	-0.059**	0.079***	0.058***	-0.090***	0.055***	-0.023	0.039**	0.053***
	(0.019)	(0.015)	(0.015)	(0.019)	(0.015)	(0.020)	(0.014)	(0.014)
Environmental impact high	0.468***	0.688***	0.571***	0.276***	0.548***	-0.101*	0.761***	0.595***
	(0.039)	(0.030)	(0.030)	(0.038)	(0.030)	(0.040)	(0.029)	(0.029)
E	-0.006	-0.085***	-0.067***	0.030+	-0.067***	0.008	-0.069***	-0.066***
	(0.016)	(0.013)	(0.013)	(0.017)	(0.013)	(0.017)	(0.013)	(0.013)
Policy reduction	-0.011	0.061***	0.063***	-0.070***	0.063***	-0.038*	0.032*	0.050***
	(0.018)	(0.014)	(0.014)	(0.018)	(0.015)	(0.019)	(0.014)	(0.014)
ExPolicy reduction	-0.058**	0.074***	0.054***	-0.088***	0.052***	-0.021	0.034*	0.049***
	(0.019)	(0.015)	(0.015)	(0.019)	(0.015)	(0.020)	(0.014)	(0.014)
Reputational impact high	-0.400***	0.052**	-0.062***	-0.376***	-0.051**	-0.188***	0.004	-0.027+
	(0.021)	(0.017)	(0.017)	(0.021)	(0.017)	(0.022)	(0.016)	(0.016)
Model	RE	RE	RE	RE	RE	RE	RE	RE
Num.Obs.	13182	13182	13641	13686	13641	13686	13182	13182
Max. R2	0.132	0.309	0.257	0.077	0.217	0.01	0.266	0.238
Min. R2	0.076	0.283	0.237	0.037	0.199	0.006	0.227	0.214

This table summarizes the panel regression results regarding the impact of biodiversity-related terms on firm risk for a set of 1993 US firms and a period of 12 years (2010-2022). Each panel corresponds to the regressión results for each of the WWF control variables (dependency, biodiversity impact, environmental impact, reputational impact). All variables are standarized, and data are annual and winsorized at 5% and winsorized at 5%. Independent variables are lagged by one year. Beta and IDS are the systematic and idiosyncratic risks, estimated form the CAPM; SD is the total risk. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the average market excess return during the past year. LPM measures losses relative to a reference point and ignores gains exceeding such a reference point. To this case, LPM is equivalent to the semivariance, as the reference point is the mean of stock's return distribution. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. VaR measures how much the value of an investment declines over a given time period with a given probability (5%). The ES is the expected return on the portfolio in the worst q % of cases (5%). E is the Thomson Reuters Environmental scores, that takes values 0 to 100. Policy reduction is a dummy variable that takes value 1 when the firm has a policy for reducing the use of natural resources or to lessen the environmental impact, and 0 otherwise. ExPolicy reduction is the interaction variable between the Environmental pillar score and the policy reduction dummy variable. Dependency high is a dummy variable that takes value 1 when the average depdendency indicator of the industryis 4 or 5, and 0 otherwise. Same methodology applies for the cases of the biodiversity impact high, environmental impact high and reputational impact high. 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 8: Biodiversity impact: firms' reporting initiatives

	Beta	*IDS*	*SD*	*Downsidebeta*	*LPM*	*Tailbeta*	*VaR*	*ES*
E	-0.004	-0.032***	-0.015+	-0.011	-0.015+	-0.016	-0.036***	-0.022**
	(0.010)	(0.008)	(0.008)	(0.010)	(0.008)	(0.011)	(0.008)	(0.008)
Land impact	0.034**	0.079***	0.069***	0.02	0.070***	-0.013	0.087***	0.064***
	(0.012)	(0.010)	(0.010)	(0.012)	(0.010)	(0.013)	(0.010)	(0.009)
ExLand impact	-0.038***	-0.009	-0.017*	-0.024*	-0.018*	-0.002	-0.023**	-0.012
	(0.010)	(0.008)	(0.008)	(0.010)	(0.008)	(0.011)	(0.008)	(0.008)
Dependency high	-0.669***	-0.208***	-0.305***	-0.580***	-0.282***	-0.197***	-0.294***	-0.267***
	(0.023)	(0.019)	(0.018)	(0.023)	(0.019)	(0.025)	(0.018)	(0.018)
E	-0.045***	-0.054***	-0.039***	-0.043***	-0.037***	-0.022*	-0.063***	-0.045***
	(0.010)	(0.008)	(0.008)	(0.010)	(0.008)	(0.011)	(0.008)	(0.008)
Land impact	0.019	0.059***	0.054***	0.013	0.056***	-0.008	0.065***	0.047***
	(0.013)	(0.010)	(0.010)	(0.013)	(0.010)	(0.013)	(0.010)	(0.010)
ExLand impact	-0.045***	-0.009	-0.019*	-0.031**	-0.020*	-0.005	-0.024**	-0.013+
	(0.010)	(0.008)	(0.008)	(0.010)	(0.008)	(0.011)	(0.008)	(0.008)
Biodiversity impact high	-0.067**	0.174***	0.086***	-0.123***	0.084***	-0.151***	0.164***	0.117***
	(0.024)	(0.019)	(0.019)	(0.024)	(0.019)	(0.025)	(0.018)	(0.018)
E	-0.045***	-0.042***	-0.031***	-0.047***	-0.030***	-0.029**	-0.051***	-0.036***
	(0.010)	(0.008)	(0.008)	(0.010)	(0.008)	(0.011)	(0.008)	(0.008)
Land impact	-0.023+	0.030**	0.025*	-0.017	0.028**	-0.013	0.028**	0.017+
	(0.013)	(0.010)	(0.010)	(0.013)	(0.010)	(0.013)	(0.010)	(0.010)
ExLand impact	-0.042***	-0.009	-0.018*	-0.029**	-0.020*	-0.004	-0.023**	-0.012
	(0.010)	(0.008)	(0.008)	(0.010)	(0.008)	(0.011)	(0.007)	(0.008)
Environmental impact high	0.543***	0.648***	0.556***	0.325***	0.530***	-0.088*	0.740***	0.579***
	(0.040)	(0.032)	(0.031)	(0.040)	(0.032)	(0.042)	(0.030)	(0.030)
E	-0.024*	-0.047***	-0.030***	-0.026*	-0.029***	-0.017	-0.054***	-0.036***
	(0.010)	(0.008)	(0.008)	(0.010)	(0.008)	(0.011)	(0.008)	(0.008)
Land impact	0.053***	0.071***	0.069***	0.039**	0.069***	-0.001	0.081***	0.061***
	(0.013)	(0.010)	(0.010)	(0.013)	(0.010)	(0.013)	(0.010)	(0.010)
ExLand impact	-0.042***	-0.011	-0.019*	-0.027**	-0.020*	-0.002	-0.026***	-0.014+
	(0.010)	(0.008)	(0.008)	(0.010)	(0.008)	(0.011)	(0.008)	(0.008)
Reputational impact high	-0.406***	0.015	-0.089***	-0.386***	-0.078***	-0.191***	-0.031+	-0.055***
	(0.022)	(0.017)	(0.017)	(0.022)	(0.018)	(0.023)	(0.017)	(0.017)
Model	RE	RE	RE	RE	RE	RE	RE	RE
Num.Obs.	13099	13099	13557	13602	13557	13602	13099	13099
Max. R2	0.131	0.308	0.255	0.076	0.216	0.01	0.265	0.237
Min. R2	0.077	0.285	0.239	0.037	0.201	0.005	0.231	0.216

This table summarizes the panel regression results regarding the impact of biodiversity-related terms on firm risk for a set of 1993 US firms and a period of 12 years (2010-2022). Each panel corresponds to the regressión results for each of the WWF control variables (dependency, biodiversity impact, environmental impact, reputational impact). All variables are standarized, and data are annual and winsorized at 5% and winsorized at 5 %. Independent variables are lagged by one year. Beta and IDS are the systematic and idiosyncratic risks, estimated form the CAPM; SD is the total risk. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the average market excess return during the past year. LPM measures losses relative to a reference point and ignores gains exceeding such a reference point. To this case, LPM is equivalent to the semivariance, as the reference point is the mean of stock's return distribution. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. VaR measures how much the value of an investment declines over a given time period with a given probability (5%). The ES is the expected return on the portfolio in the worst q % of cases (5%). E is the Thomson Reuters Environmental scores, that takes values 0 to 100. Land impact is a dummy variable that takes value 1 when the firm reports on initiatives to reduce the environmental impact on land owned, leased or managed for production activities, and 0 otherwise. ExLand impact is the interaction variable between the Environmental pillar score and the land impact dummy variable. Dependency high is a dummy variable that takes value 1 when the average depdendency indicator of the industryis 4 or 5, and 0 otherwise. Same methodology applies for the cases of the biodiversity impact high, environmental impact high and reputational impact high. 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 9: Endogeneity

	Beta	*IDS*	*SD*	*Downsidebeta*	*LPM*	*Tailbeta*	*VaR*	*ES*
Panel 1: E								
E	-0.04**	-0.001	0.008	-0.043	-0.007	-0.021	-0.025	-0.029+
	(0.013)	(0.009)	(0.009)	(0.015)	(0.009)	(0.017)	(0.015)	(0.015)
First stage	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Hausman	[0.010]	[0.188]	[0.529]	[0.728]	[0.469]	[0.732]	[0.275]	[0.208]
Panel 2: BioConcern								
BioConcern	-0.019*	0.014+	0.009	-0.017*	-0.009	-0.007	0.014+	0.005
	(0.009)	(0.009)	(0.007)	(0.010)	(0.008)	(0.012)	(0.007)	(0.009)
First stage	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Hausman	[0.964]	[0.602]	[0.721]	[0.659]	[0.898]	[0.512]	[0.979]	[0.617]
Panel 3: BioRegulation								
BioRegulation	-0.011	0.017+	0.009	-0.011	0.012+	-0.009	0.019**	0.009
	(0.009)	(0.010)	(0.007)	(0.010)	(0.009)	(0.012)	(0.007)	(0.008)
First stage	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Hausman	[0.560]	[0.585]	[0.423]	[0.258]	[0.561]	[0.170]	[0.396]	[0.523]
Panel 4: Land impact								
Land impact	-0.032**	0.033***	0.014+	0.000	0.012+	-0.028	0.015+	0.016
	(0.010)	(0.009)	(0.008)	(0.012)	(0.009)	(0.014)	(0.008)	(0.009)
First stage	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Hausman	[0.08]	[0.894]	[0.852]	[0.037]	[0.561]	[0.407]	[0.906]	[0.582]
Panel 5: Policy reduction								
Policy reduction	-0.014	0.018***	0.026***	-0.05***	0.015+	-0.041**	0.016+	0.012
	(0.011)	(0.008)	(0.007)	(0.013)	(0.008)	(0.015)	(0.008)	(0.008)
First stage	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Hausman	[0.630]	[0.169]	[0.199]	[0.220]	[0.361]	[0.646]	[0.459]	[0.438]

This table reports a summary of the IV results regarding the estimation of E score (Panel 1), and each of the independent varaible of interest, respectively on the risk measures at the firm level for an unbalanced panel of 1993 US firms and a period of 12 years (2010-2022). All variables have been standardized using annual data, and winsorized at 5%. All variables are standardized, and data are annual and winsorized at 5%. Beta is systematic risk. IDS is idiosyncratic risk. SD total risk. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the average market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. BioConcern is a dummy variable that takes value 1 when the 10K statement of firm mentions biodiversity-related terms, and 0 otherwise. BioRegulation is a variable that takes value 1 when the 10K statement of the firms show at least one sentence related to regulation risk, and 0 otherwise. Land impact is a dummy variable that takes value 1 when the firm reports on initiatives to reduce the environmental impact on land owned, leased or managed for production activities, and 0 otherwise. Policy reduction is a dummy variable that thakes value 1 when the firm has a policy for reducing the use of natural resources or to lessen the environmental impact, and 0 otherwise. E is the Thomson Reuters environmetnal score, that takes value 0-100. 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 10: Biodiversity impact: firms' reporting initiatives

	Beta	*IDS*	*SD*	*Downsidebeta*	*LPM*	*Tailbeta*	*VaR*	*ES*
E	0.027*	-0.024**	-0.002	0.01	-0.003	-0.016	-0.021*	-0.012
	(0.011)	(0.009)	(0.009)	(0.011)	(0.009)	(0.012)	(0.009)	(0.009)
BioIR	-0.003	0.152***	0.136***	-0.018	0.140***	-0.03	0.146***	0.123***
	(0.042)	(0.035)	(0.034)	(0.043)	(0.035)	(0.045)	(0.033)	(0.033)
ExBioIR	-0.130***	-0.041	-0.074**	-0.085**	-0.073**	-0.009	-0.084***	-0.060*
	(0.031)	(0.026)	(0.025)	(0.031)	(0.026)	(0.033)	(0.024)	(0.024)
Dependency high	-0.648***	-0.207***	-0.302***	-0.562***	-0.279***	-0.173***	-0.291***	-0.263***
	(0.024)	(0.020)	(0.020)	(0.025)	(0.020)	(0.026)	(0.019)	(0.019)
E	-0.001	-0.044***	-0.021*	-0.011	-0.021*	-0.016	-0.044***	-0.031***
	(0.011)	(0.009)	(0.009)	(0.011)	(0.009)	(0.012)	(0.009)	(0.009)
BioIR	-0.159***	0.063+	0.045	-0.136**	0.055	-0.046	0.037	0.031
	(0.043)	(0.035)	(0.034)	(0.043)	(0.035)	(0.044)	(0.033)	(0.033)
ExBioIR	-0.130***	-0.035	-0.073**	-0.090**	-0.073**	-0.013	-0.078**	-0.056*
	(0.031)	(0.026)	(0.025)	(0.032)	(0.026)	(0.033)	(0.024)	(0.024)
High biodiversity impact	-0.064**	0.206***	0.108***	-0.119***	0.107***	-0.163***	0.197***	0.141***
	(0.024)	(0.020)	(0.019)	(0.025)	(0.020)	(0.025)	(0.019)	(0.019)
E	-0.004	-0.035***	-0.016+	-0.016	-0.016+	-0.024*	-0.035***	-0.024**
	(0.011)	(0.009)	(0.009)	(0.011)	(0.009)	(0.012)	(0.009)	(0.009)
BioIR	-0.224***	0.025	0.005	-0.184***	0.017	-0.059	-0.012	-0.009
	(0.042)	(0.034)	(0.033)	(0.043)	(0.034)	(0.044)	(0.032)	(0.033)
ExBioIR	-0.115***	-0.022	-0.062*	-0.081*	-0.062*	-0.013	-0.062**	-0.044+
	(0.031)	(0.025)	(0.025)	(0.032)	(0.026)	(0.033)	(0.024)	(0.024)
High environmental impact	0.515***	0.707***	0.593***	0.308***	0.567***	-0.131**	0.798***	0.619***
	(0.040)	(0.032)	(0.031)	(0.040)	(0.032)	(0.041)	(0.030)	(0.031)
E	0.014	-0.037***	-0.014	0.000	-0.014	-0.016	-0.035***	-0.023**
	(0.011)	(0.009)	(0.009)	(0.011)	(0.009)	(0.012)	(0.009)	(0.009)
BioIR	-0.037	0.079*	0.082*	-0.034	0.087*	-0.01	0.066*	0.063+
	(0.043)	(0.035)	(0.034)	(0.043)	(0.035)	(0.045)	(0.034)	(0.034)
ExBioIR	-0.139***	-0.038	-0.076**	-0.094**	-0.075**	-0.014	-0.082***	-0.060*
	(0.031)	(0.026)	(0.025)	(0.032)	(0.026)	(0.033)	(0.025)	(0.024)
High reputational impact	-0.368***	0.053**	-0.056**	-0.355***	-0.046*	-0.182***	0.013	-0.021
	(0.022)	(0.018)	(0.018)	(0.022)	(0.018)	(0.023)	(0.018)	(0.017)
Model	RE	RE	RE	RE	RE	RE	RE	RE
Num.Obs.	12329	12329	12779	12824	12779	12824	12329	12329
Max. R2	0.136	0.313	0.259	0.077	0.22	0.01	0.271	0.242
Min. R2	0.086	0.286	0.239	0.042	0.201	0.006	0.231	0.217

This table summarizes the panel regression results regarding the impact of Biodiversity-related terms on firm risk for a set of 1993 US firms and a period of 12 years (2010-2022). Each panel corresponds to the regressión results for each of the WWF control variables (dependency, Biodiversity impact, environmental impact, reputational impact). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Beta and IDS are the systematic and idiosyncratic risks, estimated form the CAPM; SD is the total risk. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the average market excess return during the past year. LPM measures losses relative to a reference point and ignores gains exceeding such a reference point. To this case, LPM is equivalent to the semivariance, as the reference point is the mean of stock's return distribution. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. VaR measures how much the value of an investment declines over a given time period with a given probability (5%). The ES is the expected return on the portfolio in the worst q % of cases (5%). E is the Thomson Reuters Environmental scores, that takes values 0 to 100. BioIR is a dummy variable that takes value 1 when the firm reports on its impact on Biodiversity or on activities to reduce its impact on the native ecosystems and species, as well as the Biodiversity of protected and sensitive areas, and 0 otherwise. ExBioIR is the interaction variable between the Environmental pillar score and the BioIR dummy variable. Dependency high is a dummy variable that takes value 1 when the average depdendency indicator of the industryis 4 or 5, and 0 otherwise. Same methodology applies for the cases of the High biodiversity impact, High environmental impact and High reputational impact. 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. □

Appendix I: Risk Measures

Total risk (SD): comprises all risk factors (systematic and specific) associated with making an investment decision. It is calculated as the standard deviation of daily excess stock returns,

$$SD_i = \sqrt{\frac{\sum_{i=1}^{n}(R_i - \overline{R_i})}{n-1}} \quad (1)$$

To estimate conditional risk measures, we estimate by OLS the factor pricing model CAPM represented in the Sharpe (1964) equation:

$$R_{it} = \alpha_i + \beta_i R_{Mt} + \varepsilon_{it} \quad (2)$$

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. From this model we extract the following risk measures:

Systematic risk (Beta): β_i, from model (2) for each firm of the firms of sample and year. It measures the volatility of a security or portfolio compared to the market.

$$\beta_i = \frac{Cov(R_i, R_M)}{Var(R_M)} \quad (3)$$

Idiosyncratic risk (IDS): is the standard deviation of the residuals from the model (2). It represents a security's specific risk. So, as for the beta, it was obtained one value per year for each firm of the sample:

$$IDS_i = \sqrt{\frac{\sum_{i=1}^{n} \widehat{\varepsilon_i^2}}{n-k}} \quad (4)$$

Downside beta (Downsidebeta): we follow Atilgan et al. (2019), Ang et al. (2006) and Bawa and Lindenberg (1977) to construct the measure as the ratio of the covariance between a stock's daily excess returns and daily excess market returns to the variance of the daily excess market returns on the days that the market's excess return is less than the average market excess return during the past year.

$$Downsidebeta_i = \frac{Cov\,(R_i, R_M | R_M < \mu_M)}{VaR(R_M < \mu_M)} \quad (5)$$

Where R_i and R_M stock *i* and market's excess return for each of the market indexes respectively, and μ_M the average market excess return during the past year (250 trading days). Our proxy for market returns is the index provided by DataStream for the US.

Lower partial moment (LPM): captures the stock-specific downside risk. It is built on the notion of lower partial moment (LPM) of Markowitz (1959).

$$LPM_i = \int_{-\infty}^{h} (h - R)^m f_i(R) dr \quad (6)$$

Where h is the target return, R is the excess return on the asset, m is the order of the moment, and f_i represents the probability density function of returns for asset i. LPM measures losses relative to a reference point and ignores gains exceeding such a reference point. As in our case, when the reference point is the mean of stock's return distribution during the past year, LPM coincides with the semi-variance.

Tail beta (Tailbeta): we also compute the tail beta proposed by to Atilgan et al. (2019). Tail beta is similar to downside beta, but it focuses further to the left-tail of the market return distribution and is equal to the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less than the 10th percentile of its distribution during the past year ($P10_M$):

$$Tailbeta_i = \frac{\text{Cov}\,(R_i, R_M | R_M < P10_M)}{VaR(R_M < P10_M)} \quad (7)$$

Value-at-Risk (VaR): is the negative *α-th* quantile ($q_\alpha(R)$) of the distribution of the company's returns, R. Therefore, VaR represents the maximum loss an investor would expect to experience on an investment over a certain period of time with $(1 - \alpha)$ level of confidence. The formal definition of VaR (Artzner et al., 1999) is:

$$VaR_\alpha(R) = -q_\alpha(R) = -inf\,\{x \in \mathbb{R} \,|F(x) > \alpha\} \quad (8)$$

Where R is the returns and F the cumulative distribution function of R.

Expected Shortfall (ES): is the negative of the conditional expectation of exceedances beyond the $\alpha - th$ quantile of R, $q_\alpha(X)$. ES is the expected loss of a company if a catastrophic event happens. Therefore, the α-ES of a company returns, R, is defined as:

$$ES_\alpha(R) = -E\big(R \big| R \le q_\alpha(R)\big)) = -E(R | R \le -VaR_\alpha(R)) \quad (9)$$

Where R are the returns, $q_\alpha(R)$ the VaR at the (1- α) confidence level (Yamai et al., 2002). For high values of α, it ignores the most profitable but unlikely scenarios, while for small values of α it focuses on the worst losses. Generally, the ES value is higher than the VaR. Moreover, the ES is considered a more useful risk measure than VaR because it represents a coherent spectral measure of financial risk calculated for a given quantile-level q and defined to be the mean loss of the portfolio or asset value, given that the loss is taking place at or below the q-quantile.

Appendix II

Table A1: Correlation matrix

	Beta	*SD*	*IDS*	*Tailbeta*	*Downsidebeta*	*VaR*	*ES*	*LPM*	*BioCount*	*BioRegulation*	*E*	*Land impact*	*Policy reduction*	*ROA*	*Lev*	*MTB*	*Size*	*Liq*	*High dependency*	*High biodiversity impact*	*High environmental impact*	*High reputational impact*
Beta	1																					
SD	0.488	1																				
IDS	0.41	0.965	1																			
Tailbeta	0.286	0.107	0.097	1																		
Downsidebeta	0.85	0.38	0.353	0.357	1																	
VaR	0.521	0.936	0.876	0.132	0.435	1																
ES	0.471	0.965	0.919	0.127	0.42	0.936	1															
LPM	0.464	0.959	0.929	0.117	0.383	0.903	0.98	1														
BioConcern	-0.044	0.016	0.039	-0.026	-0.045	0.036	0.024	0.02	1													
BioRegulation	-0.033	0.017	0.039	-0.025	-0.037	0.042	0.027	0.021	0.86	1												
E	-0.148	-0.242	-0.275	-0.04	-0.109	-0.209	-0.205	-0.221	0.065	0.052	1											
Land impact	-0.046	-0.01	-0.002	-0.035	-0.052	0.008	-0.004	-0.007	0.221	0.207	0.215	1										
Policy reduction	-0.102	-0.134	-0.157	-0.037	-0.09	-0.095	-0.095	-0.114	0.057	0.053	0.639	0.147	1									
ROA	-0.199	-0.41	-0.425	-0.036	-0.149	-0.367	-0.355	-0.38	0.014	0.016	0.197	0.012	0.19	1								
Lev	0.006	0.008	0.007	0.012	0.006	0.013	0.011	0.008	-0.026	-0.028	-0.011	0.001	0	-0.003	1							
MTB	0.016	-0.002	-0.005	0.022	0.017	-0.002	-0.003	0	-0.004	-0.004	0.005	0	0.007	0.002	0.276	1						
Size	-0.194	-0.372	-0.411	-0.028	-0.11	-0.32	-0.315	-0.337	0.042	0.042	0.57	0.157	0.354	0.192	0.009	-0.003	1					
Liq	0.018	0.028	0.029	0.023	0.021	0.023	0.029	0.029	0.055	0	-0.018	-0.009	-0.026	-0.033	0	0	-0.019	1				
High dependency	-0.236	-0.151	-0.129	-0.069	-0.202	-0.147	-0.135	-0.139	0.158	0.142	0.213	0.171	0.176	0.081	-0.004	-0.008	0.097	-0.005	1			
High biodiversity impact	-0.031	0.008	0.037	-0.044	-0.058	0.036	0.023	0.014	0.177	0.187	0.151	0.28	0.157	0.07	-0.021	-0.007	0.046	0.028	0.629	1		
High environmental impact	0.103	0.118	0.141	-0.008	0.051	0.157	0.126	0.117	0.254	0.291	0.044	0.336	0.065	-0.01	-0.024	0.001	0.057	0.052	-0.09	0.547	1	
High reputational impact	-0.156	-0.071	-0.04	-0.065	-0.151	-0.047	-0.054	-0.061	0.279	0.285	0.213	0.338	0.192	0.067	-0.017	-0.007	0.118	0.024	0.837	0.858	0.469	1

This table reports the correlation coefficents of the risk measures and the indepentent and control variables. With an unbalanced panel of 1993 US firms and a period of 12 years (2010-2022). All variables are standardized, and data are annual and winsorized at 5%. Beta is systematic risk. IDS is idiosyncratic risk. SD total risk. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the average market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. BioConcern is a dummy variable that takes value 1 when the 10K statement of firm mentions biodiversity-related terms, and 0 otherwise. BioRegulation is a variable that takes value 1 when the 10K statement of the firms show at least one sentence related to regulation risk, and 0 otherwise. Land impact is a dummy variable that takes value 1 when the firm reports on initiatives to reduce the environmental impact on land owned, leased or managed for production activities, and 0 otherwise. Policy reduction is a dummy variable that thakes value 1 when the firm has a policy for reducing the use of natural resources or to lessen the environmental impact, and 0 otherwise. E is the Thomson Reuters environmetnal score, that takes value 0-100. Size is the size of the firm, calculated as the log of the total assets. 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. High dependency takes the value of 1 when a firm belongs to an industry with an average dependency indicator of 4 or 5 (classified as high or very high dependency according to WWF standards), and 0 otherwise. High biodiversity impact takes the value of 1 when a firm operates in an industry with an average biodiversity impact indicator of 4 or 5, and 0 otherwise. High environmental impact is defined as 1 when a firm's environmental impact indicator is above the industry average, and 0 otherwise. High reputational impact takes the value of 1 when a firm belongs to an industry with a reputational impact indicator of 4 or 5, and 0 otherwise.

Table A2: VIF

PANEL A

	E	BioConcern	Size	MTB	ROA	Lev	Liq	High dependency
Beta	1.571	1.032	1.524	1.079	1.051	1.080	1.007	1.062
IDS	1.571	1.032	1.524	1.079	1.051	1.080	1.007	1.062
SD	1.562	1.032	1.518	1.079	1.054	1.081	1.007	1.061
Downsidebeta	1.560	1.032	1.517	1.079	1.055	1.081	1.007	1.061
LPM	1.562	1.032	1.518	1.079	1.054	1.081	1.007	1.061
Tailbeta	1.560	1.032	1.517	1.079	1.055	1.081	1.007	1.061
VaR	1.571	1.032	1.524	1.079	1.051	1.080	1.007	1.062
ES	1.571	1.032	1.524	1.079	1.051	1.080	1.007	1.062

	E	BioRegulation	Size	MTB	ROA	Lev	Liq	High dependency
Beta	1.571	1.026	1.524	1.079	1.051	1.081	1.005	1.059
IDS	1.571	1.026	1.524	1.079	1.051	1.081	1.005	1.059
SD	1.561	1.026	1.518	1.079	1.054	1.081	1.005	1.058
Downsidebeta	1.559	1.026	1.517	1.079	1.054	1.081	1.005	1.058
LPM	1.561	1.026	1.518	1.079	1.054	1.081	1.005	1.058
Tailbeta	1.559	1.026	1.517	1.079	1.054	1.081	1.005	1.058
VaR	1.571	1.026	1.524	1.079	1.051	1.081	1.005	1.059
ES	1.571	1.026	1.524	1.079	1.051	1.081	1.005	1.059

	E	Land imapct	Size	MTB	ROA	Lev	Liq	High dependency
Beta	1.596	1.059	1.527	1.079	1.053	1.080	1.002	1.052
IDS	1.596	1.059	1.527	1.079	1.053	1.080	1.002	1.052
SD	1.586	1.058	1.521	1.080	1.056	1.080	1.002	1.051
Downsidebeta	1.585	1.058	1.520	1.080	1.056	1.080	1.002	1.050
LPM	1.586	1.058	1.521	1.080	1.056	1.080	1.002	1.051
Tailbeta	1.585	1.058	1.520	1.080	1.056	1.080	1.002	1.050
VaR	1.596	1.059	1.527	1.079	1.053	1.080	1.002	1.052
ES	1.596	1.059	1.527	1.079	1.053	1.080	1.002	1.052

	E	Policy reduciton	Size	MTB	ROA	Lev	Liq	High dependency
Beta	2.244	1.702	1.525	1.079	1.058	1.079	1.002	1.043
IDS	2.244	1.702	1.525	1.079	1.058	1.079	1.002	1.043
SD	2.233	1.701	1.519	1.079	1.062	1.080	1.002	1.042
Downsidebeta	2.232	1.702	1.518	1.079	1.063	1.080	1.002	1.042
LPM	2.233	1.701	1.519	1.079	1.062	1.080	1.002	1.042
Tailbeta	2.232	1.702	1.518	1.079	1.063	1.080	1.002	1.042
VaR	2.244	1.702	1.525	1.079	1.058	1.079	1.002	1.043
ES	2.244	1.702	1.525	1.079	1.058	1.079	1.002	1.043

PANEL B

	E	BioConcern	Size	MTB	ROA	Lev	Liq	High biodiversity impact
Beta	1.557	1.024	1.527	1.079	1.051	1.081	1.011	1.041
IDS	1.557	1.024	1.527	1.079	1.051	1.081	1.011	1.041
SD	1.547	1.024	1.521	1.079	1.054	1.081	1.011	1.039
Downsidebeta	1.546	1.024	1.520	1.079	1.055	1.081	1.011	1.039
LPM	1.547	1.024	1.521	1.079	1.054	1.081	1.011	1.039
Tailbeta	1.546	1.024	1.520	1.079	1.055	1.081	1.011	1.039
VaR	1.557	1.024	1.527	1.079	1.051	1.081	1.011	1.041
ES	1.557	1.024	1.527	1.079	1.051	1.081	1.011	1.041

	E	BioRegulation	Size	MTB	ROA	Lev	Liq	High biodiversity impact
Beta	1.556	1.026	1.527	1.079	1.051	1.081	1.009	1.045
IDS	1.556	1.026	1.527	1.079	1.051	1.081	1.009	1.045
SD	1.546	1.026	1.521	1.079	1.054	1.081	1.009	1.044
Downsidebeta	1.545	1.025	1.520	1.079	1.054	1.081	1.009	1.044
LPM	1.546	1.026	1.521	1.079	1.054	1.081	1.009	1.044
Tailbeta	1.545	1.025	1.520	1.079	1.054	1.081	1.009	1.044
VaR	1.556	1.026	1.527	1.079	1.051	1.081	1.009	1.045
ES	1.556	1.026	1.527	1.079	1.051	1.081	1.009	1.045

	E	Land imapct	Size	MTB	ROA	Lev	Liq	High biodiversity impact
Beta	1.579	1.088	1.531	1.079	1.053	1.080	1.007	1.066
IDS	1.579	1.088	1.531	1.079	1.053	1.080	1.007	1.066
SD	1.569	1.085	1.525	1.080	1.056	1.081	1.007	1.063
Downsidebeta	1.568	1.084	1.524	1.080	1.057	1.081	1.007	1.062
LPM	1.569	1.085	1.525	1.080	1.056	1.081	1.007	1.063
Tailbeta	1.568	1.084	1.524	1.080	1.057	1.081	1.007	1.062
VaR	1.579	1.088	1.531	1.079	1.053	1.080	1.007	1.066
ES	1.579	1.088	1.531	1.079	1.053	1.080	1.007	1.066

	E	Policy reduciton	Size	MTB	ROA	Lev	Liq	High biodiversity impact
Beta	2.227	1.709	1.528	1.079	1.058	1.080	1.008	1.034
IDS	2.227	1.709	1.528	1.079	1.058	1.080	1.008	1.034
SD	2.216	1.707	1.521	1.079	1.062	1.080	1.008	1.032
Downsidebeta	2.216	1.709	1.520	1.079	1.063	1.080	1.008	1.032
LPM	2.216	1.707	1.521	1.079	1.062	1.080	1.008	1.032
Tailbeta	2.216	1.709	1.520	1.079	1.063	1.080	1.008	1.032
VaR	2.227	1.709	1.528	1.079	1.058	1.080	1.008	1.034
ES	2.227	1.709	1.528	1.079	1.058	1.080	1.008	1.034

PANEL C

	E	BioConcern	Size	MTB	ROA	Lev	Liq	High environmental impact
Beta	1.533	1.050	1.526	1.079	1.051	1.081	1.017	1.058
IDS	1.533	1.050	1.526	1.079	1.051	1.081	1.017	1.058
SD	1.524	1.047	1.520	1.079	1.055	1.082	1.016	1.054
Downsidebeta	1.523	1.046	1.519	1.079	1.055	1.082	1.016	1.053
LPM	1.524	1.047	1.520	1.079	1.055	1.082	1.016	1.054
Tailbeta	1.523	1.046	1.519	1.079	1.055	1.082	1.016	1.053
VaR	1.533	1.050	1.526	1.079	1.051	1.081	1.017	1.058
ES	1.533	1.050	1.526	1.079	1.051	1.081	1.017	1.058

	E	BioRegulation	Size	MTB	ROA	Lev	Liq	High environmental impact
Beta	1.531	1.066	1.526	1.079	1.051	1.081	1.015	1.077
IDS	1.531	1.066	1.526	1.079	1.051	1.081	1.015	1.077
SD	1.523	1.061	1.520	1.079	1.055	1.082	1.014	1.072
Downsidebeta	1.521	1.060	1.519	1.079	1.055	1.082	1.014	1.070
LPM	1.523	1.061	1.520	1.079	1.055	1.082	1.014	1.072
Tailbeta	1.521	1.060	1.519	1.079	1.055	1.082	1.014	1.070
VaR	1.531	1.066	1.526	1.079	1.051	1.081	1.015	1.077
ES	1.531	1.066	1.526	1.079	1.051	1.081	1.015	1.077

	E	Land imapct	Size	MTB	ROA	Lev	Liq	High environmental impact
Beta	1.563	1.139	1.527	1.079	1.053	1.081	1.015	1.107
IDS	1.563	1.139	1.527	1.079	1.053	1.081	1.015	1.107
SD	1.554	1.132	1.522	1.080	1.056	1.081	1.014	1.099
Downsidebeta	1.552	1.129	1.520	1.080	1.056	1.081	1.014	1.096
LPM	1.554	1.132	1.522	1.080	1.056	1.081	1.014	1.099
Tailbeta	1.552	1.129	1.520	1.080	1.056	1.081	1.014	1.096
VaR	1.563	1.139	1.527	1.079	1.053	1.081	1.015	1.107
ES	1.563	1.139	1.527	1.079	1.053	1.081	1.015	1.107

	E	Policy reduciton	Size	MTB	ROA	Lev	Liq	High environmental impact
Beta	2.219	1.702	1.527	1.079	1.059	1.081	1.015	1.021
IDS	2.219	1.702	1.527	1.079	1.059	1.081	1.015	1.021
SD	2.209	1.701	1.521	1.079	1.063	1.081	1.014	1.020
Downsidebeta	2.208	1.703	1.520	1.079	1.064	1.081	1.014	1.020
LPM	2.209	1.701	1.521	1.079	1.063	1.081	1.014	1.020
Tailbeta	2.208	1.703	1.520	1.079	1.064	1.081	1.014	1.020
VaR	2.219	1.702	1.527	1.079	1.059	1.081	1.015	1.021
ES	2.219	1.702	1.527	1.079	1.059	1.081	1.015	1.021

PANEL D

	E	BioConcern	Size	MTB	ROA	Lev	Liq	High reputational impact
Beta	1.567	1.070	1.524	1.079	1.050	1.081	1.009	1.106
IDS	1.567	1.070	1.524	1.079	1.050	1.081	1.009	1.106
SD	1.556	1.068	1.518	1.079	1.053	1.081	1.009	1.102
Downsidebeta	1.555	1.068	1.517	1.079	1.054	1.081	1.009	1.101
LPM	1.556	1.068	1.518	1.079	1.053	1.081	1.009	1.102
Tailbeta	1.555	1.068	1.517	1.079	1.054	1.081	1.009	1.101
VaR	1.567	1.070	1.524	1.079	1.050	1.081	1.009	1.106
ES	1.567	1.070	1.524	1.079	1.050	1.081	1.009	1.106

	E	BioRegulation	Size	MTB	ROA	Lev	Liq	High reputational impact
Beta	1.566	1.073	1.524	1.079	1.050	1.081	1.007	1.112
IDS	1.566	1.073	1.524	1.079	1.050	1.081	1.007	1.112
SD	1.556	1.071	1.518	1.079	1.053	1.081	1.007	1.108
Downsidebeta	1.555	1.071	1.517	1.079	1.054	1.081	1.007	1.107
LPM	1.556	1.071	1.518	1.079	1.053	1.081	1.007	1.108
Tailbeta	1.555	1.071	1.517	1.079	1.054	1.081	1.007	1.107
VaR	1.566	1.073	1.524	1.079	1.050	1.081	1.007	1.112
ES	1.566	1.073	1.524	1.079	1.050	1.081	1.007	1.112

	E	Land imapct	Size	MTB	ROA	Lev	Liq	High reputational impact
Beta	1.586	1.117	1.526	1.079	1.052	1.080	1.006	1.114
IDS	1.586	1.117	1.526	1.079	1.052	1.080	1.006	1.114
SD	1.575	1.113	1.520	1.080	1.055	1.080	1.006	1.108
Downsidebeta	1.574	1.112	1.519	1.080	1.056	1.080	1.006	1.107
LPM	1.575	1.113	1.520	1.080	1.055	1.080	1.006	1.108
Tailbeta	1.574	1.112	1.519	1.080	1.056	1.080	1.006	1.107
VaR	1.586	1.117	1.526	1.079	1.052	1.080	1.006	1.114
ES	1.586	1.117	1.526	1.079	1.052	1.080	1.006	1.114

	E	Policy reduciton	Size	MTB	ROA	Lev	Liq	High reputational impact
Beta	2.235	1.708	1.525	1.079	1.057	1.080	1.006	1.050
IDS	2.235	1.708	1.525	1.079	1.057	1.080	1.006	1.050
SD	2.224	1.706	1.519	1.079	1.062	1.080	1.006	1.048
Downsidebeta	2.223	1.708	1.518	1.079	1.062	1.080	1.006	1.048
LPM	2.224	1.706	1.519	1.079	1.062	1.080	1.006	1.048
Tailbeta	2.223	1.708	1.518	1.079	1.062	1.080	1.006	1.048
VaR	2.235	1.708	1.525	1.079	1.057	1.080	1.006	1.050
ES	2.235	1.708	1.525	1.079	1.057	1.080	1.006	1.050

This table reports the variance inflation factor for all the risk measures and the E score, and for each of the independent variable of interest. Each of the panel corresponds to the unique control variable that changes in the models (that is, High depdendency, High biodiversity impact, Higher environmental impact, and High reputational impact, respectively). With an unbalanced panel of 1993 US firms and a period of 12 years (2010-2022). All variables are standardized, and data are annual and winsorized at 5%. Beta is systematic risk. IDS is idiosyncratic risk. SD total risk. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the average market excess return during the past year. LPM (lower partial moment) measures losses relative to the mean of stock's return distribution during the past year and ignores gains exceeding such a point. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. VaR is how much the value of an investment declines with a probability of 5%. ES (Expected Shortfall) is the expected return on the portfolio in the worst 5% of cases. BioConcern is a dummy variable that takes value 1 when the 10K statement of firm mentions biodiversity-related terms, and 0 otherwise. BioRegulation is a variable that takes value 1 when the 10K statement of the firms show at least one sentence related to regulation risk, and 0 otherwise. Land impact is a dummy variable that takes value 1 when the firm reports on initiatives to reduce the environmental impact on land owned, leased or managed for production activities, and 0 otherwise. Policy reduction is a dummy variable that thakes value 1 when the firm has a policy for reducing the use of natural resources or to lessen the environmental impact, and 0 otherwise. E is the Thomson Reuters environmetnal score, that takes value 0-100. Size is the size of the firm, calculated as the log of the total assets. 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. High dependency takes the value of 1 when a firm belongs to an industry with an average dependency indicator of 4 or 5 (classified as high or very high dependency according to WWF standards), and 0 otherwise. High biodiversity impact takes the value of 1 when a firm operates in an industry with an average biodiversity impact indicator of 4 or 5, and 0 otherwise. High environmental impact is defined as 1 when a firm's environmental impact indicator is above the industry average, and 0 otherwise. High reputational impact takes the value of 1 when a firm belongs to an industry with a reputational impact indicator of 4 or 5, and 0 otherwise.

Appendix III: Extended tables

Table 1: Biodiversity impact: firms' biodiversity concerns I

	Beta	*IDS*	*SD*	*Downsidebeta*	*LPM*	*Tailbeta*	*VaR*	*ES*
Intercept	0.141*	0.025	0.036	0.130*	0.044	0.053**	0.017	0.029
	(0.066)	(0.117)	(0.148)	(0.053)	(0.147)	(0.017)	(0.165)	(0.169)
E	-0.003	-0.023**	-0.008	-0.011	-0.008	-0.018	-0.027***	-0.015*
	(0.010)	(0.008)	(0.008)	(0.010)	(0.008)	(0.011)	(0.008)	(0.008)
BioConcern	-0.006	0.068***	0.052***	-0.012	0.050***	-0.019*	0.066***	0.049***
	(0.008)	(0.007)	(0.007)	(0.008)	(0.007)	(0.009)	(0.006)	(0.006)
size	-0.168***	-0.317***	-0.285***	-0.092***	-0.266***	-0.030**	-0.248***	-0.253***
	(0.010)	(0.008)	(0.008)	(0.010)	(0.008)	(0.011)	(0.008)	(0.008)
MTB	0.016*	0.005	0.007	0.013+	0.006	0.002	0.003	0.006
	(0.007)	(0.006)	(0.006)	(0.007)	(0.006)	(0.008)	(0.006)	(0.006)
ROA	-0.163***	-0.307***	-0.261***	-0.107***	-0.230***	-0.035***	-0.257***	-0.236***
	(0.009)	(0.007)	(0.007)	(0.009)	(0.007)	(0.010)	(0.007)	(0.007)
Lev	0.000	0.001	0.002	0.000	0.001	0.003	0.004	0.002
	(0.008)	(0.006)	(0.006)	(0.008)	(0.006)	(0.008)	(0.006)	(0.006)
Liq	2.581***	4.990***	4.210***	2.310***	5.186***	0.302	4.044***	4.621***
	(0.565)	(0.461)	(0.454)	(0.579)	(0.469)	(0.620)	(0.439)	(0.438)
ExBioConcern	-0.024**	-0.020**	-0.016*	-0.01	-0.014*	0.005	-0.021**	-0.014*
	(0.008)	(0.007)	(0.007)	(0.008)	(0.007)	(0.009)	(0.006)	(0.006)
Dependency high	-0.661***	-0.213***	-0.308***	-0.573***	-0.285***	-0.195***	-0.299***	-0.269***
	(0.023)	(0.019)	(0.019)	(0.024)	(0.019)	(0.025)	(0.018)	(0.018)
Model	RE	RE	RE	RE	RE	RE	RE	RE
Num.Obs.	13182	13182	13642	13687	13642	13687	13182	13182
R2	0.131	0.292	0.252	0.076	0.212	0.01	0.246	0.228
AIC	35102.5	29749.6	30377.7	37129.9	31239	39014.9	28450.4	28402.5

This table reports the panel regression results regarding the impact of biodiversity-related terms on firm risk for a set of 1993 US firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5% and winsorized at 5%. Independent variables are lagged by one year. Beta and IDS are the systematic and idiosyncratic risks, estimated form the CAPM; SD is the total risk. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the average market excess return during the past year. LPM measures losses relative to a reference point and ignores gains exceeding such a reference point. To this case, LPM is equivalent to the semivariance, as the reference point is the mean of stock's return distribution. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. VaR measures how much the value of an investment declines over a given time period with a given probability (5%). The ES is the expected return on the portfolio in the worst q % of cases (5%). E is the Thomson Reuters Environmental scores, that takes values 0 to 100. BioConcern is a dummy variable that takes value 1 when the 10K statement of firm mentions biodiversity-related terms, and 0 otherwise. Size is the size of the firm, calculated as the log of the total assets. 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. ExBioConcern is the interaction variable between the Environmental pillar score and the BioConcern dummy variable. Dependency high is a dummy variable that takes value 1 when the intensity of WWF Biodiversity risk filter for resources Dependency is above the 75% of the whole distribution, and 0 otherwise. 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 2: Biodiversity impactx firms' biodiversity concerns II

	Beta	*IDS*	*SD*	*Downsidebeta*	*LPM*	*Tailbeta*	*VaR*	*ES*
Intercept	0.054	-0.038	-0.025	0.067	-0.013	0.050**	-0.057	-0.033
	(0.064)	(0.118)	(0.149)	(0.052)	(0.148)	(0.017)	(0.167)	(0.170)
E	-0.045***	-0.048***	-0.034***	-0.043***	-0.033***	-0.023*	-0.058***	-0.041***
	(0.010)	(0.008)	(0.008)	(0.010)	(0.008)	(0.011)	(0.008)	(0.008)
BioConcern	-0.032***	0.050***	0.034***	-0.031***	0.033***	-0.021*	0.045***	0.031***
	(0.009)	(0.007)	(0.007)	(0.009)	(0.01)	(0.009)	(0.007)	(0.007)
size	-0.163***	-0.311***	-0.280***	-0.090***	-0.262***	-0.031**	-0.241***	-0.247***
	(0.011)	(0.008)	(0.008)	(0.010)	(0.008)	(0.011)	(0.008)	(0.008)
MTB	0.019*	0.006	0.008	0.015*	0.007	0.003	0.005	0.007
	(0.008)	(0.006)	(0.006)	(0.008)	(0.006)	(0.008)	(0.006)	(0.006)
ROA	-0.169***	-0.310***	-0.265***	-0.112***	-0.233***	-0.036***	-0.262***	-0.239***
	(0.009)	(0.007)	(0.007)	(0.009)	(0.007)	(0.010)	(0.007)	(0.007)
Lev	-0.002	0.002	0.002	-0.003	0.001	0.002	0.005	0.003
	(0.008)	(0.006)	(0.006)	(0.008)	(0.006)	(0.008)	(0.006)	(0.006)
Liq	2.864***	4.761***	4.146***	2.648***	5.118***	0.586	3.857***	4.501***
	(0.583)	(0.463)	(0.459)	(0.592)	(0.473)	(0.622)	(0.443)	(0.442)
ExBioConcern	-0.040***	-0.020**	-0.022**	-0.026**	-0.019**	-0.002	-0.023***	-0.018**
	(0.009)	(0.007)	(0.007)	(0.009)	(0.007)	(0.009)	(0.006)	(0.006)
High biodiversity impact	-0.066**	0.184***	0.094***	-0.120***	0.093***	-0.149***	0.173***	0.125***
	(0.024)	(0.019)	(0.018)	(0.024)	(0.019)	(0.025)	(0.018)	(0.018)
Model	RE	RE	RE	RE	RE	RE	RE	RE
Num.Obs.	13182	13182	13642	13687	13642	13687	13182	13182
R2	0.079	0.29	0.239	0.038	0.201	0.008	0.236	0.218
AIC	35879.3	29779.3	30626.2	37682.4	31435.4	39038.7	28630.8	28575.8

This table reports the panel regression results regarding the impact of biodiversity-related terms on firm risk for a set of 1993 US firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5% and winsorized at 5%. Independent variables are lagged by one year. Beta and IDS are the systematic and idiosyncratic risks, estimated form the CAPM; SD is the total risk. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the average market excess return during the past year. LPM measures losses relative to a reference point and ignores gains exceeding such a reference point. To this case, LPM is equivalent to the semivariance, as the reference point is the mean of stock's return distribution. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. VaR measures how much the value of an investment declines over a given time period with a given probability (5%). The ES is the expected return on the portfolio in the worst q % of cases (5%). E is the Thomson Reuters Environmental scores, that takes values 0 to 100. BioConcern is a dummy variable that takes value 1 when the 10K statement of firm mentions biodiversity-related terms, and 0 otherwise. Size is the size of the firm, calculated as the log of the total assets. 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. ExBioConcern is the interaction variable between the Environmental pillar score and the BioConcern dummy variable. High biodiversity impact is a dummy variable that takes value 1 when the intensity of WWF Biodiversity risk filter for impact on biodiversity factors is above the 75% of the whole distribution, and 0 otherwise. 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 3: Biodiversity impact: firms' biodiversity concerns III

	Beta	*IDS*	*SD*	*Downsidebeta*	*LPM*	*Tailbeta*	*VaR*	*ES*
Intercept	0.008	-0.049	-0.046	0.026	-0.032	0.030+	-0.076	-0.049
	(0.065)	(0.118)	(0.149)	(0.051)	(0.148)	(0.016)	(0.166)	(0.170)
E	-0.050***	-0.039***	-0.030***	-0.050***	-0.028***	-0.030**	-0.050***	-0.035***
	(0.010)	(0.008)	(0.008)	(0.010)	(0.008)	(0.011)	(0.008)	(0.008)
BioConcern	-0.059***	0.028***	0.013+	-0.051***	0.013+	-0.024**	0.018**	0.009
	(0.009)	(0.007)	(0.007)	(0.009)	(0.007)	(0.009)	(0.006)	(0.007)
size	-0.166***	-0.321***	-0.288***	-0.090***	-0.269***	-0.027*	-0.252***	-0.256***
	(0.010)	(0.008)	(0.008)	(0.010)	(0.008)	(0.011)	(0.008)	(0.008)
MTB	0.018*	0.005	0.007	0.015+	0.006	0.003	0.003	0.006
	(0.007)	(0.006)	(0.006)	(0.008)	(0.006)	(0.008)	(0.006)	(0.006)
ROA	-0.164***	-0.302***	-0.259***	-0.110***	-0.228***	-0.038***	-0.253***	-0.232***
	(0.009)	(0.007)	(0.007)	(0.009)	(0.007)	(0.010)	(0.007)	(0.007)
Lev	0.002	0.005	0.005	0.000	0.003	0.002	0.008	0.006
	(0.008)	(0.006)	(0.006)	(0.008)	(0.006)	(0.008)	(0.006)	(0.006)
Liq	2.013***	4.109***	3.491***	2.008***	4.492***	0.475	3.067***	3.860***
	(0.581)	(0.458)	(0.455)	(0.593)	(0.470)	(0.624)	(0.435)	(0.438)
ExBioConcern	-0.028***	-0.011	-0.012+	-0.017*	-0.01	-0.001	-0.012+	-0.008
	(0.008)	(0.007)	(0.007)	(0.009)	(0.007)	(0.009)	(0.006)	(0.006)
High environmental impact	0.523***	0.657***	0.558***	0.316***	0.536***	-0.085*	0.740***	0.584***
	(0.039)	(0.031)	(0.030)	(0.039)	(0.031)	(0.041)	(0.029)	(0.030)
Model	RE	RE	RE	RE	RE	RE	RE	RE
Num.Obs.	13182	13182	13642	13687	13642	13687	13182	13182
R2	0.09	0.308	0.256	0.041	0.216	0.006	0.266	0.238
AIC	35711.3	29432.4	30313.2	37642.3	31165.3	39070.7	28104.9	28240.9

This table reports the panel regression results regarding the impact of biodiversity-related terms on firm risk for a set of 1993 US firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Beta and IDS are the systematic and idiosyncratic risks, estimated form the CAPM; SD is the total risk. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the average market excess return during the past year. LPM measures losses relative to a reference point and ignores gains exceeding such a reference point. To this case, LPM is equivalent to the semivariance, as the reference point is the mean of stock's return distribution. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. VaR measures how much the value of an investment declines over a given time period with a given probability (5%). The ES is the expected return on the portfolio in the worst q % of cases (5%). E is the Thomson Reuters Environmental scores, that takes values 0 to 100. BioConcern is a dummy variable that takes value 1 when the 10K statement of firm mentions biodiversity-related terms, and 0 otherwise. Size is the size of the firm, calculated as the log of the total assets. 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. ExBioConcern is the interaction variable between the Environmental pillar score and the BioConcern dummy variable. High environmental impact is a dummy variable that takes value 1 when the intensity of WWF Biodiversity risk filter for impact on environmental factors is above the 75% of the whole distribution, and 0 otherwise. 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 4: Biodiversity impact: firms' biodiversity concerns IV

	Beta	*IDS*	*SD*	*Downsidebeta*	*LPM*	*Tailbeta*	*VaR*	*ES*
Intercept	0.126+	-0.011	0.008	0.125*	0.017	0.064***	-0.023	-0.002
	(0.065)	(0.118)	(0.148)	(0.052)	(0.147)	(0.017)	(0.166)	(0.170)
E	-0.021*	-0.040***	-0.023**	-0.024*	-0.023**	-0.018+	-0.047***	-0.031***
	(0.010)	(0.008)	(0.008)	(0.010)	(0.008)	(0.011)	(0.008)	(0.008)
BioConcern	0.000	0.057***	0.046***	-0.003	0.044***	-0.011	0.055***	0.041***
	(0.009)	(0.007)	(0.007)	(0.009)	(0.007)	(0.009)	(0.007)	(0.007)
size	-0.161***	-0.315***	-0.282***	-0.087***	-0.263***	-0.028*	-0.245***	-0.250***
	(0.010)	(0.008)	(0.008)	(0.010)	(0.008)	(0.011)	(0.008)	(0.008)
MTB	0.018*	0.006	0.008	0.014+	0.007	0.002	0.004	0.007
	(0.007)	(0.006)	(0.006)	(0.008)	(0.006)	(0.008)	(0.006)	(0.006)
ROA	-0.169***	-0.309***	-0.264***	-0.113***	-0.232***	-0.037***	-0.260***	-0.238***
	(0.009)	(0.007)	(0.007)	(0.009)	(0.007)	(0.010)	(0.007)	(0.007)
Lev	-0.003	0.000	0.001	-0.003	0.000	0.002	0.003	0.002
	(0.008)	(0.006)	(0.006)	(0.008)	(0.006)	(0.008)	(0.006)	(0.006)
Liq	3.210***	5.021***	4.387***	2.894***	5.342***	0.571	4.152***	4.748***
	(0.576)	(0.464)	(0.459)	(0.586)	(0.473)	(0.621)	(0.444)	(0.442)
ExBioConcern	-0.038***	-0.024***	-0.023***	-0.022**	-0.020**	0.001	-0.027***	-0.020**
	(0.008)	(0.007)	(0.007)	(0.008)	(0.007)	(0.009)	(0.006)	(0.006)
High reputational impact	-0.388***	0.023	-0.081***	-0.370***	-0.069***	-0.186***	-0.023	-0.046**
	(0.022)	(0.017)	(0.017)	(0.022)	(0.017)	(0.023)	(0.017)	(0.017)
Model	RE	RE	RE	RE	RE	RE	RE	RE
Num.Obs.	13182	13182	13642	13687	13642	13687	13182	13182
R2	0.100	0.285	0.239	0.056	0.2	0.01	0.231	0.216
AIC	35565.6	29872.5	30629.1	37415.9	31443.8	39008.3	28719.9	28615.9

This table reports the panel regression results regarding the impact of biodiversity-related terms on firm risk for a set of 1993 US firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Beta and IDS are the systematic and idiosyncratic risks, estimated form the CAPM; SD is the total risk. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the average market excess return during the past year. LPM measures losses relative to a reference point and ignores gains exceeding such a reference point. To this case, LPM is equivalent to the semivariance, as the reference point is the mean of stock's return distribution. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. VaR measures how much the value of an investment declines over a given time period with a given probability (5%). The ES is the expected return on the portfolio in the worst q % of cases (5%). E is the Thomson Reuters Environmental scores, that takes values 0 to 100. BioConcern is a dummy variable that takes value 1 when the 10K statement of firm mentions biodiversity-related terms, and 0 otherwise. Size is the size of the firm, calculated as the log of the total assets. 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. ExBioConcern is the interaction variable between the Environmental pillar score and the BioConcern dummy variable. High reputational impact is a dummy variable that takes value 1 when the intensity of WWF Biodiversity risk filter for impact on reputational factors is above the 75% of the whole distribution, and 0 otherwise. 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 5: Biodiversity impact: firms' BioRegulation concerns I

	Beta	*IDS*	*SD*	*Downsidebeta*	*LPM*	*Tailbeta*	*VaR*	*ES*
Intercept	0.140*	0.026	0.036	0.130*	0.045	0.053**	0.017	0.029
	(0.066)	(0.117)	(0.148)	(0.053)	(0.147)	(0.017)	(0.165)	(0.169)
E	-0.004	-0.022**	-0.007	-0.012	-0.008	-0.018+	-0.027***	-0.015+
	(0.010)	(0.008)	(0.008)	(0.010)	(0.008)	(0.011)	(0.008)	(0.008)
BioRegulation	0.007	0.069***	0.053***	-0.003	0.054***	-0.015+	0.074***	0.055***
	(0.008)	(0.007)	(0.007)	(0.008)	(0.007)	(0.009)	(0.007)	(0.007)
size	-0.169***	-0.318***	-0.285***	-0.092***	-0.267***	-0.030**	-0.249***	-0.253***
	(0.010)	(0.008)	(0.008)	(0.010)	(0.008)	(0.011)	(0.008)	(0.008)
MTB	0.016*	0.005	0.007	0.013+	0.006	0.002	0.003	0.006
	(0.007)	(0.006)	(0.006)	(0.007)	(0.006)	(0.008)	(0.006)	(0.006)
ROA	-0.164***	-0.307***	-0.262***	-0.108***	-0.230***	-0.036***	-0.258***	-0.236***
	(0.009)	(0.007)	(0.007)	(0.009)	(0.007)	(0.010)	(0.007)	(0.007)
Lev	-0.001	0.001	0.002	-0.001	0.001	0.003	0.004	0.002
	(0.008)	(0.006)	(0.006)	(0.008)	(0.006)	(0.008)	(0.006)	(0.006)
Liq	2.409***	5.015***	4.217***	2.189***	5.180***	0.265	4.019***	4.600***
	(0.565)	(0.461)	(0.454)	(0.579)	(0.469)	(0.621)	(0.439)	(0.438)
ExBioRegulation	-0.043***	-0.018**	-0.017*	-0.029***	-0.018**	-0.001	-0.026***	-0.020**
	(0.009)	(0.007)	(0.007)	(0.009)	(0.007)	(0.009)	(0.007)	(0.007)
Dependency high	-0.663***	-0.212***	-0.308***	-0.572***	-0.284***	-0.195***	-0.300***	-0.269***
	(0.023)	(0.019)	(0.018)	(0.024)	(0.019)	(0.025)	(0.018)	(0.018)
Model	RE	RE	RE	RE	RE	RE	RE	RE
Num.Obs.	13182	13182	13642	13687	13642	13687	13182	13182
R2	0.132	0.292	0.253	0.076	0.213	0.01	0.248	0.229
AIC	35088.1	29747.9	30375.4	37121.3	31230.9	39016.1	28423.5	28387.6

This table reports the panel regression results regarding the impact of biodiversity-related terms on firm risk for a set of 1993 US firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Beta and IDS are the systematic and idiosyncratic risks, estimated form the CAPM; SD is the total risk. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the average market excess return during the past year. LPM measures losses relative to a reference point and ignores gains exceeding such a reference point. To this case, LPM is equivalent to the semivariance, as the reference point is the mean of stock's return distribution. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. VaR measures how much the value of an investment declines over a given time period with a given probability (5%). The ES is the expected return on the portfolio in the worst q % of cases (5%). E is the Thomson Reuters Environmental scores, that takes values 0 to 100. BioRegulation dummy variable that takes value 1 if the 10-K statement of a company contains at least two biodiversity risk sentences and at least one of them is a biodiversity BioRegulation risk sentence, and 0 otherwise. Size is the size of the firm, calculated as the log of the total assets. 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. ExBioRegulation is the interaction variable between the Environmental pillar score and the BioRegulation dummy variable. Dependency high is a dummy variable that takes value 1 when the intensity of WWF Biodiversity risk filter for resources Dependency is above the 75% of the whole distribution, and 0 otherwise. 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: Biodiversity impact: firms' BioRegulation concerns II

	Beta	*IDS*	*SD*	*Downsidebeta*	*LPM*	*Tailbeta*	*VaR*	*ES*
Intercept	0.052	-0.038	-0.025	0.067	-0.013	0.050**	-0.057	-0.032
	(0.064)	(0.118)	(0.149)	(0.051)	(0.148)	(0.017)	(0.167)	(0.170)
E	-0.046***	-0.047***	-0.033***	-0.044***	-0.032***	-0.023*	-0.057***	-0.040***
	(0.010)	(0.008)	(0.008)	(0.010)	(0.008)	(0.011)	(0.008)	(0.008)
BioRegulation	-0.016+	0.051***	0.036***	-0.019*	0.037***	-0.015+	0.053***	0.037***
	(0.009)	(0.007)	(0.007)	(0.009)	(0.007)	(0.009)	(0.007)	(0.007)
size	-0.163***	-0.312***	-0.281***	-0.090***	-0.262***	-0.031**	-0.242***	-0.248***
	(0.011)	(0.008)	(0.008)	(0.010)	(0.008)	(0.011)	(0.008)	(0.008)
MTB	0.019*	0.006	0.008	0.015*	0.007	0.003	0.005	0.007
	(0.008)	(0.006)	(0.006)	(0.008)	(0.006)	(0.008)	(0.006)	(0.006)
ROA	-0.169***	-0.310***	-0.265***	-0.112***	-0.233***	-0.036***	-0.262***	-0.239***
	(0.009)	(0.007)	(0.007)	(0.009)	(0.007)	(0.010)	(0.007)	(0.007)
Lev	-0.003	0.002	0.002	-0.004	0.000	0.001	0.005	0.002
	(0.008)	(0.006)	(0.006)	(0.008)	(0.006)	(0.008)	(0.006)	(0.006)
Liq	2.618***	4.773***	4.123***	2.458***	5.086***	0.52	3.813***	4.459***
	(0.583)	(0.463)	(0.459)	(0.592)	(0.473)	(0.622)	(0.443)	(0.442)
ExBioRegulation	-0.058***	-0.017*	-0.021**	-0.044***	-0.022**	-0.009	-0.027***	-0.022***
	(0.009)	(0.007)	(0.007)	(0.009)	(0.007)	(0.009)	(0.007)	(0.007)
High biodiversity impact	-0.073**	0.182***	0.091***	-0.125***	0.089***	-0.151***	0.167***	0.120***
	(0.024)	(0.019)	(0.019)	(0.024)	(0.019)	(0.025)	(0.018)	(0.018)
Model	RE	RE	RE	RE	RE	RE	RE	RE
Num.Obs.	13182	13182	13642	13687	13642	13687	13182	13182
R2	0.079	0.29	0.239	0.038	0.201	0.008	0.237	0.219
AIC	35870.3	29780.5	30625.2	37673	31429.6	39038.8	28613.4	28565.5

This table reports the panel regression results regarding the impact of biodiversity-related terms on firm risk for a set of 1993 US firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Beta and IDS are the systematic and idiosyncratic risks, estimated form the CAPM; SD is the total risk. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the average market excess return during the past year. LPM measures losses relative to a reference point and ignores gains exceeding such a reference point. To this case, LPM is equivalent to the semivariance, as the reference point is the mean of stock's return distribution. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. VaR measures how much the value of an investment declines over a given time period with a given probability (5%). The ES is the expected return on the portfolio in the worst q % of cases (5%). E is the Thomson Reuters Environmental scores, that takes values 0 to 100. BioRegulation dummy variable that takes value 1 if the 10-K statement of a company contains at least two biodiversity risk sentences and at least one of them is a biodiversity BioRegulation risk sentence, and 0 otherwise. Size is the size of the firm, calculated as the log of the total assets. 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. ExBioRegulation is the interaction variable between the Environmental pillar score and the BioRegulation dummy variable. High biodiversity impact is a dummy variable that takes value 1 when the intensity of WWF Biodiversity risk filter for impact on biodiversity factors is above the 75% of the whole distribution, and 0 otherwise.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 7: Biodiversity impact: firms' BioRegulation concerns III

	Beta	*IDS*	*SD*	*Downsidebeta*	*LPM*	*Tailbeta*	*VaR*	*ES*
Intercept	0.006	-0.049	-0.046	0.024	-0.032	0.030+	-0.076	-0.049
	(0.065)	(0.118)	(0.149)	(0.051)	(0.148)	(0.016)	(0.166)	(0.170)
E	-0.051***	-0.039***	-0.029***	-0.051***	-0.028***	-0.031**	-0.050***	-0.035***
	(0.010)	(0.008)	(0.008)	(0.010)	(0.008)	(0.011)	(0.008)	(0.008)
BioRegulation	-0.049***	0.024***	0.01	-0.043***	0.013+	-0.019*	0.021**	0.012+
	(0.009)	(0.007)	(0.007)	(0.009)	(0.007)	(0.009)	(0.007)	(0.007)
size	-0.166***	-0.322***	-0.288***	-0.090***	-0.269***	-0.027*	-0.253***	-0.256***
	(0.010)	(0.008)	(0.008)	(0.010)	(0.008)	(0.011)	(0.008)	(0.008)
MTB	0.018*	0.005	0.007	0.015+	0.006	0.003	0.003	0.006
	(0.007)	(0.006)	(0.006)	(0.008)	(0.006)	(0.008)	(0.006)	(0.006)
ROA	-0.165***	-0.302***	-0.259***	-0.110***	-0.228***	-0.038***	-0.253***	-0.233***
	(0.009)	(0.007)	(0.007)	(0.009)	(0.007)	(0.010)	(0.007)	(0.007)
Lev	0.000	0.005	0.005	-0.001	0.003	0.002	0.008	0.005
	(0.008)	(0.006)	(0.006)	(0.008)	(0.006)	(0.008)	(0.006)	(0.006)
Liq	1.779**	4.130***	3.478***	1.827**	4.474***	0.413	3.041***	3.832***
	(0.581)	(0.458)	(0.455)	(0.593)	(0.470)	(0.625)	(0.435)	(0.438)
ExBioRegulation	-0.045***	-0.009	-0.012+	-0.034***	-0.013+	-0.007	-0.016*	-0.014*
	(0.009)	(0.007)	(0.007)	(0.009)	(0.007)	(0.009)	(0.007)	(0.007)
High environmental impact	0.523***	0.657***	0.560***	0.317***	0.534***	-0.086*	0.734***	0.580***
	(0.040)	(0.031)	(0.030)	(0.039)	(0.031)	(0.041)	(0.030)	(0.030)
Model	RE	RE	RE	RE	RE	RE	RE	RE
Num.Obs.	13182	13182	13642	13687	13642	13687	13182	13182
R2	0.091	0.308	0.256	0.041	0.216	0.006	0.266	0.238
AIC	35706.5	29437.4	30314.6	37635.3	31164.5	39072.2	28101.2	28238.2

This table reports the panel regression results regarding the impact of biodiversity-related terms on firm risk for a set of 1993 US firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Beta and IDS are the systematic and idiosyncratic risks, estimated form the CAPM; SD is the total risk. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the average market excess return during the past year. LPM measures losses relative to a reference point and ignores gains exceeding such a reference point. To this case, LPM is equivalent to the semivariance, as the reference point is the mean of stock's return distribution. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. VaR measures how much the value of an investment declines over a given time period with a given probability (5%). The ES is the expected return on the portfolio in the worst q % of cases (5%). E is the Thomson Reuters Environmental scores, that takes values 0 to 100. BioRegulation dummy variable that takes value 1 if the 10-K statement of a company contains at least two biodiversity risk sentences and at least one of them is a biodiversity BioRegulation risk sentence, and 0 otherwise. Size is the size of the firm, calculated as the log of the total assets. 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. ExBioRegulation is the interaction variable between the Environmental pillar score and the BioRegulation dummy variable. High environmental impact is a dummy variable that takes value 1 when the intensity of WWF Biodiversity risk filter for impact on environmental factors is above the 75% of the whole distribution, and 0 otherwise.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 8: Biodiversity impact: firms' BioRegulation concerns IV

	Beta	*IDS*	*SD*	*Downsidebeta*	*LPM*	*Tailbeta*	*VaR*	*ES*
Intercept	0.126+	-0.011	0.008	0.125*	0.018	0.064***	-0.022	-0.001
	(0.065)	(0.118)	(0.148)	(0.052)	(0.147)	(0.017)	(0.166)	(0.170)
E	-0.021*	-0.039***	-0.023**	-0.024*	-0.022**	-0.018+	-0.046***	-0.030***
	(0.010)	(0.008)	(0.008)	(0.010)	(0.008)	(0.011)	(0.008)	(0.008)
BioRegulation	0.018*	0.059***	0.049***	0.009	0.049***	-0.006	0.065***	0.049***
	(0.009)	(0.007)	(0.007)	(0.009)	(0.007)	(0.009)	(0.007)	(0.007)
size	-0.162***	-0.316***	-0.283***	-0.087***	-0.264***	-0.028*	-0.246***	-0.251***
	(0.010)	(0.008)	(0.008)	(0.010)	(0.008)	(0.011)	(0.008)	(0.008)
MTB	0.018*	0.006	0.008	0.015+	0.007	0.002	0.004	0.007
	(0.007)	(0.006)	(0.006)	(0.008)	(0.006)	(0.008)	(0.006)	(0.006)
ROA	-0.170***	-0.309***	-0.264***	-0.114***	-0.233***	-0.037***	-0.261***	-0.239***
	(0.009)	(0.007)	(0.007)	(0.009)	(0.007)	(0.010)	(0.007)	(0.007)
Lev	-0.004	0.001	0.001	-0.004	-0.001	0.002	0.003	0.001
	(0.008)	(0.006)	(0.006)	(0.008)	(0.006)	(0.008)	(0.006)	(0.006)
Liq	3.002***	5.022***	4.366***	2.740***	5.312***	0.528	4.102***	4.704***
	(0.576)	(0.464)	(0.459)	(0.586)	(0.473)	(0.621)	(0.444)	(0.442)
ExBioRegulation	-0.056***	-0.022**	-0.024***	-0.041***	-0.024***	-0.005	-0.031***	-0.026***
	(0.009)	(0.007)	(0.007)	(0.009)	(0.007)	(0.009)	(0.007)	(0.007)
High reputational impact	-0.397***	0.02	-0.084***	-0.375***	-0.073***	-0.188***	-0.031+	-0.051**
	(0.022)	(0.017)	(0.017)	(0.022)	(0.017)	(0.023)	(0.017)	(0.017)
Model	RE	RE	RE	RE	RE	RE	RE	RE
Num.Obs.	13182	13182	13642	13687	13642	13687	13182	13182
R2	0.102	0.285	0.239	0.057	0.201	0.01	0.232	0.217
AIC	35545.9	29871	30624.9	37402.4	31434	39008.9	28694.5	28600

This table reports the panel regression results regarding the impact of biodiversity-related terms on firm risk for a set of 1993 US firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Beta and IDS are the systematic and idiosyncratic risks, estimated form the CAPM; SD is the total risk. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the average market excess return during the past year. LPM measures losses relative to a reference point and ignores gains exceeding such a reference point. To this case, LPM is equivalent to the semivariance, as the reference point is the mean of stock's return distribution. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. VaR measures how much the value of an investment declines over a given time period with a given probability (5%). The ES is the expected return on the portfolio in the worst q % of cases (5%). E is the Thomson Reuters Environmental scores, that takes values 0 to 100. BioRegulation dummy variable that takes value 1 if the 10-K statement of a company contains at least two biodiversity risk sentences and at least one of them is a biodiversity BioRegulation risk sentence, and 0 otherwise.Size is the size of the firm, calculated as the log of the total assets. 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. ExBioConcern is the interaction variable between the Environmental pillar score and the BioRegulation dummy variable. High reputational impact is a dummy variable that takes value 1 when the intensity of WWF Biodiversity risk filter for impact on reputational factors is above the 75% of the whole distribution, and 0 otherwise. 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 9: Biodiversity impact: firms' reporting initiatives I

	Beta	*IDS*	*SD*	*Downsidebeta*	*LPM*	*Tailbeta*	*VaR*	*ES*
Intercept	0.146*	0.027	0.039	0.135*	0.048	0.052**	0.021	0.031
	(0.066)	(0.118)	(0.148)	(0.053)	(0.147)	(0.017)	(0.166)	(0.169)
E	-0.004	-0.032***	-0.015+	-0.011	-0.015+	-0.016	-0.036***	-0.022**
	(0.010)	(0.008)	(0.008)	(0.010)	(0.008)	(0.011)	(0.008)	(0.008)
Land impact	0.034**	0.079***	0.069***	0.02	0.070***	-0.013	0.087***	0.064***
	(0.012)	(0.010)	(0.010)	(0.012)	(0.010)	(0.013)	(0.010)	(0.009)
size	-0.168***	-0.319***	-0.287***	-0.092***	-0.268***	-0.029**	-0.250***	-0.255***
	(0.010)	(0.008)	(0.008)	(0.010)	(0.008)	(0.011)	(0.008)	(0.008)
MTB	0.016*	0.005	0.007	0.013+	0.006	0.002	0.003	0.006
	(0.007)	(0.006)	(0.006)	(0.007)	(0.006)	(0.008)	(0.006)	(0.006)
ROA	-0.164***	-0.306***	-0.261***	-0.110***	-0.230***	-0.037***	-0.256***	-0.235***
	(0.009)	(0.007)	(0.007)	(0.009)	(0.007)	(0.010)	(0.007)	(0.007)
Lev	0.002	0.000	0.001	0.001	0.000	0.003	0.003	0.002
	(0.008)	(0.006)	(0.006)	(0.008)	(0.006)	(0.008)	(0.006)	(0.006)
Liq	2.427***	5.171***	4.359***	2.202***	5.322***	0.162	4.217***	4.744***
	(0.565)	(0.461)	(0.454)	(0.579)	(0.469)	(0.621)	(0.438)	(0.438)
ExLand impact	-0.038***	-0.009	-0.017*	-0.024*	-0.018*	-0.002	-0.023**	-0.012
	(0.010)	(0.008)	(0.008)	(0.010)	(0.008)	(0.011)	(0.008)	(0.008)
Dependency high	-0.669***	-0.208***	-0.305***	-0.580***	-0.282***	-0.197***	-0.294***	-0.267***
	(0.023)	(0.019)	(0.018)	(0.023)	(0.019)	(0.025)	(0.018)	(0.018)
Model	RE	RE	RE	RE	RE	RE	RE	RE
Num.Obs.	13099	13099	13557	13602	13557	13602	13099	13099
R2	0.131	0.292	0.253	0.076	0.213	0.01	0.246	0.229
AIC	34890.9	29523.8	30196.2	36900.9	31040	38818.7	28236.4	28199

This table reports the panel regression results regarding the impact of biodiversity-related terms on firm risk for a set of 1993 US firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Beta and IDS are the systematic and idiosyncratic risks, estimated form the CAPM; SD is the total risk. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the average market excess return during the past year. LPM measures losses relative to a reference point and ignores gains exceeding such a reference point. To this case, LPM is equivalent to the semivariance, as the reference point is the mean of stock's return distribution. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. VaR measures how much the value of an investment declines over a given time period with a given probability (5%). The ES is the expected return on the portfolio in the worst q % of cases (5%). E is the Thomson Reuters Environmental scores, that takes values 0 to 100. Land impact is a dummy variable that takes value 1 when the firm reports on initiatives to reduce the environmental impact on land owned, leased or managed for production activities, and 0 otherwise. Size is the size of the firm, calculated as the log of the total assets. 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. ExLand impact is the interaction variable between the Environmental pillar score and the Land impact dummy variable. Dependency high is a dummy variable that takes value 1 when the intensity of WWF Biodiversity risk filter for resources Dependency is above the 75% of the whole distribution, and 0 otherwise. 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 10: Biodiversity impact: firms' reporting initiatives II

	Beta	*IDS*	*SD*	*Downsidebeta*	*LPM*	*Tailbeta*	*VaR*	*ES*
Intercept	0.056	-0.036	-0.021	0.07	-0.008	0.049**	-0.053	-0.03
	(0.064)	(0.119)	(0.149)	(0.051)	(0.148)	(0.017)	(0.167)	(0.170)
E	-0.045***	-0.054***	-0.039***	-0.043***	-0.037***	-0.022*	-0.063***	-0.045***
	(0.010)	(0.008)	(0.008)	(0.010)	(0.008)	(0.011)	(0.008)	(0.008)
Land impact	0.019	0.059***	0.054***	0.013	0.056***	-0.008	0.065***	0.047***
	(0.013)	(0.010)	(0.010)	(0.013)	(0.010)	(0.013)	(0.010)	(0.010)
size	-0.162***	-0.312***	-0.281***	-0.090***	-0.263***	-0.031**	-0.243***	-0.248***
	(0.011)	(0.008)	(0.008)	(0.011)	(0.008)	(0.011)	(0.008)	(0.008)
MTB	0.018*	0.006	0.008	0.015+	0.008	0.003	0.005	0.007
	(0.008)	(0.006)	(0.006)	(0.008)	(0.006)	(0.008)	(0.006)	(0.006)
ROA	-0.170***	-0.310***	-0.265***	-0.114***	-0.234***	-0.037***	-0.261***	-0.240***
	(0.009)	(0.007)	(0.007)	(0.009)	(0.007)	(0.010)	(0.007)	(0.007)
Lev	0.001	0.001	0.002	0.000	0.000	0.002	0.005	0.003
	(0.008)	(0.006)	(0.006)	(0.008)	(0.006)	(0.008)	(0.006)	(0.006)
Liq	2.559***	4.869***	4.214***	2.429***	5.180***	0.431	3.935***	4.545***
	(0.584)	(0.462)	(0.460)	(0.593)	(0.473)	(0.624)	(0.443)	(0.442)
ExLand impact	-0.045***	-0.009	-0.019*	-0.031**	-0.020*	-0.005	-0.024**	-0.013+
	(0.010)	(0.008)	(0.008)	(0.010)	(0.008)	(0.011)	(0.008)	(0.008)
High biodiversity impact	-0.067**	0.174***	0.086***	-0.123***	0.084***	-0.151***	0.164***	0.117***
	(0.024)	(0.019)	(0.019)	(0.024)	(0.019)	(0.025)	(0.018)	(0.018)
Model	RE	RE	RE	RE	RE	RE	RE	RE
Num.Obs.	13099	13099	13557	13602	13557	13602	13099	13099
R2	0.077	0.29	0.239	0.037	0.201	0.008	0.236	0.218
AIC	35693.2	29561.3	30446.2	37473.2	31238.7	38844.3	28421.8	28377.1

This table reports the panel regression results regarding the impact of biodiversity-related terms on firm risk for a set of 1993 US firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Beta and IDS are the systematic and idiosyncratic risks, estimated form the CAPM; SD is the total risk. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the average market excess return during the past year. LPM measures losses relative to a reference point and ignores gains exceeding such a reference point. To this case, LPM is equivalent to the semivariance, as the reference point is the mean of stock's return distribution. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. VaR measures how much the value of an investment declines over a given time period with a given probability (5%). The ES is the expected return on the portfolio in the worst q % of cases (5%). E is the Thomson Reuters Environmental scores, that takes values 0 to 100. Land impact is a dummy variable that takes value 1 when the firm reports on initiatives to reduce the environmental impact on land owned, leased or managed for production activities, and 0 otherwise. Size is the size of the firm, calculated as the log of the total assets. 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. ExLand impact is the interaction variable between the Environmental pillar score and the Land impact dummy variable. High biodiversity impact is a dummy variable that takes value 1 when the intensity of WWF Biodiversity risk filter for impact on biodiversity factors is above the 75% of the whole distribution, and 0 otherwise. 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 11: Biodiversity impact: firms' reporting initiatives III

	Beta	*IDS*	*SD*	*Downsidebeta*	*LPM*	*Tailbeta*	*VaR*	*ES*
Intercept	0.008	-0.049	-0.044	0.026	-0.03	0.029+	-0.074	-0.049
	(0.064)	(0.119)	(0.149)	(0.051)	(0.148)	(0.017)	(0.167)	(0.170)
E	-0.045***	-0.042***	-0.031***	-0.047***	-0.030***	-0.029**	-0.051***	-0.036***
	(0.010)	(0.008)	(0.008)	(0.010)	(0.008)	(0.011)	(0.008)	(0.008)
Land impact	-0.023+	0.030**	0.025*	-0.017	0.028**	-0.013	0.028**	0.017+
	(0.013)	(0.010)	(0.010)	(0.013)	(0.010)	(0.013)	(0.010)	(0.010)
size	-0.164***	-0.321***	-0.287***	-0.089***	-0.269***	-0.027*	-0.252***	-0.255***
	(0.011)	(0.008)	(0.008)	(0.011)	(0.008)	(0.011)	(0.008)	(0.008)
MTB	0.017*	0.005	0.007	0.014+	0.006	0.003	0.003	0.006
	(0.007)	(0.006)	(0.006)	(0.008)	(0.006)	(0.008)	(0.006)	(0.006)
ROA	-0.168***	-0.303***	-0.261***	-0.114***	-0.230***	-0.039***	-0.255***	-0.234***
	(0.009)	(0.007)	(0.007)	(0.009)	(0.007)	(0.010)	(0.007)	(0.007)
Lev	0.006	0.004	0.005	0.003	0.003	0.003	0.009	0.006
	(0.008)	(0.006)	(0.006)	(0.008)	(0.006)	(0.008)	(0.006)	(0.006)
Liq	1.559**	4.123***	3.463***	1.687**	4.467***	0.308	3.020***	3.809***
	(0.583)	(0.458)	(0.456)	(0.594)	(0.471)	(0.626)	(0.436)	(0.438)
ExLand impact	-0.042***	-0.009	-0.018*	-0.029**	-0.020*	-0.004	-0.023**	-0.012
	(0.010)	(0.008)	(0.008)	(0.010)	(0.008)	(0.011)	(0.007)	(0.008)
High environmental impact	0.543***	0.648***	0.556***	0.325***	0.530***	-0.088*	0.740***	0.579***
	(0.040)	(0.032)	(0.031)	(0.040)	(0.032)	(0.042)	(0.030)	(0.030)
Model	RE	RE	RE	RE	RE	RE	RE	RE
Num.Obs.	13099	13099	13557	13602	13557	13602	13099	13099
R2	0.089	0.308	0.255	0.039	0.216	0.005	0.265	0.237
AIC	35519.5	29231.5	30145.1	37433	30981.7	38876.1	27909.5	28056.7

This table reports the panel regression results regarding the impact of biodiversity-related terms on firm risk for a set of 1993 US firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Beta and IDS are the systematic and idiosyncratic risks, estimated form the CAPM; SD is the total risk. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the average market excess return during the past year. LPM measures losses relative to a reference point and ignores gains exceeding such a reference point. To this case, LPM is equivalent to the semivariance, as the reference point is the mean of stock's return distribution. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. VaR measures how much the value of an investment declines over a given time period with a given probability (5%). The ES is the expected return on the portfolio in the worst q % of cases (5%). E is the Thomson Reuters Environmental scores, that takes values 0 to 100. Land impact is a dummy variable that takes value 1 when the firm reports on initiatives to reduce the environmental impact on land owned, leased or managed for production activities, and 0 otherwise. Size is the size of the firm, calculated as the log of the total assets. 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. ExLand impact is the interaction variable between the Environmental pillar score and the Land impact dummy variable. High environmental impact is a dummy variable that takes value 1 when the intensity of WWF Biodiversity risk filter for impact on environmental factors is above the 75% of the whole distribution, and 0 otherwise. 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 13: Biodiversity impact: firms' use natural resources I

	Beta	*IDS*	*SD*	*Downsidebeta*	*LPM*	*Tailbeta*	*VaR*	*ES*
Intercept	0.174**	-0.024	-0.001	0.183***	0.009	0.065**	-0.008	-0.005
	(0.067)	(0.116)	(0.146)	(0.054)	(0.145)	(0.021)	(0.163)	(0.168)
E	0.006	-0.074***	-0.057***	0.040*	-0.057***	0.008	-0.056***	-0.056***
	(0.016)	(0.013)	(0.013)	(0.016)	(0.013)	(0.017)	(0.013)	(0.013)
Policy reduction	-0.003	0.071***	0.072***	-0.066***	0.072***	-0.039*	0.044**	0.060***
	(0.018)	(0.014)	(0.014)	(0.018)	(0.015)	(0.019)	(0.014)	(0.014)
size	-0.170***	-0.314***	-0.282***	-0.095***	-0.264***	-0.031**	-0.247***	-0.251***
	(0.010)	(0.008)	(0.008)	(0.010)	(0.008)	(0.011)	(0.008)	(0.008)
MTB	0.016*	0.005	0.007	0.013+	0.006	0.002	0.003	0.006
	(0.007)	(0.006)	(0.006)	(0.007)	(0.006)	(0.008)	(0.006)	(0.006)
ROA	-0.166***	-0.305***	-0.261***	-0.110***	-0.230***	-0.034***	-0.257***	-0.235***
	(0.009)	(0.007)	(0.007)	(0.009)	(0.007)	(0.010)	(0.007)	(0.007)
Lev	0.001	0.000	0.001	0.000	0.000	0.004	0.003	0.002
	(0.008)	(0.006)	(0.006)	(0.008)	(0.006)	(0.008)	(0.006)	(0.006)
Liq	2.598***	5.270***	4.437***	2.302***	5.407***	0.203	4.341***	4.830***
	(0.564)	(0.462)	(0.454)	(0.578)	(0.468)	(0.619)	(0.440)	(0.438)
ExPolicy reduction	-0.050**	0.078***	0.059***	-0.083***	0.056***	-0.019	0.039**	0.053***
	(0.018)	(0.015)	(0.015)	(0.019)	(0.015)	(0.020)	(0.014)	(0.014)
Dependency high	-0.674***	-0.193***	-0.296***	-0.579***	-0.273***	-0.198***	-0.281***	-0.257***
	(0.023)	(0.019)	(0.018)	(0.023)	(0.019)	(0.025)	(0.018)	(0.018)
Model	RE	RE	RE	RE	RE	RE	RE	RE
Num.Obs.	13182	13182	13641	13686	13641	13686	13182	13182
R2	0.132	0.288	0.251	0.077	0.211	0.01	0.241	0.226
AIC	35094.9	29821.4	30412.4	37105.5	31266.3	39011.6	28542.9	28440.1

This table reports the panel regression results regarding the impact of biodiversity-related terms on firm risk for a set of 1993 US firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Beta and IDS are the systematic and idiosyncratic risks, estimated form the CAPM; SD is the total risk. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the average market excess return during the past year. LPM measures losses relative to a reference point and ignores gains exceeding such a reference point. To this case, LPM is equivalent to the semivariance, as the reference point is the mean of stock's return distribution. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. VaR measures how much the value of an investment declines over a given time period with a given probability (5%). The ES is the expected return on the portfolio in the worst q % of cases (5%). E is the Thomson Reuters Environmental scores, that takes values 0 to 100. Policy reduction is a dummy variable that takes value 1 when the firm has a policy for reducing the use of natural resources or to lessen the environmental impact, and 0 otherwise. Size is the size of the firm, calculated as the log of the total assets. 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. ExPolicy reduction is the interaction variable between the Environmental pillar score and the Policy reduction dummy variable. Dependency high is a dummy variable that takes value 1 when the intensity of WWF Biodiversity risk filter for resources Dependency is above the 75% of the whole distribution, and 0 otherwise. 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 13: Biodiversity impact: firms' use natural resources I

	Beta	*IDS*	*SD*	*Downsidebeta*	*LPM*	*Tailbeta*	*VaR*	*ES*
Intercept	0.174**	-0.024	-0.001	0.183***	0.009	0.065**	-0.008	-0.005
	(0.067)	(0.116)	(0.146)	(0.054)	(0.145)	(0.021)	(0.163)	(0.168)
E	0.006	-0.074***	-0.057***	0.040*	-0.057***	0.008	-0.056***	-0.056***
	(0.016)	(0.013)	(0.013)	(0.016)	(0.013)	(0.017)	(0.013)	(0.013)
Policy reduction	-0.003	0.071***	0.072***	-0.066***	0.072***	-0.039*	0.044**	0.060***
	(0.018)	(0.014)	(0.014)	(0.018)	(0.015)	(0.019)	(0.014)	(0.014)
size	-0.170***	-0.314***	-0.282***	-0.095***	-0.264***	-0.031**	-0.247***	-0.251***
	(0.010)	(0.008)	(0.008)	(0.010)	(0.008)	(0.011)	(0.008)	(0.008)
MTB	0.016*	0.005	0.007	0.013+	0.006	0.002	0.003	0.006
	(0.007)	(0.006)	(0.006)	(0.007)	(0.006)	(0.008)	(0.006)	(0.006)
ROA	-0.166***	-0.305***	-0.261***	-0.110***	-0.230***	-0.034***	-0.257***	-0.235***
	(0.009)	(0.007)	(0.007)	(0.009)	(0.007)	(0.010)	(0.007)	(0.007)
Lev	0.001	0.000	0.001	0.000	0.000	0.004	0.003	0.002
	(0.008)	(0.006)	(0.006)	(0.008)	(0.006)	(0.008)	(0.006)	(0.006)
Liq	2.598***	5.270***	4.437***	2.302***	5.407***	0.203	4.341***	4.830***
	(0.564)	(0.462)	(0.454)	(0.578)	(0.468)	(0.619)	(0.440)	(0.438)
ExPolicy reduction	-0.050**	0.078***	0.059***	-0.083***	0.056***	-0.019	0.039**	0.053***
	(0.018)	(0.015)	(0.015)	(0.019)	(0.015)	(0.020)	(0.014)	(0.014)
Dependency high	-0.674***	-0.193***	-0.296***	-0.579***	-0.273***	-0.198***	-0.281***	-0.257***
	(0.023)	(0.019)	(0.018)	(0.023)	(0.019)	(0.025)	(0.018)	(0.018)
Model	RE	RE	RE	RE	RE	RE	RE	RE
Num.Obs.	13182	13182	13641	13686	13641	13686	13182	13182
R2	0.132	0.288	0.251	0.077	0.211	0.01	0.241	0.226
AIC	35094.9	29821.4	30412.4	37105.5	31266.3	39011.6	28542.9	28440.1

This table reports the panel regression results regarding the impact of biodiversity-related terms on firm risk for a set of 1993 US firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Beta and IDS are the systematic and idiosyncratic risks, estimated form the CAPM; SD is the total risk. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the average market excess return during the past year. LPM measures losses relative to a reference point and ignores gains exceeding such a reference point. To this case, LPM is equivalent to the semivariance, as the reference point is the mean of stock's return distribution. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. VaR measures how much the value of an investment declines over a given time period with a given probability (5%). The ES is the expected return on the portfolio in the worst q % of cases (5%). E is the Thomson Reuters Environmental scores, that takes values 0 to 100. Policy reduction is a dummy variable that takes value 1 when the firm has a policy for reducing the use of natural resources or to lessen the environmental impact, and 0 otherwise. Size is the size of the firm, calculated as the log of the total assets. 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. ExPolicy reduction is the interaction variable between the Environmental pillar score and the Policy reduction dummy variable. Dependency high is a dummy variable that takes value 1 when the intensity of WWF Biodiversity risk filter for resources Dependency is above the 75% of the whole distribution, and 0 otherwise. 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 14: Biodiversity impact: firms' use natural resources II

	Beta	*IDS*	*SD*	*Downsidebeta*	*LPM*	*Tailbeta*	*VaR*	*ES*
Intercept	0.091	-0.085	-0.059	0.123*	-0.045	0.062**	-0.079	-0.064
	(0.066)	(0.117)	(0.147)	(0.053)	(0.146)	(0.021)	(0.165)	(0.169)
E	-0.022	-0.087***	-0.072***	0.017	-0.071***	0.003	-0.073***	-0.071***
	(0.017)	(0.013)	(0.013)	(0.017)	(0.013)	(0.017)	(0.013)	(0.013)
Policy reduction	-0.028	0.053***	0.055***	-0.082***	0.056***	-0.039*	0.022	0.042**
	(0.018)	(0.014)	(0.014)	(0.018)	(0.015)	(0.019)	(0.014)	(0.014)
size	-0.165***	-0.308***	-0.278***	-0.094***	-0.260***	-0.033**	-0.240***	-0.245***
	(0.011)	(0.008)	(0.008)	(0.011)	(0.008)	(0.011)	(0.008)	(0.008)
MTB	0.018*	0.006	0.008	0.015+	0.007	0.003	0.005	0.007
	(0.008)	(0.006)	(0.006)	(0.008)	(0.006)	(0.008)	(0.006)	(0.006)
ROA	-0.170***	-0.307***	-0.263***	-0.113***	-0.232***	-0.035***	-0.260***	-0.238***
	(0.009)	(0.007)	(0.007)	(0.009)	(0.007)	(0.010)	(0.007)	(0.007)
Lev	0.001	0.002	0.002	-0.001	0.001	0.002	0.005	0.003
	(0.008)	(0.006)	(0.006)	(0.008)	(0.006)	(0.008)	(0.006)	(0.006)
Liq	2.759***	4.916***	4.263***	2.543***	5.235***	0.481	4.012***	4.598***
	(0.583)	(0.463)	(0.459)	(0.591)	(0.473)	(0.621)	(0.443)	(0.442)
ExPolicy reduction	-0.061**	0.071***	0.052***	-0.090***	0.050**	-0.02	0.031*	0.046**
	(0.019)	(0.015)	(0.015)	(0.019)	(0.015)	(0.020)	(0.014)	(0.014)
High biodiversity impact	-0.077**	0.201***	0.102***	-0.125***	0.100***	-0.151***	0.189***	0.134***
	(0.024)	(0.019)	(0.018)	(0.024)	(0.019)	(0.025)	(0.018)	(0.018)
Model	RE	RE	RE	RE	RE	RE	RE	RE
Num.Obs.	13182	13182	13641	13686	13641	13686	13182	13182
R2	0.076	0.288	0.238	0.037	0.2	0.008	0.233	0.217
AIC	35916.6	29812.2	30639.5	37681.5	31444.8	39037.3	28675.5	28589.5

This table reports the panel regression results regarding the impact of biodiversity-related terms on firm risk for a set of 1993 US firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Beta and IDS are the systematic and idiosyncratic risks, estimated form the CAPM; SD is the total risk. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the average market excess return during the past year. LPM measures losses relative to a reference point and ignores gains exceeding such a reference point. To this case, LPM is equivalent to the semivariance, as the reference point is the mean of stock's return distribution. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. VaR measures how much the value of an investment declines over a given time period with a given probability (5%). The ES is the expected return on the portfolio in the worst q % of cases (5%). E is the Thomson Reuters Environmental scores, that takes values 0 to 100. Policy reduction is a dummy variable that takes value 1 when the firm has a policy for reducing the use of natural resources or to lessen the environmental impact, and 0 otherwise. Size is the size of the firm, calculated as the log of the total assets. 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. ExPolicy reduction is the interaction variable between the Environmental pillar score and the Policy reduction dummy variable. High biodiversity impact is a dummy variable that takes value 1 when the intensity of WWF Biodiversity risk filter for impact on biodiversity factors is above the 75% of the whole distribution, and 0 otherwise. 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 15: Biodiversity impact: firms' use natural resources III

	Beta	*IDS*	*SD*	*Downsidebeta*	*LPM*	*Tailbeta*	*VaR*	*ES*
Intercept	0.045	-0.101	-0.084	0.083	-0.068	0.045*	-0.102	-0.084
	(0.066)	(0.117)	(0.147)	(0.053)	(0.146)	(0.021)	(0.165)	(0.169)
E	-0.024	-0.082***	-0.069***	0.015	-0.068***	-0.001	-0.069***	-0.067***
	(0.017)	(0.013)	(0.013)	(0.017)	(0.013)	(0.017)	(0.012)	(0.012)
Policy reduction	-0.036*	0.056***	0.054***	-0.092***	0.055***	-0.046*	0.025+	0.043**
	(0.018)	(0.014)	(0.014)	(0.018)	(0.014)	(0.019)	(0.014)	(0.014)
size	-0.168***	-0.319***	-0.286***	-0.094***	-0.267***	-0.029**	-0.252***	-0.254***
	(0.011)	(0.008)	(0.008)	(0.010)	(0.008)	(0.011)	(0.008)	(0.008)
MTB	0.017*	0.005	0.007	0.014+	0.006	0.003	0.003	0.006
	(0.007)	(0.006)	(0.006)	(0.008)	(0.006)	(0.008)	(0.006)	(0.006)
ROA	-0.166***	-0.299***	-0.257***	-0.111***	-0.226***	-0.037***	-0.250***	-0.230***
	(0.009)	(0.007)	(0.007)	(0.009)	(0.007)	(0.010)	(0.007)	(0.007)
Lev	0.004	0.005	0.005	0.002	0.004	0.003	0.009	0.006
	(0.008)	(0.006)	(0.006)	(0.008)	(0.006)	(0.008)	(0.006)	(0.006)
Liq	1.840**	4.129***	3.492***	1.859**	4.500***	0.376	3.081***	3.846***
	(0.582)	(0.457)	(0.455)	(0.593)	(0.469)	(0.624)	(0.435)	(0.437)
ExPolicy reduction	-0.059**	0.079***	0.058***	-0.090***	0.055***	-0.023	0.039**	0.053***
	(0.019)	(0.015)	(0.015)	(0.019)	(0.015)	(0.020)	(0.014)	(0.014)
High environmental impact	0.468***	0.688***	0.571***	0.276***	0.548***	-0.101*	0.761***	0.595***
	(0.039)	(0.030)	(0.030)	(0.038)	(0.030)	(0.040)	(0.029)	(0.029)
Model	RE	RE	RE	RE	RE	RE	RE	RE
Num.Obs.	13182	13182	13641	13686	13641	13686	13182	13182
R2	0.086	0.309	0.257	0.039	0.217	0.006	0.266	0.238
AIC	35780.5	29420.7	30300.9	37657.4	31153.1	39068.6	28105.6	28230

This table reports the panel regression results regarding the impact of biodiversity-related terms on firm risk for a set of 1993 US firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Beta and IDS are the systematic and idiosyncratic risks, estimated form the CAPM; SD is the total risk. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the average market excess return during the past year. LPM measures losses relative to a reference point and ignores gains exceeding such a reference point. To this case, LPM is equivalent to the semivariance, as the reference point is the mean of stock's return distribution. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. VaR measures how much the value of an investment declines over a given time period with a given probability (5%). The ES is the expected return on the portfolio in the worst q % of cases (5%). E is the Thomson Reuters Environmental scores, that takes values 0 to 100. Policy reduction is a dummy variable that takes value 1 when the firm has a policy for reducing the use of natural resources or to lessen the environmental impact, and 0 otherwise. Size is the size of the firm, calculated as the log of the total assets. 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. ExPolicy reduction is the interaction variable between the Environmental pillar score and the Policy reduction dummy variable. High environmental impact is a dummy variable that takes value 1 when the intensity of WWF Biodiversity risk filter for impact on environmental factors is above the 75% of the whole distribution, and 0 otherwise. 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 16: Biodiversity impact: firms' use natural resources IV

	Beta	*IDS*	*SD*	*Downsidebeta*	*LPM*	*Tailbeta*	*VaR*	*ES*
Intercept	0.164*	-0.063	-0.03	0.182***	-0.018	0.077***	-0.049	-0.036
	(0.067)	(0.117)	(0.147)	(0.053)	(0.146)	(0.022)	(0.164)	(0.168)
E	-0.006	-0.085***	-0.067***	0.030+	-0.067***	0.008	-0.069***	-0.066***
	(0.016)	(0.013)	(0.013)	(0.017)	(0.013)	(0.017)	(0.013)	(0.013)
Policy reduction	-0.011	0.061***	0.063***	-0.070***	0.063***	-0.038*	0.032*	0.050***
	(0.018)	(0.014)	(0.014)	(0.018)	(0.015)	(0.019)	(0.014)	(0.014)
size	-0.163***	-0.313***	-0.280***	-0.091***	-0.261***	-0.029**	-0.244***	-0.248***
	(0.010)	(0.008)	(0.008)	(0.010)	(0.008)	(0.011)	(0.008)	(0.008)
MTB	0.017*	0.006	0.008	0.014+	0.007	0.002	0.004	0.007
	(0.007)	(0.006)	(0.006)	(0.008)	(0.006)	(0.008)	(0.006)	(0.006)
ROA	-0.173***	-0.306***	-0.263***	-0.115***	-0.232***	-0.036***	-0.259***	-0.237***
	(0.009)	(0.007)	(0.007)	(0.009)	(0.007)	(0.010)	(0.007)	(0.007)
Lev	-0.002	0.000	0.001	-0.002	0.000	0.002	0.003	0.002
	(0.008)	(0.006)	(0.006)	(0.008)	(0.006)	(0.008)	(0.006)	(0.006)
Liq	3.276***	5.192***	4.547***	2.934***	5.498***	0.518	4.345***	4.883***
	(0.575)	(0.464)	(0.459)	(0.585)	(0.473)	(0.620)	(0.445)	(0.442)
ExPolicy reduction	-0.058**	0.074***	0.054***	-0.088***	0.052***	-0.021	0.034*	0.049***
	(0.019)	(0.015)	(0.015)	(0.019)	(0.015)	(0.020)	(0.014)	(0.014)
High reputational impact	-0.400***	0.052**	-0.062***	-0.376***	-0.051**	-0.188***	0.004	-0.027+
	(0.021)	(0.017)	(0.017)	(0.021)	(0.017)	(0.022)	(0.016)	(0.016)
Model	RE	RE	RE	RE	RE	RE	RE	RE
Num.Obs.	13182	13182	13641	13686	13641	13686	13182	13182
R2	0.1	0.283	0.237	0.057	0.199	0.01	0.227	0.214
AIC	35568.2	29916.8	30656.6	37393.1	31464.2	39002.9	28785.1	28642.4

This table reports the panel regression results regarding the impact of biodiversity-related terms on firm risk for a set of 1993 US firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Beta and IDS are the systematic and idiosyncratic risks, estimated form the CAPM; SD is the total risk. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the average market excess return during the past year. LPM measures losses relative to a reference point and ignores gains exceeding such a reference point. To this case, LPM is equivalent to the semivariance, as the reference point is the mean of stock's return distribution. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. VaR measures how much the value of an investment declines over a given time period with a given probability (5%). The ES is the expected return on the portfolio in the worst q % of cases (5%). E is the Thomson Reuters Environmental scores, that takes values 0 to 100. Policy reduction is a dummy variable that takes value 1 when the firm has a policy for reducing the use of natural resources or to lessen the environmental impact, and 0 otherwise. Size is the size of the firm, calculated as the log of the total assets. 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. ExPolicy reduction is the interaction variable between the Environmental pillar score and the Policy reduction dummy variable. High reputational impact is a dummy variable that takes value 1 when the intensity of WWF Biodiversity risk filter for impact on reputational factors is above the 75% of the whole distribution, and 0 otherwise. 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 17: Biodiversity impact: firms' reporting initiatives I

	Beta	*IDS*	*SD*	*Downsidebeta*	*LPM*	*Tailbeta*	*VaR*	*ES*
Intercept	0.141*	0.064	0.073	0.124*	0.072	0.049**	0.043	0.054
	(0.067)	(0.120)	(0.150)	(0.055)	(0.149)	(0.017)	(0.167)	(0.171)
E	0.027*	-0.024**	-0.002	0.01	-0.003	-0.016	-0.021*	-0.012
	(0.011)	(0.009)	(0.009)	(0.011)	(0.009)	(0.012)	(0.009)	(0.009)
BioIR	-0.003	0.152***	0.136***	-0.018	0.140***	-0.03	0.146***	0.123***
	(0.042)	(0.035)	(0.034)	(0.043)	(0.035)	(0.045)	(0.033)	(0.033)
size	-0.168***	-0.321***	-0.288***	-0.092***	-0.269***	-0.032**	-0.252***	-0.256***
	(0.011)	(0.009)	(0.009)	(0.011)	(0.009)	(0.011)	(0.008)	(0.008)
MTB	0.016*	0.005	0.007	0.013+	0.006	0.003	0.003	0.006
	(0.007)	(0.006)	(0.006)	(0.008)	(0.006)	(0.008)	(0.006)	(0.006)
ROA	-0.163***	-0.313***	-0.265***	-0.111***	-0.233***	-0.032**	-0.261***	-0.239***
	(0.009)	(0.008)	(0.007)	(0.009)	(0.008)	(0.010)	(0.007)	(0.007)
Lev	0.003	0.000	0.002	0.002	0.000	0.002	0.004	0.002
	(0.008)	(0.006)	(0.006)	(0.008)	(0.006)	(0.008)	(0.006)	(0.006)
Liq	2.651***	5.999***	5.024***	2.395***	6.093***	0.201	4.828***	5.425***
	(0.596)	(0.498)	(0.490)	(0.618)	(0.505)	(0.649)	(0.474)	(0.472)
ExBioIR	-0.130***	-0.041	-0.074**	-0.085**	-0.073**	-0.009	-0.084***	-0.060*
	(0.031)	(0.026)	(0.025)	(0.031)	(0.026)	(0.033)	(0.024)	(0.024)
High dependency	-0.648***	-0.207***	-0.302***	-0.562***	-0.279***	-0.173***	-0.291***	-0.263***
	(0.024)	(0.020)	(0.020)	(0.025)	(0.020)	(0.026)	(0.019)	(0.019)
Model	RE	RE	RE	RE	RE	RE	RE	RE
Num.Obs.	12329	12329	12779	12824	12779	12824	12329	12329
R2	0.136	0.292	0.252	0.077	0.212	0.009	0.244	0.229
AIC	32705	28249.5	28876.9	34946.3	29644	36219.6	27058.4	26936

This table reports the panel regression results regarding the impact of biodiversity-related terms on firm risk for a set of 1993 US firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Beta and IDS are the systematic and idiosyncratic risks, estimated form the CAPM; SD is the total risk. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the average market excess return during the past year. LPM measures losses relative to a reference point and ignores gains exceeding such a reference point. To this case, LPM is equivalent to the semivariance, as the reference point is the mean of stock's return distribution. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. VaR measures how much the value of an investment declines over a given time period with a given probability (5%). The ES is the expected return on the portfolio in the worst q % of cases (5%). E is the Thomson Reuters Environmental scores, that takes values 0 to 100. BioIR is a dummy variable that takes value 1 when the firm reports on its impact on biodiversity or on activities to reduce its impact on the native ecosystems and species, as well as the biodiversity of protected and sensitive areas, and 0 otherwise. Size is the size of the firm, calculated as the log of the total assets. 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. ExBioIR is the interaction variable between the Environmental pillar score and the BioIR dummy variable. High dependency is a dummy variable that takes value 1 when the intensity of WWF Biodiversity risk filter for resources dependency is above the 75% of the whole distribution, and 0 otherwise. 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 18: Biodiversity impact: firms' reporting initiatives II

	Beta	*IDS*	*SD*	*Downsidebeta*	*LPM*	*Tailbeta*	*VaR*	*ES*
Intercept	0.071	0.005	0.019	0.076	0.021	0.054**	-0.024	-0.001
	(0.066)	(0.121)	(0.151)	(0.054)	(0.149)	(0.017)	(0.168)	(0.172)
E	-0.001	-0.044***	-0.021*	-0.011	-0.021*	-0.016	-0.044***	-0.031***
	(0.011)	(0.009)	(0.009)	(0.011)	(0.009)	(0.012)	(0.009)	(0.009)
BioIR	-0.159***	0.063+	0.045	-0.136**	0.055	-0.046	0.037	0.031
	(0.043)	(0.035)	(0.034)	(0.043)	(0.035)	(0.044)	(0.033)	(0.033)
size	-0.157***	-0.311***	-0.279***	-0.085***	-0.261***	-0.034**	-0.240***	-0.246***
	(0.011)	(0.009)	(0.009)	(0.011)	(0.009)	(0.011)	(0.008)	(0.008)
MTB	0.019*	0.006	0.008	0.015*	0.007	0.003	0.005	0.007
	(0.007)	(0.006)	(0.006)	(0.008)	(0.006)	(0.008)	(0.006)	(0.006)
ROA	-0.171***	-0.318***	-0.270***	-0.117***	-0.237***	-0.032***	-0.267***	-0.244***
	(0.010)	(0.008)	(0.007)	(0.010)	(0.008)	(0.010)	(0.007)	(0.007)
Lev	0.003	0.002	0.003	0.001	0.001	0.001	0.006	0.004
	(0.008)	(0.006)	(0.006)	(0.008)	(0.006)	(0.008)	(0.006)	(0.006)
Liq	2.794***	5.636***	4.840***	2.632***	5.912***	0.501	4.486***	5.183***
	(0.615)	(0.499)	(0.495)	(0.631)	(0.509)	(0.651)	(0.478)	(0.476)
ExBioIR	-0.130***	-0.035	-0.073**	-0.090**	-0.073**	-0.013	-0.078**	-0.056*
	(0.031)	(0.026)	(0.025)	(0.032)	(0.026)	(0.033)	(0.024)	(0.024)
High biodiversity impact	-0.064**	0.206***	0.108***	-0.119***	0.107***	-0.163***	0.197***	0.141***
	(0.024)	(0.020)	(0.019)	(0.025)	(0.020)	(0.025)	(0.019)	(0.019)
Model	RE	RE	RE	RE	RE	RE	RE	RE
Num.Obs.	12329	12329	12779	12824	12779	12824	12329	12329
R2	0.086	0.292	0.24	0.042	0.202	0.009	0.237	0.22
AIC	33397.9	28246	29080.6	35431.5	29804.5	36222.8	27177.9	27069.1

This table reports the panel regression results regarding the impact of biodiversity-related terms on firm risk for a set of 1993 US firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Beta and IDS are the systematic and idiosyncratic risks, estimated form the CAPM; SD is the total risk. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the average market excess return during the past year. LPM measures losses relative to a reference point and ignores gains exceeding such a reference point. To this case, LPM is equivalent to the semivariance, as the reference point is the mean of stock's return distribution. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. VaR measures how much the value of an investment declines over a given time period with a given probability (5%). The ES is the expected return on the portfolio in the worst q % of cases (5%). E is the Thomson Reuters Environmental scores, that takes values 0 to 100. BioIR is a dummy variable that takes value 1 when the firm reports on its impact on biodiversity or on activities to reduce its impact on the native ecosystems and species, as well as the biodiversity of protected and sensitive areas, and 0 otherwise. Size is the size of the firm, calculated as the log of the total assets. 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. ExBioIR is the interaction variable between the Environmental pillar score and the BioIR dummy variable. High biodiversity impact is a dummy variable that takes value 1 when the intensity of WWF Biodiversity risk filter for impact on biodiversity factors is above the 75% of the whole distribution, and 0 otherwise. 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 19: Biodiversity impact: firms' reporting initiatives III

	Beta	*IDS*	*SD*	*Downsidebeta*	*LPM*	*Tailbeta*	*VaR*	*ES*
Intercept	0.030	-0.004	-0.001	0.037	0.003	0.036*	-0.041	-0.016
	(0.067)	(0.121)	(0.151)	(0.054)	(0.149)	(0.017)	(0.168)	(0.172)
E	-0.004	-0.035***	-0.016+	-0.016	-0.016+	-0.024*	-0.035***	-0.024**
	(0.011)	(0.009)	(0.009)	(0.011)	(0.009)	(0.012)	(0.009)	(0.009)
BioIR	-0.224***	0.025	0.005	-0.184***	0.017	-0.059	-0.012	-0.009
	(0.042)	(0.034)	(0.033)	(0.043)	(0.034)	(0.044)	(0.032)	(0.033)
size	-0.158***	-0.321***	-0.285***	-0.083***	-0.267***	-0.028*	-0.250***	-0.254***
	(0.011)	(0.009)	(0.008)	(0.011)	(0.009)	(0.011)	(0.008)	(0.008)
MTB	0.018*	0.005	0.007	0.015+	0.006	0.004	0.003	0.006
	(0.007)	(0.006)	(0.006)	(0.008)	(0.006)	(0.008)	(0.006)	(0.006)
ROA	-0.167***	-0.309***	-0.264***	-0.115***	-0.232***	-0.035***	-0.258***	-0.237***
	(0.009)	(0.008)	(0.007)	(0.010)	(0.008)	(0.010)	(0.007)	(0.007)
Lev	0.007	0.006	0.006	0.004	0.004	0.001	0.010+	0.007
	(0.008)	(0.006)	(0.006)	(0.008)	(0.006)	(0.008)	(0.006)	(0.006)
Liq	1.824**	4.834***	4.052***	1.907**	5.162***	0.424	3.517***	4.410***
	(0.613)	(0.493)	(0.490)	(0.632)	(0.505)	(0.654)	(0.468)	(0.470)
ExBioIR	-0.115***	-0.022	-0.062*	-0.081*	-0.062*	-0.013	-0.062**	-0.044+
	(0.031)	(0.025)	(0.025)	(0.032)	(0.026)	(0.033)	(0.024)	(0.024)
High environmental impact	0.515***	0.707***	0.593***	0.308***	0.567***	-0.131**	0.798***	0.619***
	(0.040)	(0.032)	(0.031)	(0.040)	(0.032)	(0.041)	(0.030)	(0.031)
Model	RE	RE	RE	RE	RE	RE	RE	RE
Num.Obs.	12329	12329	12779	12824	12779	12824	12329	12329
R2	0.098	0.313	0.259	0.044	0.22	0.006	0.271	0.242
AIC	33238.1	27876.1	28755.1	35395.4	29524.6	36254.4	26616.3	26721.2

This table reports the panel regression results regarding the impact of biodiversity-related terms on firm risk for a set of 1993 US firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Beta and IDS are the systematic and idiosyncratic risks, estimated form the CAPM; SD is the total risk. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the average market excess return during the past year. LPM measures losses relative to a reference point and ignores gains exceeding such a reference point. To this case, LPM is equivalent to the semivariance, as the reference point is the mean of stock's return distribution. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. VaR measures how much the value of an investment declines over a given time period with a given probability (5%). The ES is the expected return on the portfolio in the worst q % of cases (5%). E is the Thomson Reuters Environmental scores, that takes values 0 to 100. BioIR is a dummy variable that takes value 1 when the firm reports on its impact on biodiversity or on activities to reduce its impact on the native ecosystems and species, as well as the biodiversity of protected and sensitive areas, and 0 otherwise. Size is the size of the firm, calculated as the log of the total assets. 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. ExBioIR is the interaction variable between the Environmental pillar score and the BioIR dummy variable. High environmental impact is a dummy variable that takes value 1 when the intensity of WWF Biodiversity risk filter for impact on environmental factors is above the 75% of the whole distribution, and 0 otherwise. 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 20: Biodiversity impact: firms' reporting initiatives IV

	Beta	*IDS*	*SD*	*Downsidebeta*	*LPM*	*Tailbeta*	*VaR*	*ES*
Intercept	0.128+	0.029	0.047	0.121*	0.047	0.061***	0.005	0.026
	(0.067)	(0.121)	(0.151)	(0.054)	(0.149)	(0.017)	(0.168)	(0.172)
E	0.014	-0.037***	-0.014	0.000	-0.014	-0.016	-0.035***	-0.023**
	(0.011)	(0.009)	(0.009)	(0.011)	(0.009)	(0.012)	(0.009)	(0.009)
BioIR	-0.037	0.079*	0.082*	-0.034	0.087*	-0.01	0.066*	0.063+
	(0.043)	(0.035)	(0.034)	(0.043)	(0.035)	(0.045)	(0.034)	(0.034)
size	-0.160***	-0.316***	-0.283***	-0.086***	-0.264***	-0.031**	-0.245***	-0.250***
	(0.011)	(0.009)	(0.009)	(0.011)	(0.009)	(0.011)	(0.008)	(0.008)
MTB	0.018*	0.006	0.008	0.015+	0.007	0.003	0.004	0.007
	(0.007)	(0.006)	(0.006)	(0.008)	(0.006)	(0.008)	(0.006)	(0.006)
ROA	-0.170***	-0.316***	-0.268***	-0.116***	-0.236***	-0.033***	-0.265***	-0.243***
	(0.009)	(0.008)	(0.007)	(0.009)	(0.008)	(0.010)	(0.007)	(0.007)
Lev	0.000	0.001	0.001	-0.001	0.000	0.001	0.005	0.002
	(0.008)	(0.006)	(0.006)	(0.008)	(0.006)	(0.008)	(0.006)	(0.006)
Liq	3.273***	5.922***	5.128***	2.992***	6.178***	0.502	4.820***	5.471***
	(0.608)	(0.500)	(0.495)	(0.625)	(0.509)	(0.650)	(0.479)	(0.476)
ExBioIR	-0.139***	-0.038	-0.076**	-0.094**	-0.075**	-0.014	-0.082***	-0.060*
	(0.031)	(0.026)	(0.025)	(0.032)	(0.026)	(0.033)	(0.025)	(0.024)
High reputational impact	-0.368***	0.053**	-0.056**	-0.355***	-0.046*	-0.182***	0.013	-0.021
	(0.022)	(0.018)	(0.018)	(0.022)	(0.018)	(0.023)	(0.018)	(0.017)
Model	RE	RE	RE	RE	RE	RE	RE	RE
Num.Obs.	12329	12329	12779	12824	12779	12824	12329	12329
R2	0.105	0.286	0.239	0.058	0.201	0.01	0.231	0.217
AIC	33133.7	28345.9	29102.1	35206.2	29827.1	36203.4	27284.6	27123.1

This table reports the panel regression results regarding the impact of biodiversity-related terms on firm risk for a set of 1993 US firms and a period of 12 years (2010-2022). All variables are standarized, and data are annual and winsorized at 5%. Independent variables are lagged by one year. Beta and IDS are the systematic and idiosyncratic risks, estimated form the CAPM; SD is the total risk. Downsidebeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of the daily excess market returns on the days that the market' s excess return is less than the average market excess return during the past year. LPM measures losses relative to a reference point and ignores gains exceeding such a reference point. To this case, LPM is equivalent to the semivariance, as the reference point is the mean of stock's return distribution. Tailbeta is the ratio of the covariance between daily excess returns of a stock and daily excess market returns to the variance of daily excess market returns on the days that the market's excess return is less the 10th percentile of its distribution during the past year. VaR measures how much the value of an investment declines over a given time period with a given probability (5%). The ES is the expected return on the portfolio in the worst q % of cases (5%). E is the Thomson Reuters Environmental scores, that takes values 0 to 100. BioIR is a dummy variable that takes value 1 when the firm reports on its impact on biodiversity or on activities to reduce its impact on the native ecosystems and species, as well as the biodiversity of protected and sensitive areas, and 0 otherwise. Size is the size of the firm, calculated as the log of the total assets. 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. ExBioIR is the interaction variable between the Environmental pillar score and the BioIR dummy variable. High reputational impact is a dummy variable that takes value 1 when the intensity of WWF Biodiversity risk filter for impact on reputational factors is above the 75% of the whole distribution, and 0 otherwise. 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. □