Corporate Social Responsibility and Environmental Management

WILEY

Corporate Social Responsibility and Environmental Management

RESEARCH ARTICLE OPEN ACCESS

Does ESG Performance Reduce Default Risk in Insurance Firms? Evidence From Life and Non-Life Sectors

S. Miani[1] | M. Mantovani[1] | E. Palmieri[1,2]

[1]University of Udine, Udine, Italy | [2]Institute of European Finance - Responsible Banking, The Albert Gubay Business School, Bangor University, Bangor, UK

Correspondence: E. Palmieri (egidio.palmieri@uniud.it)

Received: 12 July 2025 | **Revised:** 5 February 2026 | **Accepted:** 14 February 2026

Keywords: ESG performance | financial stability | insurance firms | probability of default | solvency

ABSTRACT

This study examines whether environmental, social, and governance performance is associated with lower default risk in European insurance firms, and whether the strength of this association differs between life and non-life business models. Default risk is measured through Bloomberg market implied probabilities of default derived from structural credit risk models at 1 year and five-year horizons. ESG performance is proxied by the composite ESG score provided by LSEG. Using an unbalanced panel of 152 insurers from 22 European countries over 2014 to 2023, we estimate panel quantile regressions to allow the ESG default risk relationship to vary across the conditional distribution of default risk. Across the full sample, higher ESG performance is associated with lower short term and long-term default probabilities, with economically larger and more robust effects among non-life insurers and among firms in the upper quantiles of default risk. For life insurers, the estimated association is weaker and less consistently significant across quantiles, suggesting that capital strength and asset liability management remain the primary drivers of market implied solvency over longer horizons, while ESG performance operates as a complementary factor rather than a dominant determinant. A set of robustness exercises based on alternative functional forms, lagged ESG measures, an accounting-based stability proxy, and endogeneity-oriented specifications support the main pattern of results. The findings have practical implications for integrating sustainability variables into solvency relevant risk governance. In non-life, governance quality, transparency, and operational risk controls appear most closely linked to lower default risk. In life, ESG policies are best interpreted as part of long horizon risk management and investment discipline, and not as a substitute for core capital and asset liability management.

JEL Classification: G22, G32, C33, M14, Q56

1 | Introduction

KPMG (2011) has reported that, since the beginning of 2010, a growing number of corporations worldwide have been directing their attention and interest increasingly towards sustainability. Consequently, environmental, social and governance (ESG) criteria have had a significant impact on corporate strategies and investment decisions across various sectors, especially in the banking industry (Chen et al. 2025; Du et al. 2026). Indeed, the financial sector is now acting as one of the principal channels for ESG, with financial intermediaries increasingly integrating ESG practices into their investment decisions, risk assessment and capital allocation (Amel-Zadeh and Serafeim 2018).

Although the impact of ESG factors on corporate governance and financial performance has been extensively studied (Hong and Kacperczyk 2009; Dhaliwal et al. 2011; Chen et al. 2018; Krueger et al. 2024; Mbanyele et al. 2022; Li et al. 2022), their impact on the default risk of insurance companies has not been as thoroughly examined. This is a significant gap because

insurance company default risk can have broader implications for the stability of the entire financial system. Not only are insurers exposed to ESG risks within their investment portfolios and underwriting activities, but they also act as financial intermediaries capable of amplifying or mitigating ESG-driven shocks. This effect is a consequence of the nature of insurers' business model. More specifically, the insurance industry is particularly exposed to ESG considerations due to its inherent focus on risk management and long-term stability (Meral et al. 2025). The core business of insurers consists of risk pooling, capital preservation, and long-term liability management, all of which are closely linked to ESG risks such as climate change, demographic change, and poor governance. Therefore, understanding the interaction between sustainable growth programmes and default risk of insurers is vital, given its impact on corporate management, strategy and practices (Sun and Cui 2014; Dal Maso et al. 2024). To our knowledge, no study has comprehensively assessed whether and how ESG performance correlates with default risk in insurance firms. Nor has existing literature accounted for the structural differences between life and non-life insurers, which differ significantly in terms of liability duration, business models and exposure to ESG-sensitive risks.

Beyond the limited empirical coverage in existing studies, analysing the relationship between ESG performance and default risk in insurance firms is theoretically and institutionally relevant because default risk is the primary object of prudential supervision in the insurance sector and a key determinant of systemic confidence (Vassalou and Xing 2004). Unlike standard performance indicators, default probability directly captures insurers' ability to honour long-term contractual obligations under adverse conditions, which is central to the economic function of insurance. ESG factors can influence this ability through multiple channels that are not fully internalised by traditional solvency metrics, including the pricing of climate-sensitive risks, governance-driven risk selection and monitoring, and policyholder trust (Bolton and Kacperczyk 2021; Lins et al. 2017). As a result, ignoring ESG performance when assessing insurers' default risk may lead to an incomplete understanding of financial fragility and resilience. This study therefore moves beyond descriptive ESG–performance associations and contributes to the conceptual debate on whether sustainability-related practices operate as risk-mitigating mechanisms within insurers' core solvency dynamics.

This study addresses these gaps by providing evidence on the relationship between ESG performance and market implied default probabilities in the European insurance sector, while explicitly distinguishing between life and non-life insurers. The analysis is structured around two time horizons that are relevant for prudential supervision and market discipline: a 1-year probability of default capturing near term distress risk and a five-year probability of default capturing longer horizon solvency pressure. Because insurers are heterogeneous and default risk is highly skewed, the empirical design focuses on quantile effects, allowing the ESG default risk relationship to differ between relatively safe and relatively stressed firms.

We test two hypotheses: The first hypothesis states that higher ESG performance is associated with a lower short-term probability of default, with a stronger association expected in non-life insurers given their greater exposure to underwriting volatility and operational shocks. The second hypothesis states that higher ESG performance is associated with a lower long-term probability of default in insurance firms, with the magnitude of the association expected to vary across life and non-life business models because liability duration, investment dependence, and the transmission of ESG-related risks differ across segments.

The paper contributes to the literature by treating default probability as the core outcome of interest, which is directly aligned with solvency and prudential objectives in insurance, rather than focusing on valuation or accounting performance. It also provides a sector-specific interpretation of ESG as an internal capability set that can affect risk selection, monitoring, operational resilience, and stakeholder trust, and it evaluates whether these channels operate differently across business models and across the distribution of distress. Empirically, the results indicate a negative association between ESG performance and default risk that is concentrated in the non-life segment and is present at both the 1 year and five-year horizons, with the strongest effects among insurers with higher default probabilities. In the life segment, the association is weaker and less stable across the distribution, which is consistent with a setting where market implied solvency is driven mainly by capital strength and asset liability discipline, while ESG performance plays a complementary role. These findings imply that supervisors and risk managers should treat ESG information as potentially relevant for solvency assessment, but with segment-specific expectations about where the link to default risk is most pronounced.

The remainder of the paper proceeds as follows. Section 2 reviews the relevant literature on ESG and insurer risk. Section 3 describes the data, variable construction, and econometric strategy. Section 4 presents the main results and robustness analyses. Section 5 concludes and discusses implications for managerial practice and policy design.

2 | Literature Review

The existing literature shows that life and non-life insurers have significantly different risk demographics, liability outlay, and vulnerability to sustainability-related risks, which is why they should be analysed differently. Long-term liabilities, a high degree of reliance on the performance of investments, and the central concern with the quality of governance characterise life insurers, which makes their solvency highly vulnerable to long-horizon risk management and ESG-related oversight systems (Firdaus and Endri 2025). On the contrary, non-life insurers face more short-term and medium-term underwriting risks, such as climate-related disasters and lawsuits, which makes them concerned with environmental preparedness and operational resilience (Stechemesser et al. 2015; Eling 2024). Empirical results also indicate that ESG scandals and governance failure may lead to a large rise in insolvency risk in insurance companies, having non-homogenous impacts across business lines (Giráldez-Puig et al. 2025). The systematic review also establishes that the implementation of ESG in the insurance sector is directly associated with the reduction of risks and strategic adjustment to new conditions, especially climate change and regulatory challenges (Goel et al. 2023; Sood and Özen 2024). These structural

differences form the basis of the need to differentiate life and non-life insurers in the analysis of the nexus between the ESG performance and default risk.

The risk that a firm might fail to pay its debt obligations on maturity is referred to as default risk and it is generally considered to be a major indicator of financial weakness and balance-sheet sustainability (Vassalou and Xing 2004; Bakshi et al. 2006). High default risk compromises creditor protection, market confidence, and long-term sustainability, which is a key issue among investors, regulators, and policymakers (Foster et al. 1998; Rego et al. 2009; Ho et al. 2020). In this context, the increasing popularity of the correlation between ESG performance and default risk is the manifestation of the understanding that sustainability practices can change the risk profile of firms not exactly via the market relationships but via the inner organisational processes.

The theoretical model that has been used in this study is the resource-based view. Barney (1986) argued that companies develop long-lasting competitive advantage by developing resources that are valuable and hard to copy. Going further, the concept of natural-resource-based view frames the environmental, social, and governance (ESG) capabilities as strategic intangible resources that increase the ability of firms to deal with long-term risks (Hart 1995). The capabilities in the insurance companies are the good governance frameworks, the environmental risk management frameworks, and consistent relationship between stakeholders and all these enhance organisational adaptability and resilience to external shocks. In line with this framework, empirical evidence has shown that the ESG performance is typically linked to better financial performance (Friede et al. 2015), recent meta-analytic studies directly suggest that its relationship with default risk should be further explored (Khan 2022). In response to this call, the recent research evidence shows that compulsory ESG reporting can lower the default risk due to improvement in transparency and the quality of governance (Do and Xuan 2023). Regulatory-wise, the default risk is already perceived as the major source of systemic instability as it can cause cascading failures (Anginer et al. 2017; Maquieira et al. 2024), and the effect of ESG issues on the default risk relies on the adaptive capacity and ESG maturity of the firms in its institutional setting (Korzeb et al. 2025). This interpretation is further supported by evidence provided by the family-firm studies of which the positive relationship between ESG-performance and financial stability is observed through the use of the *Z*-scores (Espinosa-Méndez and Jara 2021; Daspit et al. 2021).

The empirical evidence collected in a wide geographical setting has shown that increased involvement in ESG and corporate social responsibility (CSR) practices has a general effect of decreasing the levels of financial distress. The studies focusing on the emerging markets indicate that companies with strong CSR profiles are more likely to have increased *Z*-scores and reduced Z-scores, hence implying greater short-term financial sustainability (Farooq and Noor 2021). Although these results provide useful information, they are based on heterogeneous sectors and institutional environments and, as a result, cannot be smoothly generalised to the insurance industry. The environment that insurance companies are in encompasses a strong capital intensity, widespread prudential regulation, and liabilities with long and uncertain tails. These structural features suggest that ESG performance is a source of default risk, which is driven not by generic market mechanisms, but by firm-specific organisational capabilities.

According to the resource-based view, ESG performance is a set of internal resources that increase the ability of insurers to deal with underwriting volatility and other operational shocks. Capabilities related to governance quality, environmental risk preparedness, and internal control systems have a fundamental role in short-term solvency in non-life insurance where exposure to catastrophe risk and changes in claims are particularly high. These observations imply that ESG participation enhances the operational capacities of insurers that are directly applicable in reducing the short-term risk of default.

ESG performance and ESG controversies were critically differentiated in the literature. ESG scandals focus on realised negative incidences, such as environmental mishaps, labour malpractices, corruption, or governance malfunctions, which are indicators of failures in the internal capacities of firms. Controversies show singular failures, unlike ESG performance scores, which are proxies of sustained policies and organisational practices, which can submerge current risk-management frameworks. It has been shown that markets do not respond to these events asymmetrically, and incidences involving negative ESG events and activities lead to significant and sustained losses of value (Krueger et al. 2024). Such failures especially are expensive in regulated industries (such as insurance), since they may trigger supervisory action and reputational harm. There is direct evidence of ESG controversies, in particular, those connected to governance, posing a high risk of insolvency, which supports the importance of ESG capabilities in preventing short-term financial distress (Giráldez-Puig et al. 2025).

Market research also supports the applicability of the ESG-related capabilities in the European insurance industry. Downgrades in the ESG rating are linked to strong negative stock-market responses of the insurance companies, but upgrades have smaller positive impacts, showing that investors mostly price the risk of poor ESG performance (Di Tommaso and Mazzuca 2023; Karwowski and Raulinajtys-Grzybek 2021). This view is supplemented by the behavioural evidence, which shows that consumers are strongly averse to insurers' default risk and require large reductions in premium even to small increases in insolvency risk (Wakker et al. 1997; Zimmer et al. 2009), and that increased default risk reduces the allure of purchasing insurance contracts (Albrecht and Maurer 2000). Combined, this data indicates that ESG performance boosts the internal capacity of insurers to address operational risk, maintain trust, and have short-term solvency, especially in non-life insurance business models.

H1. *Higher ESG performance is associated with a lower short-term probability of default in insurance firms, particularly in the non-life segment.*

The available evidence suggests that the association between ESG performance and financial stability is complex and even non-linear whereby governance mechanisms and proprietary features are included. Empirical studies in the context of family firms also uncover how non-linear effects of governance

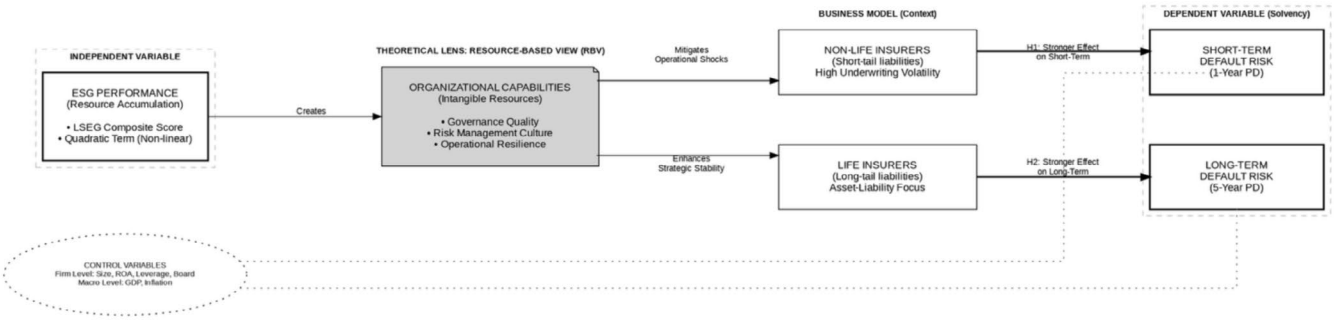

FIGURE 1 | Theoretical framework. This figure presents the conceptual framework guiding the empirical analysis. ESG performance is the main independent variable and is interpreted through the resource-based view as a source of internal organisational capabilities. These capabilities operate within insurers' business models and are transmitted differently for non-life insurers with short-term liabilities and for life insurers with long-term liabilities. Arrows indicate hypothesised directional relationships, while dashed lines represent conditional paths linked to business model characteristics. Control variables are included in the empirical models but are not shown as primary causal links.

quality and ownership concentration may lead to a financial stability level, which is measured using *Z*-scores and indicate that ESG-related capabilities would act non-mechanically between internal organisational structures (Espinosa-Méndez and Jara 2021; Daspit et al. 2021). On a larger macro scale, a negative correlation between green innovation and default risk has been reported by European studies using both market-based and accounting-based distress measures, which in turn supports the sustainability-related capabilities of long-term financial sustainability (Meles et al. 2023). Regular firm-level data also indicate that improved CSR and ESG performance are positively associated with a lower default risk in a range of institutional frameworks, such as Taiwan, China, and Iran, despite the difference in regulatory and financial institutions (Chang et al. 2013; Li et al. 2022; Kamalirezaei et al. 2020). All these results offer a solid empirical base to consider ESG performance as a predictor of default risk in the long run.

According to the resource-based view, ESG disclosure transparency demonstrates ethical ability and long-term accountability by a firm, thus making it easy to accumulate intangible resources in an organisation. These resources reduce financing frictions, reduce costs of capital, and increase loyalty of stakeholders in times of uncertainty. Market-based research supports the view that ESG information is rapidly priced in the stock market; declines in ESG ratings attract significant adverse stock market responses, and improvements in ESG ratings feel relatively weak positive ones, which suggests that investors take the ESG indicator as a sign of long-term riskiness instead of short-term adjustments in performance (Di Tommaso and Mazzuca 2023; Karwowski and Raulinajtys-Grzybek 2021). The same trends are seen in the banking industry, as the environmental and governance scores also have an inverse correlation with the default probability, especially when a business model is vulnerable to more volatility (Palmieri et al. 2024). Although these effects are generally short-horizon-based, they indicate more fundamental interventions between the quality of ESG and the structural risk profile of the firms.

Under the RBV framework, long-term ESG activity allows companies to build the capacity that would lead to greater resiliency to structural and slow-moving risks. Such abilities in the insurance industry include climate-resilience in investment policies, good board governance, and support of social licence to operate in highly regulated environments. These competencies are essential in dealing with risks that have a longer-term occurrence such as demographic change, long-term health trend, environmental transition risk, and changing prudential regulation. It is supported by empirical evidence that stable ESG performance is linked to the high *Z*-score and low risk of default, especially in firms with a long investment horizon (Korzeb et al. 2025; Liu and Zhang 2024). Even if several studies specialise in the banking field, nevertheless their findings on business models with a long horizon suggest that life insurers have much in common with them, as the liabilities of life insurers last decades, and their sustainability requires a high level of strategic discipline. Taken together, these arguments suggest that ESG performance is an ability to limit risks, but over the long term, especially with life insurers, which results in the following hypothesis:

H2. *Higher ESG performance is associated with a lower long-term probability of default in insurance firms, particularly in the life segment.*

The entire theoretical framework is represented in Figure 1.

3 | Methodology

3.1 | Data and Sample

The study utilises data from LSEG and Bloomberg to analyse the entire European insurance industry. The study covers the period from 2014 to 2023, with the initial dataset comprising all 542 insurance companies available in LSEG and Bloomberg. The implementation of data continuity filters was instrumental in ensuring the integrity and balance of the panel data. The country coverage of the sample reflects both the structure of the European insurance market and the application of strict data continuity and quality filters. Large insurance groups operate on a cross-border basis and are subject to comparable prudential supervision, disclosure standards, and market discipline across major European jurisdictions. However, consistent estimation of default risk and ESG effects requires continuous firm-level information over time. For this reason, the initial sample was subjected to data continuity filters to exclude firms and countries with intermittent ESG

TABLE 1 | Country and sector sample distribution.

Country	Number	%	Sector	Number	%
United Kingdom	49	32.24%	Life insurance	20	13.16%
Switzerland	16	10.53%	Non-life insurance	132	86.84%
The Netherlands	4	2.63%	Total	152	100.00%
Italy	10	6.58%			
Belgium	4	2.63%			
Turkey	6	3.95%			
Montenegro	6	3.95%			
Norway	5	3.29%			
Bulgaria	4	2.63%			
Sweden	3	1.97%			
Romania	3	1.97%			
Austria	9	5.92%			
Germany	9	5.92%			
France	4	2.63%			
Finland	2	1.32%			
Denmark	3	1.97%			
Poland	2	1.32%			
Serbia	2	1.32%			
Ireland	1	0.66%			
Spain	4	2.63%			
Slovenia	3	1.97%			
Greece	3	1.97%			
Total	152	100.00%			

Note: The following table provides a synopsis of the geographical and inter-industry classification of the insurance firms that have been selected as part of the final sample. The left-hand graph provides a numerical representation of the number and percentage of companies by nation, whereas the right-hand graph facilitates the separation of companies by line of business, thereby illustrating the percentage of life and non-life insurance companies within the data set. The percentages are computed in view of the cumulative sample size of 152 European insurance companies monitored over the period 2014–2023.

coverage, incomplete default risk measures, or structural breaks in reporting. These filters naturally restrict the geographical scope to 22 European countries that combine economic relevance in the insurance market with stable and comparable ESG and solvency data over the sample period. Including countries that fail to meet these criteria would introduce noise driven by data gaps rather than by firm-level ESG behaviour, thereby weakening identification. The resulting sample captures the economically meaningful segment of the European insurance industry while preserving internal validity and robustness of the empirical analysis.

After applying data continuity and quality filters, the final unbalanced panel comprises 1229 firm-year observations for 152 insurance companies operating across 22 European countries, including Austria, Belgium, Bulgaria, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Montenegro, the Netherlands, Norway, Poland, Romania, Serbia, Slovenia, Spain, Sweden, Switzerland, Turkey, and the United Kingdom (Table 1). Most of the firms in the sample are engaged in the operation of non-life insurance business lines, constituting 86.84% of the total. This clearly demonstrates the significance of non-life coverage products such as building indemnity, third-party liability (TPL), and medical expense reimbursement in the European markets under study.

3.2 | Measures

3.2.1 | Dependent Variables

The dependent variables are "*PD short-term*" and "*PD long-term*" probabilities of default (PD). Both measures are obtained from Bloomberg and are based on structural models of credit risk according to Merton's distance to default, which combine equity prices, market-based information, and asset volatility to infer firm-level default probabilities over fixed horizons. This approach is consistent with the use of market-based default indicators in the asset pricing and credit risk

literature, where one-year and multi-year structural PDs are standard measures of corporate insolvency risk (Vassalou and Xing 2004; Bharath and Shumway 2008). The "*PD short-term*" is defined as the one-year market-implied probability that the insurer will fail to meet its financial obligations. The "*PD long-term*" corresponds to the five-year horizon and captures the cumulative risk that the firm will breach solvency conditions over a longer period. Both measures are expressed in percentage terms.

As an alternative dependent variable in robustness tests we use the "*Z*-score", a widely adopted proxy for distance to default and overall financial stability in banking and insurance studies. The *Z* score is computed as the sum of return on assets (ROA) and the equity to total assets ratio, divided by the standard deviation of ROA over a rolling window. Higher *Z* score values indicate a lower probability of insolvency since a larger earnings and capital buffer is available before losses exhaust equity. This construction follows the standard practice in the banking stability literature (Laeven and Levine 2009; Beck et al. 2013) and allows us to verify that ESG performance is associated with both lower PD and higher solvency buffers. The *Z*-score has been computed as follows (Moreno et al. 2022):

$$Z_{i,t} = \frac{\mathrm{ROA}_{i,t} + \frac{\mathrm{Equity}_{i,t}}{\mathrm{Total\ assets}_{i,t}}}{\sigma\left(\mathrm{ROA}_{i,t}\right)}$$

where $\sigma\left(\mathrm{ROA}_{i,t}\right)$ is the standard deviation of ROA computed over a rolling window for firm i at time t. This measure has been elaborated using Bloomberg data.

In this study, the *Z*-score is not treated as a mediating mechanism between ESG performance and probability of default. It is used as an auxiliary solvency-based outcome that complements the market implied PD measures and serves as a robustness validation of the main results. While PD is a forward-looking market-based indicator of default likelihood over fixed horizons derived from structural credit risk models (Vassalou and Xing 2004; Bharath and Shumway 2008), the *Z*-score captures accounting-based financial soundness through the joint contribution of profitability, capitalisation, and earnings volatility. This distinction is important in the insurance context because market implied PD can react rapidly to changes in market conditions and expectations, whereas the *Z*-score reflects the internal capacity of an insurer to absorb losses through earnings and capital buffers. Prior research in the ESG and distress literature has relied on *Z*-score type measures to proxy for financial stability and to evaluate whether sustainability-related practices are associated with stronger solvency buffers (Sun and Cui 2014; Meles et al. 2023). Therefore, finding a consistent association between ESG performance and PD, together with a consistent association between ESG performance and the *Z*-score, strengthens the interpretation that ESG performance is linked to insurers' solvency conditions rather than reflecting a purely market sentiment channel.

3.2.2 | Independent Variables

The main explanatory variable is "ESG score", which is the overall ESG score assigned by LSEG at the firm-year level. This specification aligns with the empirical ESG and risk literature, which typically relies on third party ESG scores to proxy for firms' sustainability practices and non-financial risk management (Hong and Kacperczyk 2009; Albuquerque et al. 2019; Lins et al. 2017; Palmieri et al. 2024).

The *ESG score* is measured using the *composite ESG score* provided by LSEG, formerly Refinitiv. The LSEG ESG score is a firm-year composite indicator ranging from 0 to 100 and is constructed as a weighted aggregation of ESG pillar scores. Each pillar is based on a broad set of publicly disclosed indicators covering corporate policies, outcomes, and governance structures. The scoring methodology relies on reported and publicly verifiable information, and firms are implicitly penalised for limited disclosure through lower scores rather than through imputation. In this study, we rely on the LSEG *ESG score* as the primary measure because it provides the most consistent historical coverage for European insurance firms over the sample period and ensures comparability across countries and years. To address concerns related to changes in disclosure standards and ESG reporting frameworks over time, all regressions include firm, country, and time fixed effects, which absorb common methodological updates and regulatory shifts affecting ESG disclosure practices during the period under analysis. This approach mitigates potential biases arising from changes in scoring frameworks rather than from firms' underlying ESG-related behaviour. In order to strengthen our analysis, we have also checked for non-linear relations between *ESG scores* and PDs introducing the square value of the variable and it is called "ESG score squared".

3.2.3 | Control Variables

Firm-specific control variables capture insurance firm characteristics. The profitability dimension is proxied by "earnings on total assets". This ratio is a standard determinant of default risk since more profitable firms accumulate internal capital and are less likely to breach debt covenants or regulatory solvency requirements (Campbell et al. 2008; Bharath and Shumway 2008). Insurance firm size is proxied by the natural logarithm of "*total assets*". Larger insurers can benefit from diversification and easier access to funding, although size can also be associated with complexity. Controlling for firm size is consistent with the structural default literature, where leverage and scale affect the distribution of asset values relative to liabilities (Vassalou and Xing 2004; Bharath and Shumway 2008). In addition to profitability and size, the analysis includes insurance-specific financial and governance controls to capture underwriting scale, financial structure, and board-level oversight. "*Premiums collected*", measured as the logarithm of gross premiums earned, proxy for insurers' business scale and underwriting activity, which directly affect risk exposure and cash-flow stability (Eling and Marek 2014). "*Leverage*", defined as the debt-to-assets ratio, captures financial risk arising from balance-sheet structure and is a key determinant of default risk in financial institutions (Campbell et al. 2008). "Cost of debt", measured as interest expenses over total debt, reflects credit market conditions and lenders' assessment of firm risk (Almeida et al. 2011). Governance quality is further proxied by "Board Gender Equality" and "Board Education Level", which capture board diversity and human capital. Prior evidence shows that board

composition and expertise influence risk-taking, monitoring effectiveness, and financial stability (Adams and Ferreira 2009; Laeven and Levine 2009). All these control variables are gathered from Bloomberg.

Macroeconomic conditions are proxied by two country level variables. "*Inflation rate*" is the annual percentage change in the consumer price index for each insurer's home country. Economic Development is measured by real "GDP growth rate", defined as the annual percentage change in real gross domestic product. Both variables are included to control for the business cycle and price level conditions that influence insurers' asset returns, underwriting performance, and policyholder behaviour. Prior work on bank and firm risk documents that macroeconomic growth and inflation are important drivers of default frequencies and solvency indicators (Laeven and Levine 2009; Beck et al. 2013). All these control variables are gathered from the Word Bank database.

3.2.4 | Instrumental Variables

In the instrumental variable specification, ESG Performance is instrumented using three variables that capture country level environmental policy and exposure from World Bank database. "*Carbon Footprint*" is the per capita level of greenhouse gas emissions in the insurer's home country. "*Environmental Protection*" is proxied by public expenditure on environmental protection activities, measured in constant prices and expressed per capita. "*Environmental Taxation*" is measured by total environmentally related tax revenues per capita (Bolton and Kacperczyk 2021; Albuquerque et al. 2019). These instruments reflect exogenous differences in national climate policy and environmental pressure that affect firms' ESG scores through regulatory and social channels, while they are unlikely to be directly related to the idiosyncratic default risk of individual insurers, conditional on macroeconomic controls. The choice of instruments is consistent with recent literature in financial economics that links environmental regulation and carbon risk to firm level outcomes and risk premia. All these instrumental variables are gathered from Word Bank database. In Table 2 we exhibit the list of variables.

3.3 | Statistical Summary

Table 3 exhibits the statistical summary of the variables that constitute our dataset. The minimum value for the short-term probability of default is 0.007, while its maximum value is 18.141, with a mean of 0.837. The median equals 0.404, which implies that in most cases, the immediate risk of bankruptcy is very low except for extreme cases where it can reach up to more than 18 times higher than the average level. On the other hand, long-term PD has higher average values ranging from 0.087 to 28.21, with the mean being equal to 2.05. The aggregate ESG score ranges between 26.45 and 91.32, averaging around 49.70.

Table 4 shows the correlation matrix, visually representing how different measures are related. ESG score has inverse relations with PD_short_term (−0.10) and PD_long_term (−0.11), implying that organisations with better environmental social governance performance exhibit lesser risks in these areas. The ESG quadratic term on the other hand exhibits in both PD a positive correlation coefficient (+0.06).

3.4 | Econometric Specification

The panel quantile regression is used to perform the baseline empirical analysis, making the relationship between ESG performance and default risk different across the conditional distribution of the probability of default instead of basing it on the conditional mean. This technique is especially applicable when firms are not homogeneous and where the risk of default is highly skewed, and the determinants of low-risk and high-risk insurers may be different. Quantile regression allows estimating the effects of ESGs at various levels of the default risk distribution, including whether ESG performance is more pertinent in the case of insurers that are subjected to greater financial pressure. The analysis is applied to both short run and long run default probabilities. Regressions of each dependent variable are estimated at the 10th, 25th, 50th, 75th, and 90th quantiles. This enables the study to differentiate ESG effects of relatively safe insurers and insurers of high default risk. The empirical specification incorporates financial controls, governance characteristics, and macroeconomic variables at the firm level, and it controls for the presence of unobserved heterogeneity by insurance specific, country, and time fixed effects. The estimated quantile regression model may be written as follows:

$$\mathrm{PD}_{it}^{(\tau)} = \alpha^{(\tau)} + \beta_1^{(\tau)}\,\mathrm{ESG}_{it} + \beta_2^{(\tau)}\,\mathrm{ESG}_{it}^2 + \beta_3^{(\tau)\prime} X_{i,t} + \beta_4^{(\tau)\prime} Z_{c,t} + \mu_i + \lambda_c + \partial_t + \epsilon_{i,t}^{(\tau)}$$

where $\mathrm{PD}_{it}^{(\tau)}$ denotes either the short-term or long-term probability of default for insurer i at time t evaluated at quantile τ. ESG_{it} is the *ESG score* and ESG_{it}^2 captures potential non-linear effects. $X_{i,t}$ is a vector of firm-level controls including profitability, premiums collected, size, leverage, cost of debt, and board characteristics, while $Z_{c,t}$ includes country-level macroeconomic variables such as *inflation rate* and *GDP growth rate*. The terms μ_i, λ_c, and ∂_t represent insurance-specific, country, and time fixed effects, respectively.

The inclusion of the quadratic ESG term allows for the possibility that ESG performance exhibits diminishing or non-linear effects on default risk, which is consistent with the idea that moderate ESG engagement may enhance risk management capabilities, while excessive ESG investment may generate additional costs. Estimating the model across quantiles provides a comprehensive assessment of how ESG performance interacts with insurers' risk profiles under different degrees of financial vulnerability, thereby offering a richer understanding of solvency dynamics than mean-based estimation methods.

3.5 | Robustness

A comprehensive set of robustness checks is implemented to assess the stability, identification, and causal interpretation of the estimated relationship between ESG performance and default risk. First, the baseline quantile regression results are tested for sensitivity to extreme observations through winsorisation of the dependent variable and key regressors. This procedure is commonly adopted in financial risk analysis to

TABLE 2 | List of variables.

Variable	Description	Data source	Construction/calculation method	Key references
PD short-term	Log of short-term probability of default	Bloomberg	Natural logarithm of the 1-year market-implied probability of default derived from structural credit risk models based on Merton's distance-to-default framework	Vassalou and Xing (2004), Bharath and Shumway (2008)
PD long-term	Log of long-term probability of default	Bloomberg	Natural logarithm of the 5-year market-implied probability of default estimated from equity prices, asset volatility, and balance sheet information	Vassalou and Xing (2004), Bharath and Shumway (2008)
Z-score	Financial resilience proxy	Bloomberg	Winsorised reciprocal of the *Z*-score (1/*Z*-score), where the *Z*-score is computed as (ROA + equity/total assets) divided by the standard deviation of ROA; higher values indicate greater vulnerability	Beck et al. (2013), Meles et al. (2023)
ESG score	ESG performance	LSEG (Refinitiv)	Standardised logarithm of the composite ESG score, aggregating environmental, social, and governance pillar scores based on publicly disclosed and verified firm-level information	Albuquerque et al. (2019), Lins et al. (2017)
ESG score squared	Non-linear ESG effect	LSEG (Refinitiv)	Squared term of the standardised ESG score to capture potential non-linear or diminishing marginal effects of ESG performance on default risk	Espinosa-Méndez and Jara (2021), Korzeb et al. (2025)
Earning on total assets	Capitalisation/profitability proxy	Bloomberg	Logarithm of the equity-to-total assets ratio (ETA), capturing insurers' capitalisation and internal loss-absorption capacity	Campbell et al. (2008), Bharath and Shumway (2008)
Premiums collected	Business scale	Bloomberg	Natural logarithm of gross premiums earned, capturing underwriting activity and market presence	Eling and Marek (2014)
Total assets	Firm size	Bloomberg	Natural logarithm of total assets, proxying for scale, diversification, and market power	Vassalou and Xing (2004), Beck et al. (2013)
Leverage	Financial leverage	Bloomberg	Natural logarithm of the ratio between total debt and total assets	Campbell et al. (2008)
Cost of debt	Cost of debt financing	Bloomberg	Natural logarithm of interest expenses divided by total debt, proxying firms' borrowing cost and credit conditions	Almeida et al. (2011)
Board gender equality	Institutional and social environment	Bloomberg	Log-transformed Gender Equality Index capturing gender parity in economic and social participation	Ho et al. (2020)

(Continues)

TABLE 2 | (Continued)

Variable	Description	Data source	Construction/calculation method	Key references
Board education level	Governance quality proxy	Bloomberg	Log-transformed index measuring the average educational attainment of board members	Laeven and Levine (2009)
Inflation rate	Macroeconomic conditions	World Bank	Annual percentage change in the consumer price index for each firm's home country	Laeven and Levine (2009)
GDP growth rate	Business cycle indicator	World Bank	Annual real GDP growth rate at the country level	Beck et al. (2013)

Note: This table reports the list of variables used in the empirical analysis. The sample consists of 1229 firm-year observations. Probability of default measures are expressed in logarithmic form. The ESG score squared term is included to capture potential non-linear effects. Financial variables are measured at the firm level, while inflation and GDP growth are country-level indicators.

ensure that estimated effects are not driven by tail realisations (Koenker 2005). Second, potential reverse causality is examined by re-estimating the model using lagged ESG measures. This approach allows us to verify whether ESG performance predicts future default risk rather than reflecting contemporaneous financial conditions, a standard concern in ESG–risk studies (Albuquerque et al. 2019). Third, functional form robustness is evaluated by estimating both linear and non-linear specifications of ESG performance. In particular, the inclusion of a quadratic ESG term enables the model to capture potential non-monotonic relationships, which are increasingly documented in sustainability and corporate risk research (Espinosa-Méndez and Jara 2021).

With regard to endogeneity concerns in the context of ESG variables, the two-stage least squares (2SLS) method is employed. In the initial stage of the study, a regression analysis was conducted on ESG, with instrumental variables (IVs) comprising "*carbon footprint*", "*environmental protection*" initiatives (EPI), and "*environmental taxes*". The selection of instruments was made on the basis of their pertinence to ESG performance, with the assumption that they are exogenous to PD. The second stage employs predicted values from the first stage as proxies for actual levels of ESG, followed by the simultaneous analysis of predicted ESG and other covariates against PD. This approach enables the estimation of consistent parameters within the 2SLS framework. Finally, in order to correct for heteroscedasticity, heteroscedasticity-consistent standard errors are employed in the regression analysis following Arellano coefficient estimations (Arellano and Bover 1995). Formal endogeneity diagnostics are conducted. The Wu–Hausman test is employed to assess the endogeneity of ESG performance, while the Sargan test evaluates the validity of overidentifying restrictions. Instrument relevance is further examined through weak-instrument diagnostics. These tests follow established econometric practice in panel data settings where ESG measures may be correlated with unobserved firm characteristics (Wooldridge 2010).

In order to rule out regulatory confounding effects, a Difference-in-Differences design exploiting the introduction of the EU Non-Financial Reporting Directive is implemented. An event-study specification is used to verify the parallel trends assumption, as illustrated in Figure 4, in line with, to overcome the issues that the baseline results could be explained by mandatory disclosure policies rather than the inherent ESG performance, the adoption of the EU Non-Financial Reporting Directive (NFRD) is adopted as an exogenous regulatory shock. The NFRD (Directive 2014/95/EU) mandated the disclosure of non-financial and diversity information of large entities of public interest, and it came into effect on financial years starting on or after 1 January 2017. A difference-in differences (DiD) design will be used to compose firms that are forced to disclose (Treatment Group) and firms not under the mandate (Control Group). Since the NFRD is a sample of large firms, that is, those with over 500 employees and a balance-sheet total above the sample mean, the sample size is used to proxy the treatment assignment, with larger insurance firms belonging to the Treated group (Treated $i = 1$), and small players belonging to the Control group. The post-treatment variable, Post $t = 1$ in years 2017 and above, and 0 otherwise. Since the NFRD eligibility criteria include thresholds for both employee count and balance sheet total, we utilise total

TABLE 3 | Statistical summary.

Statistic	Mean	Min	Median	Max
PD short-term	0.837	0.007	0.404	18.141
PD long-term	2.05	0.087	1.322	28.21
Z-score	4.10	0.020	2.524	98.61
ESG score	49.70	26.45	48.35	91.32
ESG score squared	0.999	0.0002	0.504	7.852
Earning on total assets	7.33	−25.77	6.338	48.15
Premiums collected	11.488	3.761	11.581	16.380
Total assets	58,047.10	124.70	23,423	849,141
Leverage	4.826	−4.025	4.926	11.157
Cost of debt	1.129	−4.605	1.356	3.382
Board gender equality	1.852	1.727	1.862	1.924
Board education level	1.629	1.360	1.671	1.751
Inflation rate	1.849	−1.140	1.230	10.000
GDP growth rate	1.269	−11.330	1.710	24.370

Note: This table reports descriptive statistics for the variables used in the empirical analysis. The sample consists of 1229 firm-year observations. Probability of default measures are expressed in logarithmic form. The ESG score squared term is included to capture potential non-linear effects. Financial variables are measured at the firm level, while inflation and GDP growth are country-level indicators. The statistics provide an overview of the distribution, dispersion, and range of the variables prior to econometric estimation.

assets as the primary identification variable to define the treatment group, capturing the subset of large insurers most likely to fall under the mandatory reporting scope. The model is defined as below (Angrist and Pischke 2009):

$$\mathrm{PD}_{it} = \alpha + ß_1 \left(\mathrm{Treated}_i * \mathrm{Post}_t\right) + \gamma X_{it} + \mu_i + \lambda_c + \partial_t + \varepsilon_{i,t}^{(\tau)}$$

where PD_{it} represents the probability of default, X_{it} is the vector of controls (ESG, Inflation, GDP, etc.), and μ_i represent firm, ∂_t year, and λ_c country fixed effects, respectively. The coefficient of interest $ß_1$, captures the causal effect of the mandatory disclosure regulation on credit risk.

The 2014–2023 window spans heterogeneous macroeconomic regimes in Europe. To prevent the ESG coefficient from capturing time-specific macro shocks, the baseline specification includes two-way fixed effects, with year effects absorbing common shocks and cyclical forces affecting all firms in a given year, and country effects capturing time-invariant cross-country differences in institutional and supervisory environments. In addition, inflation and GDP growth are included as time-varying macro controls to capture cross-country business cycle conditions. To further address the possibility that the ESG default risk association differs across macro phases, we implement a robustness exercise based on subperiod estimation and a complementary interaction specification in which ESG is interacted with regime dummies that identify the post-crisis recovery, the COVID period, and the inflation and tightening period. This allows the analysis to verify whether the magnitude and significance of ESG effects remain stable when the sample is segmented by macroeconomic stages. Finally, we have used *Z*-score as an alternative proxy of financial resilience. Therefore, we have verified through panel quantile regression a positive association between ESG score and ESG score squared with *Z*-score. Due to the negative relationship existing between default probabilities and *Z*-Score.

4 | Results

4.1 | Baseline Results

Table 5 reports panel quantile regression estimates of short-term and long-term PD on ESG performance, its squared term, and a standard set of firm level and macroeconomic controls, with insurance, country, and time fixed effects. The quantile design is central in this setting because default risk is highly skewed and insurers differ in their capacity to translate ESG policies into solvency relevant organisational capabilities, as suggested by the resource based view.

Two results stand out. First, the ESG Score enters with a negative coefficient that is statistically significant in the lower and middle parts of the conditional default risk distribution for both horizons. For short term PD, the ESG coefficient is negative (−15.027**; −13.576***; −9.486**) and significant at the 10th, 25th and 50th quantiles, with magnitudes that decline in absolute value as one moves to higher quantiles. At the 75th and 90th quantiles, the coefficient remains negative but is no longer statistically significant. The long-term PD estimates display the same pattern. The ESG coefficient is negative and strongly significant through the median quantile (−12.512***; −11.717***; −7.481***), while the association weakens and becomes statistically insignificant in the upper tail. The data support a negative ESG default risk relationship in the pooled sample and at both horizons, consistent with the direction of H1 and H2, but the association is concentrated among insurers that are not already in the highest default risk states. This is also consistent with a capability interpretation. ESG-related investments in governance, controls, risk selection and operational discipline can reduce expected distress when firms are not constrained by severe balance sheet fragility, whereas in the high-risk tail default probabilities appear dominated by binding financial constraints and other fundamentals that ESG policies may not offset in the short run.

Second, ESG Score Squared is positive and statistically significant in the lower and median quantiles for both horizons (1.925**; 1.736***; 1.185**) and (1.592***; 1.488***; 0.927***). Combined with the negative linear term, this implies a convex relationship between ESG performance and default risk. The marginal reduction in PD associated with an increase in ESG performance declines as ESG rises, and the estimates allow for the possibility that beyond a threshold additional

TABLE 4 | Correlation matrix.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
PD short-term (1)	1	0.99	0.004	−0.10	0.06	−0.40	0.09	0.17	−0.04	0.03	−0.03	−0.01	−0.08	−0.06
PD long-term (2)		1	0.005	−0.11	0.06	−0.39	0.09	0.17	−0.04	0.04	−0.03	−0.02	−0.08	−0.06
Z-score (3)			1	−0.08	−0.03	−0.08	−0.29	0.22	−0.47	0.05	−0.01	0.03	0.02	0.06
ESG score (4)				1	0.08	0.13	−0.02	−0.48	0.28	0.04	0.01	0.02	−0.01	−0.03
ESG score squared (5)					1	0.02	−0.05	−0.08	0.01	0.003	0.03	0.01	−0.03	−0.03
Earning on total assets (6)						1	−0.07	−0.40	0.22	−0.05	0.06	0.003	−0.02	−0.03
Premiums collected (7)							1	0.09	0.57	0.52	0.06	−0.11	−0.05	−0.08
Total assets (8)								1	−0.54	−0.01	−0.02	−0.02	0.03	0.06
Leverage (9)									1	−0.06	0.05	−0.03	−0.06	−0.10
Cost of debt (10)										1	0.04	−0.13	−0.03	−0.05
Inflation rate (11)											1	0.02	0.30	0.20
GDP growth rate (12)												1	0.03	0.06
Board gender equality (13)													1	0.88
Board education level (14)														1

Note: The representation of the pair-wise correlation coefficients between the major variables in the analysis is achieved by such a table. The matrix facilitates the preliminary estimation of the sign and magnitude of the linear dependencies between the indicators of default probability, financial characteristics, the dimensions of ESG performance, and even instrumental variables. The values of the correlation coefficient range from −1 (*perfect negative*) to +1 (*perfect positive*), with values closer to 0 indicating a negligible linear relationship. The following summary is intended to facilitate the determination of the potential presence of multicollinearity, thereby enabling more informed interpretation of subsequent regressions.

ESG improvements do not translate into further reductions in market implied PD. This nonlinearity matches the paper's theoretical framing. Early improvements in ESG can build scarce, valuable organisational resources such as stronger governance and internal control quality, better risk governance, and higher stakeholder trust, while at higher levels the incremental solvency benefit can taper as practices become embedded and as marginal implementation costs increase.

Control variables behave largely in line with standard credit risk predictions. Earnings on total assets are strongly negative across all quantiles and both horizons, confirming that profitability and internal capital generation are first-order determinants of default risk. Leverage is economically and statistically relevant mainly in the upper tail of short-term PD, consistent with the idea that capital structure matters most when near-term solvency pressure is elevated. Board Gender Equality is associated with lower PD in parts of the distribution, including the upper tail, which aligns with the governance channel emphasised in the conceptual framework. Board Education Level is positively related to PD at the 90th quantile in both horizons, a pattern that is more consistent with firm complexity or reactive governance changes in stressed firms than with a stabilising governance effect.

TABLE 5 | Quantile regression estimates of ESG performance and default risk.

	PD short-term					PD long-term				
	Q10	**Q25**	**Q50**	**Q75**	**Q90**	**Q10**	**Q25**	**Q50**	**Q75**	**Q90**
Constant	34.210***	29.189***	23.454***	18.789*	22.499**	28.252***	25.437***	18.359***	11.663	16.567**
	(12.226)	(6.897)	(8.491)	(10.085)	(9.148)	(7.382)	(7.094)	(5.481)	(7.853)	(7.077)
ESG score	−15.027**	−13.576***	−9.486**	−6.463	−6.503	−12.512***	−11.717***	−7.481***	−3.439	−3.946
	(6.207)	(3.603)	(4.055)	(4.983)	(4.556)	(3.778)	(3.490)	(2.466)	(3.891)	(3.471)
ESG score squared	1.925**	1.736***	1.185**	0.775	0.783	1.592***	1.488***	0.927***	0.396	0.467
	(0.812)	(0.467)	(0.515)	(0.640)	(0.585)	(0.492)	(0.449)	(0.307)	(0.498)	(0.446)
Earning on total assets	−0.459***	−0.625***	−0.624***	−0.688***	−0.722***	−0.288***	−0.439***	−0.449***	−0.485***	−0.570***
	(0.061)	(0.066)	(0.052)	(0.060)	(0.041)	(0.045)	(0.053)	(0.037)	(0.041)	(0.039)
Premiums collected	0.022	0.047	0.034	0.001	−0.064	−0.015	0.048	0.005	−0.003	−0.033
	(0.051)	(0.049)	(0.048)	(0.054)	(0.052)	(0.044)	(0.040)	(0.034)	(0.044)	(0.039)
Total assets	0.028	−0.008	0.030	0.020	0.061	0.042	−0.013	0.040	0.016	0.018
	(0.074)	(0.057)	(0.054)	(0.060)	(0.056)	(0.057)	(0.045)	(0.037)	(0.048)	(0.050)
Leverage	0.036	−0.012	0.010	0.024	0.093*	0.053	−0.014	0.030	0.022	0.053
	(0.063)	(0.046)	(0.043)	(0.052)	(0.050)	(0.049)	(0.037)	(0.032)	(0.042)	(0.042)
Cost of debt	0.005	−0.031	−0.034	0.032	0.106	0.035	−0.033	0.005	0.044	0.080
	(0.065)	(0.059)	(0.061)	(0.061)	(0.065)	(0.055)	(0.046)	(0.042)	(0.052)	(0.053)
Board gender equality	−3.531*	−1.459	−2.732	−3.006	−5.918***	−2.156	−0.938	−1.621	−1.938	−4.641**
	(1.860)	(1.966)	(2.371)	(2.206)	(1.790)	(1.402)	(1.745)	(1.750)	(1.626)	(1.814)
Board education level	−0.533	−0.664	−0.034	0.536	1.887***	−0.386	−0.363	0.066	0.438	1.475**
	(0.710)	(0.787)	(0.891)	(0.854)	(0.691)	(0.563)	(0.671)	(0.653)	(0.635)	(0.695)
Inflation rate	0.020	0.027	0.015	−0.003	0.010	0.011	0.019	0.010	−0.002	0.005
	(0.022)	(0.018)	(0.018)	(0.016)	(0.017)	(0.017)	(0.015)	(0.011)	(0.013)	(0.014)
GDP growth rate	−0.007	0.005	0.007	−0.010	−0.020**	−0.003	0.008	0.001	−0.006	−0.012
	(0.009)	(0.010)	(0.009)	(0.009)	(0.008)	(0.006)	(0.006)	(0.006)	(0.007)	(0.007)
Insurance fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

(Continues)

TABLE 5 | (Continued)

	PD short-term					PD long-term				
	Q10	Q25	Q50	Q75	Q90	Q10	Q25	Q50	Q75	Q90
Country fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1229	1229	1229	1229	1229	1229	1229	1229	1229	1229

Note: This table reports quantile regression results for short term and long-term probability of default at the 10th, 25th, 50th, 75th and 90th percentiles. The key explanatory variable is the ESG score, included together with its squared term to capture potential non-linear effects. Firm level financial characteristics, board attributes and macroeconomic controls are included. All specifications control for insurance, country and time fixed effects. Standard errors are reported in parentheses. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

Figure 2 illustrates how the marginal effect of ESG performance on default risk varies across the conditional distribution of insurers' probability of default. For both short-term and long-term horizons, the estimated ESG coefficients are negative throughout the distribution, but their magnitude is clearly heterogeneous. The effect is strongest in the lower and middle quantiles, corresponding to insurers with relatively low to moderate default risk, and it becomes progressively weaker as one moves toward the upper tail. Confidence intervals widen at higher quantiles, indicating greater uncertainty among financially stressed insurers, although the point estimates remain below zero over most of the range. This pattern is consistent with the resource based view interpretation adopted in the paper. ESG performance reflects internal organisational capabilities that are more effective when firms operate under normal or moderately adverse conditions, while their ability to offset severe financial distress is limited. The figure therefore complements the regression results by showing that ESG-related capabilities contribute to reducing default risk primarily where solvency is not already critically impaired, and that their stabilising role diminishes at the extreme tail of the risk distribution.

4.2 | Life and Non-Life Analysis

Table 6 reports the sectorial analysis results obtained from segment specific estimations and allows a direct assessment of the two hypotheses within the resource based view framework. The evidence points to a clear asymmetry between life and non-life insurers, both in economic magnitude and statistical significance, which is consistent with the theoretical arguments developed in the manuscript. In order to cope with potential endogeneity issues, we use a 2SLS-IV model.

Starting from short term default risk, the coefficient on the ESG score is negative and statistically significant only for non-life insurers (−0.087* for short term and −0.081** in the long run), while it is small and not significant for life insurers. This finding provides direct support for H1. Within the resource based view, ESG performance proxies for internal organisational capabilities related to governance quality, operational controls, transparency, and risk monitoring. These capabilities are particularly relevant in non-life insurance, where underwriting volatility, exposure to catastrophe risk, and operational shocks dominate short horizon solvency conditions. The positive and significant coefficient on the squared ESG term in the non-life sample suggests a non-linear relationship, where moderate to high ESG engagement is associated with a lower probability of default, but marginal benefits decline at very high ESG levels. This pattern is consistent with the idea that ESG related investments enhance core risk management capabilities up to a point, after which additional commitments may generate costs that do not proportionally improve short-term resilience. For life insurers, the absence of a significant ESG effect at the one-year horizon is coherent with a business model in which short term market implied default risk is mainly driven by capital buffers and asset allocation rather than by operational ESG capabilities.

Turning to long term default risk, the results again show a strong and robust negative association between ESG performance and default probability for non-life insurers, while the coefficients

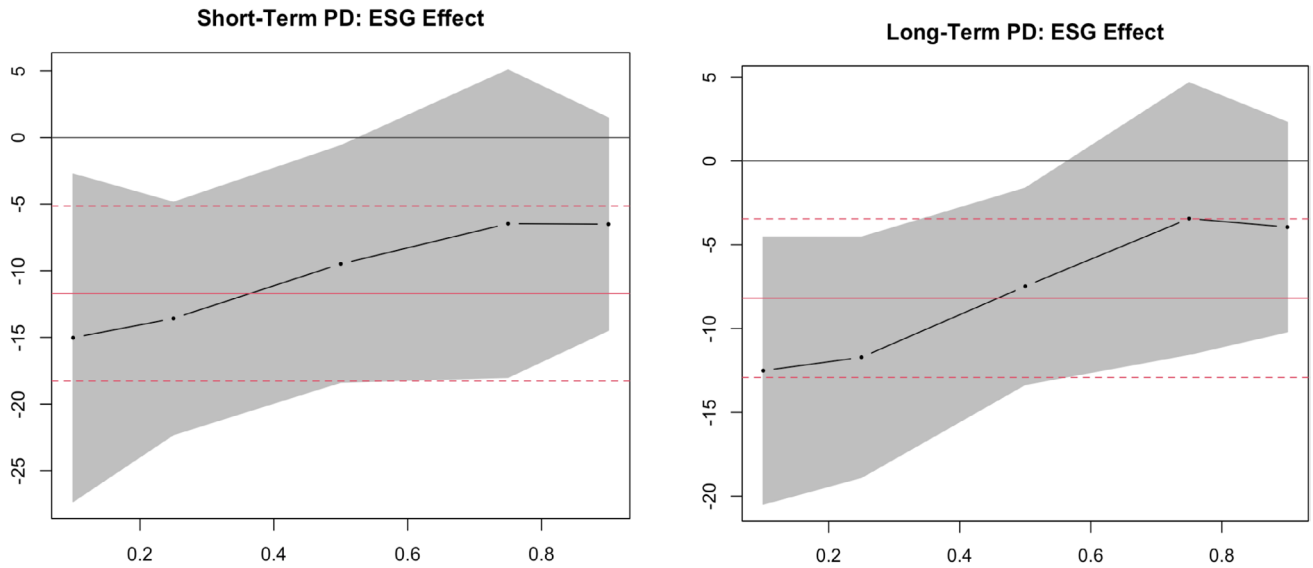

FIGURE 2 | ESG effect on default risk across the distribution. The figure plots quantile regression estimates of the marginal effect of the ESG score on short-term and long-term probability of default across selected quantiles. Point estimates are reported along the quantile distribution, with the shaded areas representing confidence intervals. Horizontal reference lines indicate zero effect and benchmark effect levels for comparison.

for life insurers remain statistically weak. This partially supports H2 but in a different direction than initially expected. Under the resource based view, ESG capabilities contribute to sustained risk control, reputational capital, and regulatory credibility, which lower long horizon distress risk when liabilities are shorter and underwriting exposure remains central. For non-life insurers, these capabilities continue to matter even over a five-year horizon because claims volatility, legal risk, and governance failures accumulate over time. The persistence of the non-linear ESG effect reinforces the interpretation that ESG operates as an internal capability set with diminishing marginal returns rather than as a pure signalling device.

For life insurers, the weak ESG default risk link at the long horizon suggests that market implied solvency over 5 years is still dominated by balance sheet strength, asset liability discipline, and investment performance. ESG performance appears to act as a complementary factor rather than a primary driver of default risk. This result aligns with the resource based view when applied to long duration business models, where intangible ESG capabilities support strategic discipline and credibility but do not substitute for core financial resources.

Control variables behave as expected. Profitability strongly reduces default risk across segments and horizons, while leverage increases risk mainly in non-life insurers. Board gender equality is strongly associated with lower default risk in life insurers, indicating that governance quality plays a structural role in long horizon stability. Overall, the results confirm that ESG performance matters for default risk, but its relevance is conditional on business model characteristics and the horizon over which solvency is assessed.

Although the empirical analysis relies on the composite ESG score, the literature suggests that the three pillars can affect risk outcomes through different channels. The environmental dimension is likely to be particularly relevant for non-life insurers because underwriting portfolios are directly exposed to climate and catastrophe-related claims, and climate risk management capabilities are increasingly viewed as part of insurers' strategic adaptation to long-horizon environmental change (Stechemesser et al. 2015; Thistlethwaite and Wood 2018). By contrast, governance quality may be a dominant channel in life insurers given the long duration of liabilities and the centrality of board oversight, transparency, and risk control in sustaining long-term asset liability management. Evidence from related financial intermediaries is consistent with this view, since environmental and governance scores appear to be the most robust pillars in reducing default risk for European banks, with effects that vary across business models (Palmieri et al. 2024). The social dimension can also matter through customer trust and conduct-related risks, which are particularly salient in insurance markets where policyholder behaviour is sensitive to perceptions of reliability (Zimmer et al. 2009). These considerations indicate that a composite ESG score may mask pillar-specific transmission mechanisms, and future research could estimate pillar-level specifications to identify which ESG dimensions are most effective in reducing default risk across insurance business models. According to past studies on resilience, the qualities of governance, trust of stakeholders, and environmental readiness may be especially critically needed during moments of greater uncertainty or systemic stress, when companies are more closely regulated, subjected to liquidity pressures, and reputational risks (Eccles et al. 2014; Feng et al. 2022). Such dynamics can be of particular importance in the insurance industry, where insurers are vulnerable to macroeconomic shocks, disasters, and regulatory intervention.

4.3 | Robustness Test

4.3.1 | Endogeneity, Multicollinearity and Heterogeneity Issues

Tables 7 and 8 address potential endogeneity, functional form, and identification concerns in the ESG–default risk relationship and provide a rigorous validation of the baseline results. Taken

TABLE 6 | ESG performance and default risk across insurance segments—2SLS estimation for endogeneity.

	PD short-term		PD long-term	
	Life	**Non-life**	**Life**	**Non-life**
ESG score	0.013	−0.087*	0.012	−0.081**
	(0.090)	(0.051)	(0.075)	(0.034)
ESG score squared	−0.070	0.086**	−0.045	0.062***
	(0.067)	(0.035)	(0.052)	(0.023)
Earning on total assets	−0.696***	−0.587***	−0.494***	−0.435***
	(0.131)	(0.060)	(0.109)	(0.042)
Premiums collected	−0.047	−0.057	−0.011	−0.035
	(0.070)	(0.050)	(0.054)	(0.028)
Total assets	0.132	0.101*	0.087	0.062*
	(0.090)	(0.059)	(0.065)	(0.033)
Leverage	0.028	0.105**	0.014	0.073***
	(0.051)	(0.043)	(0.032)	(0.020)
Cost of debt	−0.013	0.109	0.010	0.065
	(0.057)	(0.068)	(0.058)	(0.043)
Board gender equality	−12.285***	−0.130	−8.501***	−0.149
	(3.918)	(2.741)	(3.070)	(1.984)
Board education level	3.517**	−0.926	2.474*	−0.527
	(1.688)	(1.009)	(1.299)	(0.721)
Inflation rate	0.137***	−0.003	0.087***	0.003
	(0.041)	(0.014)	(0.030)	(0.009)
GDP growth rate	0.011	−0.002	0.015	−0.003
	(0.015)	(0.010)	(0.013)	(0.007)
Insurance fixed effect	Yes	Yes	Yes	Yes
Country fixed effect	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes
Observations	160	1069	160	1069

Note: This table reports regression results for life and non-life insurance companies, separately for short term and long term probability of default. ESG performance is captured by the ESG score and its squared term. All specifications include firm level financial controls, board characteristics and macroeconomic variables, as well as insurance segment, country and time fixed effects. Standard errors are reported in parentheses. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

together, these robustness checks reinforce the interpretation of ESG performance as an internal organisational capability rather than a spurious correlate of insurers' financial conditions.

Table 7 reports the results from the instrumental variable estimation based on a two-stage least squares framework, complemented by Arellano-type robust inference. ESG performance is instrumented using country-level environmental policy and exposure variables, which affect firms' ESG profiles through regulatory and social pressure but are plausibly exogenous to idiosyncratic insurer default risk. The ESG coefficient remains statistically significant in both the short term and long-term default risk equations, confirming that the core ESG–risk association is not driven by reverse causality or omitted firm characteristics. The change in sign and magnitude relative to the baseline estimates reflects the well-known sensitivity of IV coefficients, but the economic interpretation remains consistent: ESG performance is systematically related to default risk once endogeneity is addressed. The squared ESG term is not statistically significant in the IV setting, suggesting that non-linearities are less precisely estimated once identification relies on exogenous variation. This outcome is common in IV applications and does not undermine the broader evidence of diminishing marginal effects observed in reduced-form

TABLE 7 | 2SLS-IV and Arellano coefficient estimation results.

2SLS	PD short-term	PD long-term
Constant	5.201**	5.056***
	(2.515)	(1.819)
ESG	0.078***	0.055***
	(0.028)	(0.021)
ESG^2	−0.166	−0.173
	(0.335)	(0.242)
Earning on total assets	−0.581***	−0.407***
	(0.050)	(0.036)
Premiums collected	0.028	0.013
	(0.046)	(0.033)
Insurance size	−0.030	−0.031
	(0.112)	(0.081)
Leverage	0.013	0.017
	(0.044)	(0.032)
Cost of debt	−0.012	0.007
	(0.056)	(0.041)
Gender equality	−2.997	−2.404*
	(1.823)	(1.318)
Board education	0.129	0.218
	(0.711)	(0.514)
Inflation rate	0.012	0.008
	(0.015)	(0.011)
GDP growth rate	−0.001	−0.001
	(0.007)	(0.005)
Insurance fixed effect	Yes	Yes
Country fixed effect	Yes	Yes
Time fixed effect	Yes	Yes
Observations	1229	1229
R^2	0.174	0.159
Adjusted R^2	0.166	0.152
Residual std. error (df = 1217)	1.136	0.821

Note: This table reports two-stage least squares estimates of the relationship between ESG performance and short-term and long-term probability of default. ESG and its squared term are instrumented to address potential endogeneity. The models include firm-level financial controls, board characteristics and macroeconomic variables, together with insurance, country and time fixed effects. Standard errors are reported in parentheses. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

specifications. The control variables retain their expected signs, with profitability exerting a strong and stabilising effect on default risk, in line with standard structural credit risk models.

Figure 3 provides a visual synthesis of the nonlinear ESG–default risk relationship identified in the baseline quantile regressions and in the instrumental variable specification. The figure plots the predicted log probability of default against the log ESG score for different quantiles of the risk distribution, together with the curve implied by the 2SLS IV model. Across all specifications, the relationship exhibits a clear U-shaped pattern, with default risk declining as ESG performance improves up to an intermediate range and then flattening or mildly increasing at higher ESG levels. The consistency of this shape across quantiles is informative. At lower quantiles, corresponding to financially safer insurers, the curvature is relatively mild, indicating limited marginal gains from ESG once baseline stability is achieved. At higher quantiles, where insurers face greater distress, the curvature is more pronounced, suggesting that ESG-related capabilities yield stronger risk-reducing effects up to a point. Beyond this range, additional ESG engagement appears to deliver diminishing benefits, in line with the interpretation that ESG investments entail organisational and compliance costs that may not translate proportionally into further reductions in default risk.

Table 8 provides a comprehensive set of diagnostic and sensitivity tests that further strengthen the credibility of the empirical strategy. Winsorisation of extreme values leaves the ESG coefficient negative and economically meaningful, ruling out the possibility that the results are driven by outliers. Lagged ESG specifications yield insignificant coefficients, suggesting that the relationship is contemporaneous rather than reflecting delayed adjustments, which is consistent with market-based default measures that rapidly incorporate information. Linear ESG specifications fail to capture the relationship, while the non-linear specification confirms a U-shaped pattern with a turning point at higher ESG levels, supporting the conceptual argument that ESG capabilities generate benefits up to a threshold. Multicollinearity diagnostics show variance inflation factors well below critical levels, indicating stable coefficient estimates.

Crucially, the Durbin–Wu–Hausman test fails to reject the null of ESG exogeneity, implying no statistical evidence that ESG performance is endogenous in the baseline models ($\chi^2 = 0.077$; p value 0.781). The Sargan test supports the validity of the overidentifying restrictions, and the weak instrument diagnostics confirm that the chosen instruments have sufficient explanatory power ($\chi^2 = 1.039$; p value 0.595). From a resource based view perspective, these findings are coherent with the idea that ESG performance reflects accumulated organisational resources embedded in governance structures and risk management processes, rather than being mechanically determined by short term financial outcomes. Overall, the IV and diagnostic evidence strongly supports the robustness and internal validity of the ESG–default risk relationship documented in the paper.

4.3.2 | Time Effects

Tables 9–11 provide complementary robustness evidence that strengthens the interpretation of the baseline results and helps

TABLE 8 | Robustness and diagnostic tests for the ESG–default risk relationship.

Diagnostic test	Key statistic(s)	*p*	Purpose	Interpretation
Outlier treatment (winsorisation)	ESG baseline: −9.4862 | ESG winsorised: −5.1359	—	Sensitivity to extreme values	The ESG coefficient remains negative after winsorisation, indicating that the estimated effect is not driven by outliers.
Lagged ESG specification	ESG ($t-1$): 0.0301	$t=0.70$	Reverse causality	The lagged ESG term is not statistically significant, suggesting a contemporaneous rather than delayed relationship.
Linear ESG specification	ESG (linear): −0.1676	$t=-0.98$	Functional form	A linear specification fails to capture the ESG–risk relationship, supporting the need for non-linearity.
Non-linear (U-shaped) specification	ESG: −9.4862 | ESG^2: 1.1845	—	Shape of relationship	The positive quadratic term implies a U-shaped relationship, with a turning point at log ESG ≈ 4.
Multicollinearity (VIF)	Max VIF (controls): 4.415	—	Coefficient stability	VIF values remain below critical thresholds, indicating no severe multicollinearity concerns.
Wu–Hausman test (endogeneity)	$\chi^2=0.077$	0.781	Endogeneity of ESG	The null of exogeneity cannot be rejected, suggesting no evidence of ESG endogeneity.
Sargan test (overidentifying restrictions)	$\chi^2=1.039$	0.595	Instrument validity	The null of instrument exogeneity is not rejected, supporting the validity of the IV set.
Weak instruments test	F-statistic = 5.057	0.0017	Instrument relevance	The null of weak instruments is rejected, indicating that the instruments are sufficiently strong.

Variable	ESG score	Earning on total assets (ETA)	Premiums earned	Total assets	Leverage
VIF value	1.137	1.103	1.029	1.295	1.171

Variable	Cost of debt	Inflation rate	GDP growth rate	Board gender equality	Board education level
VIF value	1.038	1.117	1.015	4.415	4.207

Note: This table reports diagnostic tests for the instrumental variable (2SLS) specifications. The Cragg–Donald statistic is reported to assess instrument relevance and potential weak instrument concerns in the first-stage regressions. The large *p* values indicate that the null hypothesis of weak instruments cannot be rejected, suggesting that the instruments exhibit sufficient explanatory power for ESG performance. In addition, the Durbin–Wu–Hausman (DWH) test is reported to evaluate the presence of endogeneity in ESG performance. The reported *p* values indicate that the null hypothesis of exogeneity cannot be rejected at conventional significance levels, implying that ESG performance does not exhibit statistically significant endogeneity in the baseline specifications. Taken together, these diagnostics support the validity of the instrumental variable strategy and confirm the robustness of the 2SLS estimates for both short-term and long-term default risk models.

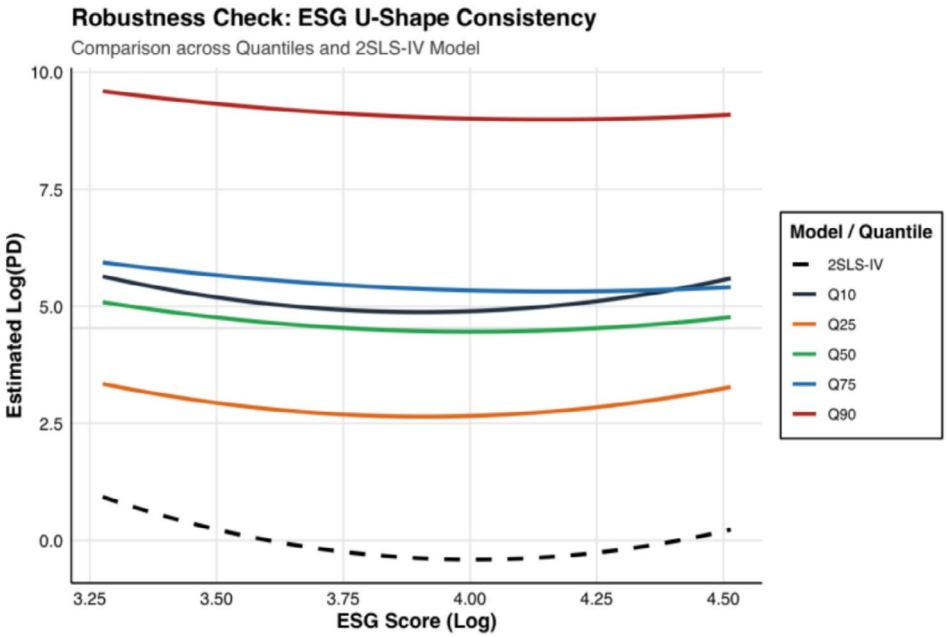

FIGURE 3 | Robustness check of the ESG U-shaped effect on default risk. The figure compares the estimated relationship between ESG performance and the logarithm of probability of default across quantile regressions and the 2SLS instrumental variable specification. Curves report predicted values over the ESG distribution, highlighting the consistency of the non-linear pattern across quantiles and econometric approaches.

clarify the role of ESG performance within the resource based view framework.

Table 9 exploits the introduction of the EU Non-Financial Reporting Directive as an external regulatory shock to disentangle the effect of mandatory disclosure from the intrinsic relationship between ESG performance and default risk. The DiD coefficient is statistically insignificant for both short-term and long-term PD, indicating that mandatory ESG disclosure per se does not mechanically reduce insurers' default risk (0.115; 0.099). This result is important from a theoretical perspective. It suggests that the negative association between ESG performance and default risk identified in the baseline analysis is not driven by compliance effects or reporting obligations, but rather by firm-specific ESG capabilities. Consistently with the resource based view, ESG performance appears to reflect accumulated internal resources related to governance quality, risk control, and organisational discipline, rather than a pure disclosure artefact. At the same time, the ESG score retains a negative and significant coefficient in both horizons, while the squared term remains positive and significant. This confirms the presence of a non-linear relationship even after accounting for regulatory shocks. The pattern supports the interpretation that ESG capabilities reduce default risk up to a point, with diminishing marginal returns, in line with the view that excessive ESG investments may entail costs without proportionate gains in solvency. Similar interpretations are advanced in studies linking governance quality and financial stability in regulated financial intermediaries, including Anginer et al. (2017) and Korzeb et al. (2025).

Table 10 addresses time heterogeneity by estimating the ESG default risk relationship across distinct macroeconomic subperiods. The results show that ESG effects are not constant over time. In the pre NFRD and low-interest rate periods, ESG coefficients are generally small and statistically weak. By contrast, during the inflationary and monetary tightening phase of 2022–2023, ESG performance exhibits a strong and statistically significant negative association with both short-term and long-term default risk, accompanied by a significant quadratic term. This finding is consistent with resilience-based interpretations in the literature. Prior work argues that governance quality, stakeholder trust, and organisational preparedness become more valuable during periods of systemic stress and heightened uncertainty, when firms face tighter supervision and reputational pressures (Feng et al. 2022). In insurance markets, where solvency is sensitive to macroeconomic shocks and regulatory scrutiny, ESG-related capabilities appear to operate as stabilising resources particularly in adverse regimes. Overall, these robustness checks reinforce the core conclusion that ESG performance functions as an internal capability set whose impact on default risk is conditional on both regulatory context and macroeconomic conditions, in line with the resource based view.

Figure 4 plots the coefficients of the interaction between the Treatment assignment and year dummies, with 2016 serving as the reference year (coefficient normalised to zero). The results confirm the validity of our research design. For the pre-treatment period (2014–2015), the point estimates are statistically indistinguishable from zero (as indicated by the 95% confidence intervals crossing the horizontal axis). This confirms that, prior to the NFRD implementation, the Treated and Control groups followed parallel trends in terms of credit risk. Furthermore, the post-treatment coefficients (2017–2023) remain statistically insignificant, reinforcing the conclusion that the regulatory shock itself did not act as a confounder in the relationship between ESG performance and default probability.

TABLE 9 | Difference in differences estimates of ESG and default risk under a regulatory shock.

Difference-in-differences analysis (regulatory shock)	PD short-term	PD long-term
Constant	5.781**	5.497***
	(2.489)	(1.792)
DiD	0.115	0.099
	(0.092)	(0.066)
ESG score	−0.074**	−0.067**
	(0.037)	(0.027)
ESG score squared	0.072***	0.049***
	(0.026)	(0.019)
Earning on total assets	−0.574***	−0.399***
	(0.041)	(0.030)
Premiums collected	0.031	0.016
	(0.045)	(0.032)
Total assets	−0.028	−0.021
	(0.053)	(0.038)
Leverage	0.009	0.013
	(0.042)	(0.030)
Cost of debt	−0.015	0.003
	(0.053)	(0.038)
Board gender equality	−3.445*	−2.813**
	(1.819)	(1.310)
Board education level	0.236	0.318
	(0.704)	(0.507)
Inflation rate	0.009	0.006
	(0.015)	(0.011)
GDP growth rate	−0.001	−0.001
	(0.007)	(0.005)
Insurance fixed effect	Yes	Yes
Country fixed effect	Yes	Yes
Time fixed effect	Yes	Yes
Observations	1229	1229
R^2	0.179	0.172
Adjusted R^2	0.171	0.164
F Statistic (df = 12; 1216)	22.063***	21.023***

Note: This table reports difference-in-differences regression results assessing the impact of a regulatory shock on short-term and long-term probability of default. The DiD coefficient captures the average treatment effect, while ESG performance is modelled through a quadratic specification. All models include firm-level financial controls, board characteristics, macroeconomic variables, and insurance, country, and time fixed effects. Standard errors are reported in parentheses. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

Table 11 further examines the stability of the ESG default risk relationship by allowing ESG effects to vary across macroeconomic regimes. The baseline ESG coefficient remains negative and statistically significant for short-term default risk, while it is negative but not significant for the long-term horizon. This result confirms that, on average, ESG performance is associated with lower near-term market implied default risk, even after explicitly accounting for regime shifts. From a resource based view perspective, this finding is consistent with the interpretation of ESG as a set of internal capabilities that support operational resilience and risk control under normal conditions.

The regime dummies capturing the COVID period and the monetary tightening phase are not statistically significant, suggesting that these macro shocks do not mechanically alter insurers' default risk once firm, country, and time fixed effects are taken into account. More importantly, the interaction terms between ESG and the macroeconomic regimes are also statistically insignificant for both horizons. This indicates that the marginal effect of ESG performance on default risk does not differ systematically during periods of extreme stress or tighter financial conditions. In theoretical terms, this suggests that ESG-related capabilities operate as structural features of insurers' organisational architecture rather than as countercyclical buffers that become effective only in crisis periods. These findings complement the subperiod analysis by showing that, while ESG effects may become more visible in specific adverse regimes, their average contribution to reducing default risk is not driven by temporary macroeconomic interactions. Instead, ESG performance reflects persistent internal resources linked to governance quality, transparency, and risk management, which align with the resource based view interpretation developed in the manuscript.

4.3.3 | Alternative Dependent Variable

Table 12 and Figure 5 provide a robustness assessment based on an alternative dependent variable that captures insurers' financial stability through the Z score. This robustness is important because it allows verification of whether the ESG default risk relationship identified with market implied PD is also reflected in an accounting-based measure of solvency and loss absorption capacity. The results confirm a coherent and economically meaningful pattern across the conditional distribution of financial stability.

The ESG coefficient is small and statistically insignificant at the lower quantiles of the Z score distribution, while it becomes positive and statistically significant from the median onwards (0.001*; 0.010**; 0.025**), with the largest effects observed at the upper quantiles. This implies that ESG performance is more strongly associated with higher financial stability among insurers that already exhibit stronger solvency buffers. Figure 5 visually reinforces this result by showing an increasing ESG effect across quantiles, with point estimates rising above the OLS mean effect at the upper tail. From a resource based view perspective, this pattern suggests that ESG related capabilities complement existing financial resources rather than substituting for them. Firms with weak capital

TABLE 10 | Time-varying effects of ESG on default risk across subperiods.

	PD short-term				PD long-term			
	2014–2016	**2017–2019**	**2020–2021**	**2022–2023**	**2014–2016**	**2017–2019**	**2020–2021**	**2022–2023**
Constant	−1.582	5.155	−1.642	−8.108	0.072	5.527**	1.609	−3.901
	(6.258)	(4.236)	(14.201)	(12.607)	(4.248)	(2.598)	(9.011)	(9.692)
ESG score	−0.034	0.005	0.051	−0.253***	−0.037	−0.029	0.029	−0.203***
	(0.118)	(0.056)	(0.083)	(0.054)	(0.085)	(0.045)	(0.034)	(0.039)
ESG score squared	0.031	0.037	0.149**	0.075**	0.020	0.015	0.104***	0.077**
	(0.085)	(0.036)	(0.059)	(0.038)	(0.059)	(0.029)	(0.023)	(0.030)
Earning on total assets	−0.928***	−0.420***	−0.547***	−0.651***	−0.648***	−0.354***	−0.400***	−0.492***
	(0.131)	(0.080)	(0.100)	(0.065)	(0.096)	(0.057)	(0.075)	(0.058)
Premiums collected	0.039	0.001	−0.037	0.180*	0.041	0.010	−0.045	0.176
	(0.097)	(0.067)	(0.110)	(0.100)	(0.061)	(0.062)	(0.073)	(0.121)
Total assets	−0.165	0.118	0.159	−0.126	−0.116	0.041	0.134*	−0.152
	(0.114)	(0.081)	(0.119)	(0.109)	(0.076)	(0.061)	(0.076)	(0.124)
Leverage	−0.069	0.053	0.047	−0.145	−0.057	0.029	0.064	−0.154
	(0.094)	(0.055)	(0.099)	(0.090)	(0.059)	(0.057)	(0.063)	(0.119)
Cost of debt	−0.027	−0.002	0.079	−0.155	−0.031	−0.009	0.086	−0.168
	(0.110)	(0.090)	(0.145)	(0.135)	(0.074)	(0.074)	(0.098)	(0.148)
Board gender equality	3.298	−2.359	−1.115	6.333	2.236	−2.081	−2.664	3.974
	(5.145)	(3.245)	(9.833)	(9.071)	(3.466)	(2.026)	(6.553)	(7.035)
Board education level	−1.331	−1.533	1.386	−2.254	−1.060	−0.860	1.861	−1.348
	(2.290)	(1.432)	(2.564)	(2.567)	(1.527)	(1.006)	(1.848)	(2.049)
Inflation rate	−0.098	−0.040	−0.204	0.033	−0.078	−0.047	−0.127	0.033
	(0.125)	(0.070)	(0.228)	(0.042)	(0.087)	(0.052)	(0.142)	(0.034)
GDP growth rate	−0.057**	0.044	0.013	0.047	−0.038**	0.022	0.002	0.037
	(0.024)	(0.048)	(0.024)	(0.030)	(0.016)	(0.025)	(0.016)	(0.026)
Insurance fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	304	382	265	278	304	382	265	278

Note: This table reports regression estimates for short term and long-term probability of default over four subperiods covering 2014–2016, 2017–2019, 2020–2021 and 2022–2023. ESG performance is modelled through a quadratic specification to allow for non-linear effects that may vary over time. All regressions include firm level financial controls, board characteristics and macroeconomic variables, as well as insurance, country and time fixed effects. Standard errors are reported in parentheses. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

and volatile earnings do not immediately translate ESG engagement into stronger stability, whereas well capitalised and profitable insurers are better positioned to leverage governance quality, risk management practices, and organisational discipline embedded in ESG performance.

The presence of a negative squared ESG term around the median quantiles indicates mild nonlinearity, consistent with diminishing marginal returns to ESG investments once a certain level of stability is achieved. This aligns with the interpretation advanced in the default risk analysis, where ESG acts as an internal capability set that improves resilience but does not generate unlimited gains. Control variables behave as expected. Leverage consistently reduces the Z score across all quantiles, while premiums collected contribute positively to stability at higher quantiles, reflecting scale and diversification effects.

TABLE 11 | Time-robustness analysis with macroeconomic regime interactions.

Time robustness	PD short term	PD long term
ESG	−0.010*	−0.015
	(0.006)	(0.010)
Covid	−0.031	−0.056
	(0.057)	(0.100)
Tightening	−0.001	−0.001
	(0.016)	(0.027)
ESG*Covid	0.001	0.002
	(0.007)	(0.012)
ESG*tightening	0.003	−0.001
	(0.007)	(0.012)
Insurance fixed effect	Yes	Yes
Country fixed effect	Yes	Yes
Time fixed effect	Yes	Yes
Observations	1299	1299
R^2	0.178	0.189

Note: This table reports time robustness regressions examining the relationship between ESG performance and short term and long term probability of default under different macroeconomic regimes. Interaction terms capture differential ESG effects during the COVID period and phases of monetary tightening. All specifications include insurance, country and time fixed effects. Standard errors are reported in parentheses. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

The negative association between firm size and *Z* score at upper quantiles suggests that complexity may offset scale benefits in highly stable insurers.

5 | Conclusions

This study evaluates whether ESG performance is associated with lower default risk in European insurance firms, and whether the association differs between life and non-life business models. The incremental contribution is threefold. First, the paper treats default probability as the core outcome, using Bloomberg market implied PD at 1 and 5 years. This shifts the focus from generic performance metrics to a forward-looking measure that is directly connected to solvency and market discipline. Second, the empirical strategy relies on panel quantile regressions with firm, country, and year fixed effects, allowing the ESG association to vary along the conditional distribution of default risk rather than being constrained to an average effect. Third, the analysis is explicitly structured around the segmentation of life versus non-life insurers and two supervisory relevant horizons, recognising that liability duration, underwriting versus investment dominance, and the channels through which ESG can matter are not comparable across business models.

Across 152 insurers from 22 European countries over 2014 to 2023, higher ESG scores are associated with lower short-term and long-term market implied default probabilities in the pooled sample. The distributional evidence indicates that the association is statistically strongest in the lower and middle quantiles of default risk, while it becomes weaker and less precisely estimated in the upper tail. Point estimates remain

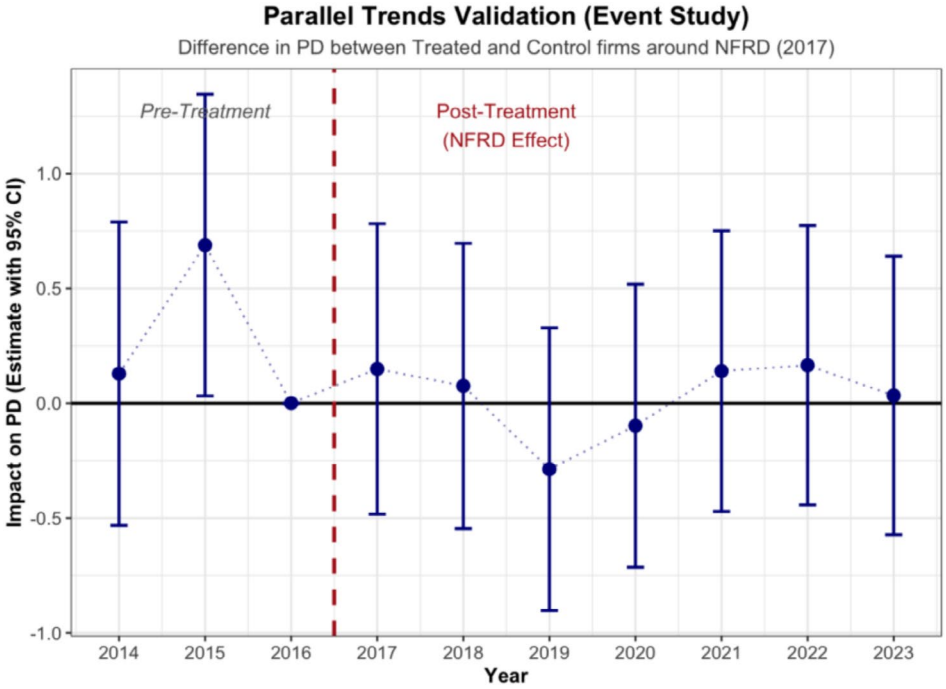

FIGURE 4 | Parallel trends and event study around the NFRD introduction. The figure reports event study estimates of the difference in probability of default between treated and control firms around the introduction of the NFRD in 2017. Point estimates are shown with 95% confidence intervals. The vertical line marks the policy implementation year. Pre-treatment coefficients are statistically indistinguishable from zero, supporting the parallel trends assumption, while post-treatment dynamics capture the regulatory effect over time.

TABLE 12 | Quantile regression estimates of ESG and financial stability.

	Z-score				
	Q10	**Q25**	**Q50**	**Q75**	**Q90**
Constant	0.063***	0.094***	0.304***	0.803***	2.293***
	(0.016)	(0.026)	(0.071)	(0.279)	(0.691)
ESG score	0.0001	0.0001	0.001*	0.010**	0.025**
	(0.0001)	(0.0002)	(0.001)	(0.004)	(0.010)
ESG score squared	−0.00004	−0.0001	−0.001*	−0.001	−0.010
	(0.0001)	(0.0001)	(0.0005)	(0.003)	(0.007)
Earning on total assets	0.0001	0.0004	0.001	0.004	0.006
	(0.0002)	(0.0003)	(0.001)	(0.005)	(0.010)
Premiums collected	0.0002	0.002**	0.010*	0.037***	0.036*
	(0.0003)	(0.001)	(0.006)	(0.012)	(0.020)
Total assets	−0.0001	−0.002**	−0.010	−0.045***	−0.048**
	(0.0003)	(0.001)	(0.006)	(0.012)	(0.021)
Leverage	−0.008***	−0.011***	−0.021***	−0.067***	−0.099***
	(0.001)	(0.002)	(0.006)	(0.011)	(0.019)
Cost of debt	−0.0001	−0.002*	−0.008	−0.031***	−0.029
	(0.0003)	(0.001)	(0.006)	(0.012)	(0.021)
Board gender equality	−0.006	−0.017	−0.130***	−0.193	−1.046**
	(0.006)	(0.014)	(0.047)	(0.206)	(0.502)
Board education level	−0.003	−0.003	0.032*	0.011	0.262
	(0.002)	(0.005)	(0.017)	(0.075)	(0.178)
Inflation rate	0.00005	0.0001*	0.0001	−0.001	0.007*
	(0.00005)	(0.0001)	(0.0004)	(0.001)	(0.004)
GDP growth rate	−0.00000	0.00004	0.00001	0.0003	−0.002
	(0.00002)	(0.00004)	(0.0001)	(0.001)	(0.001)
Insurance fixed effect	Yes	Yes	Yes	Yes	Yes
Country fixed effect	Yes	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes	Yes
Observations	1229	1229	1229	1229	1229

Note: This table reports quantile regression results for the *Z* score across the 10th, 25th, 50th, 75th, and 90th percentiles. ESG performance is included together with its squared term to allow for non-linear effects. All specifications control for firm level financial characteristics, board attributes, and macroeconomic variables, and include insurance, country, and time fixed effects. Standard errors are reported in parentheses. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

generally negative across quantiles, but confidence intervals widen for the riskiest firms, which is consistent with a setting in which acute balance sheet constraints dominate market implied distress in the extreme tail. The quadratic specification further indicates nonlinearity. In the baseline quantile results, the positive squared term combined with a negative linear term is consistent with diminishing marginal benefits, meaning that improvements in ESG are associated with reductions in default risk up to an intermediate range, after which additional improvements deliver smaller incremental reductions.

The life versus non-life evidence is central for interpretation and relevance. In endogeneity-oriented segment specifications, the negative ESG association is concentrated in non-life insurers at both horizons, while the corresponding association for life insurers is weaker and not consistently significant. This asymmetry is consistent with business model differences. For non-life insurers, solvency over one to 5 years is materially affected by underwriting volatility, catastrophe exposure management, claims governance, operational risk controls, and conduct risk. ESG performance can proxy for

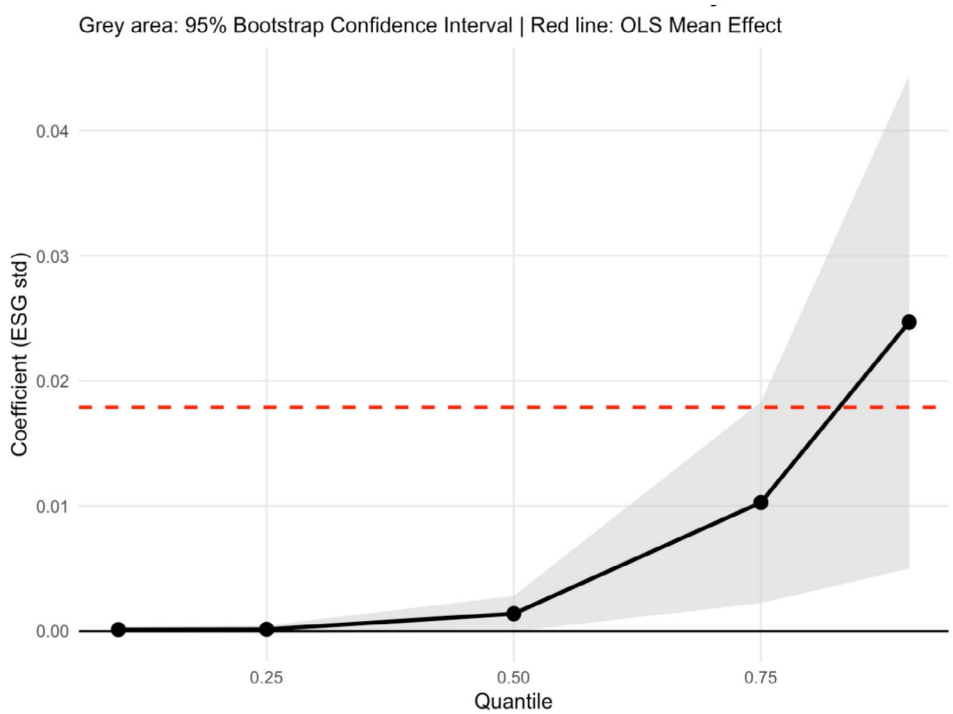

FIGURE 5 | Robustness of the ESG effect on financial resilience. The figure reports quantile specific estimates of the ESG effect on financial vulnerability, measured by the *Z* score. Black dots and connecting lines denote quantile regression coefficients, while the shaded area represents 95% bootstrap confidence intervals. The dashed horizontal line indicates the average OLS effect, providing a benchmark for comparison across the distribution.

the quality of governance and internal control systems that influence these drivers and that are quickly priced by markets. For life insurers, market implied solvency over longer horizons appears more tightly linked to capital strength, strategic asset allocation, and asset liability management, with ESG operating as a complementary discipline rather than a dominant determinant.

The robustness checks support the main pattern and improve identification. Results are stable to alternative functional forms, outlier treatment, and accounting-based stability tests using a *Z* score proxy. Instrumental variable specifications and diagnostics reduce concerns that the association is driven purely by reverse causality. In addition, a difference in differences design around the EU Non-Financial Reporting Directive suggests that mandatory disclosure alone does not mechanically reduce default risk, which supports an interpretation where underlying ESG quality and risk governance matter more than compliance reporting. Subperiod evidence indicates that the ESG association is most visible in the tightening phase, while complementary interaction tests do not indicate a mechanically different ESG slope in crisis periods once fixed effects and controls are included.

The results have concrete implications for solvency relevant risk governance. For supervisors and policymakers, ESG information is most actionable when embedded in core prudential processes with proportional, segment specific expectations. In non-life insurance, supervisory review can emphasise governance of underwriting limits for climate and catastrophe exposure, reinsurance strategy, claims and reserving governance, and operational risk controls. A practical implementation is to require explicit mapping of ESG policies into the risk appetite statement and the Own Risk and Solvency Assessment, with documented board oversight, escalation rules, and evidence that ESG-related risk metrics are used in underwriting and risk control decisions. For life insurers, ESG assessment should be linked to long horizon investment governance, stewardship policies, transition risk management, and consistency with asset liability management discipline, rather than being interpreted as a substitute for capital adequacy. For management teams and investors, the evidence supports treating ESG performance as a risk governance signal whose solvency relevance is strongest in non-life, and using it in credit assessment alongside conventional fundamentals, while recognising non-linearities and segment differences.

The current study supplements the growing body of literature that connects the concept of sustainability practices to corporate risk, through empirical determination of a systematic inverse correlation between ESG performance and default risk in the insurance industry. This finding is consistent with the prior empirical evidence that ESG engagement strengthens the resilience of firms by boosting the quality of governance, enhanced stakeholder relationships, and risk-management procedures (Dal Maso et al. 2024). The empirical results support the hypothesis that the ESG initiatives are risk-reduction mechanisms to mitigate the environmental and operational risks, and not a mere reputational artefact (Feng et al. 2022).

The division of the analysis according to life and non-life insurers is an addition to existing literature that shows that the stabilising effect of ESG is relatively high in the business models that include short-term and medium-term underwriting and

catastrophe risk coverage. Concurrently, the observed diminished correlation with the life insurers underscores the substantial impact of liability duration and asset allocation strategies on the efficacy of ESG engagement as a risk-mitigating practice. Comprehensively, the results validate the current debates that promote a conceptual approach to assess the sustainability practices on a risk-based approach, especially in the area that is characterised by long-term relationships and strict prudential regulation.

The present study is subject to a number of limitations, which also suggest avenues for future research. Firstly, the research employs a solitary performance-based ESG score provided by LSEG. Whilst the present method ensures uniformity and longitudinal coverage, the utilisation of multiple data providers on ESG, or the creation of composite indices, would be advantageous for future studies, in that it would enable a more thorough assessment of the sensitivity of measurement. Secondly, the analysis is dependent on a general ESG indicator, which may obscure heterogeneous impacts at the ESG levels. It is recommended that future research focus on the effects of pillars and their interaction with the business models of insurers. Finally, the approximate relationship between ESG default risk and time is a mean time-variation. Extensions that could be used are extensions that use sub-sample analysis or a time-varying coefficient model to investigate the possibility that the risk-reducing effect of ESG practice is magnified in times of macroeconomic stress or systemic shock.

Acknowledgments

Open access publishing facilitated by Universita degli Studi di Udine, as part of the Wiley - CRUI-CARE agreement.

References

Adams, R. B., and D. Ferreira. 2009. "Women in the Boardroom and Their Impact on Governance and Performance." *Journal of Financial Economics* 94, no. 2: 291–309. https://doi.org/10.1016/j.jfineco.2008.10.007.

Albrecht, P., and R. Maurer. 2000. "Zur Bedeutung Der Ausfallbedrohtheit von Versicherungskontrakten—Ein Beitrag Zur Behavioral Insurance." *Zeitschrift Für Die Gesamte Versicherungswissenschaft* 89: 339–355. https://doi.org/10.1007/BF03188230.

Albuquerque, R., Y. Koskinen, and C. Zhang. 2019. "Corporate Social Responsibility and Firm Risk: Theory and Empirical Evidence." *Management Science* 65, no. 10: 4451–4469. https://doi.org/10.1287/mnsc.2018.3043.

Almeida, H., M. Campello, and M. S. Weisbach. 2011. "Corporate Financial and Investment Policies When Future Financing Is Not Frictionless." *Journal of Corporate Finance* 17, no. 3: 675–693. https://doi.org/10.1016/j.jcorpfin.2009.04.001.

Amel-Zadeh, A., and G. Serafeim. 2018. "Why and How Investors Use ESG Information: Evidence From a Global Survey." *Financial Analysts Journal* 74, no. 3: 87–103. https://doi.org/10.2469/faj.v74.n3.2.

Anginer, D., E. Cerutti, and M. S. M. Pería. 2017. "Foreign Bank Subsidiaries' Default Risk During the Global Crisis: What Factors Help Insulate Affiliates From Their Parents?" *Journal of Financial Intermediation* 29: 19–31. https://doi.org/10.1016/j.jfi.2016.05.004.

Angrist, J. D., and J. S. Pischke. 2009. *Mostly Harmless Econometrics: An Empiricist's Companion*. Princeton University Press.

Arellano, M., and O. Bover. 1995. "Another Look at the Instrumental Variable Estimation of Error-Components Models." *Journal of Econometrics* 68, no. 1: 29–51. https://doi.org/10.1016/0304-4076(94)01642-D.

Bakshi, G., D. Madan, and F. X. Zhang. 2006. "Investigating the Role of Systematic and Firm-Specific Factors in Default Risk: Lessons From Empirically Evaluating Credit Risk Models." *Journal of Business* 79: 1955–1987. https://doi.org/10.1086/503653.

Barney, J. B. 1986. "Strategic Factor Markets: Expectations, Luck, and Business Strategy." *Management Science* 32, no. 10: 1231. https://doi.org/10.1287/mnsc.32.10.1231.

Beck, T., A. Demirgüç-Kunt, and O. Merrouche. 2013. "Islamic vs. Conventional Banking: Business Model, Efficiency and Stability." *Journal of Banking & Finance* 37, no. 2: 433–447. https://doi.org/10.1016/j.jbankfin.2012.09.016.

Bharath, S. T., and T. Shumway. 2008. "Forecasting Default With the Merton Distance to Default Model." *Review of Financial Studies* 21, no. 3: 1339–1369. https://doi.org/10.1093/rfs/hhn044.

Bolton, P., and M. Kacperczyk. 2021. "Do Investors Care About Carbon Risk?" *Journal of Financial Economics* 142, no. 2: 517–549. https://doi.org/10.1016/j.jfineco.2021.05.008.

Campbell, J. Y., J. Hilscher, and J. Szilagyi. 2008. "In Search of Distress Risk." *Journal of Finance* 63, no. 6: 2899–2939. https://doi.org/10.1111/j.1540-6261.2008.01416.x.

Chang, T.-C., Y.-C. Yan, and L.-C. Chou. 2013. "Is Default Probability Associated With Corporate Social Responsibility?" *Asia-Pacific Journal of Accounting & Economics* 20, no. 4: 457–472. https://doi.org/10.1080/16081625.2013.825228.

Chen, S. L., D. N. Wang, and H. W. Chen. 2025. "The Impact of ESG Factors on Credit Ratings: An Empirical Study of European Banks." *International Review of Economics and Finance* 99: 104056. https://doi.org/10.1016/j.iref.2025.104056.

Chen, Y.-C., M. Hung, and Y. Wang. 2018. "The Effect of Mandatory Csr Disclosure on Firm Profitability and Social Externalities: Evidence From China." *Journal of Accounting and Economics* 65: 169–190. https://doi.org/10.1016/j.jacceco.2017.11.009.

Dal Maso, L., L. Gianfagna, F. Maglione, and N. Lattanzi. 2024. "Going Green: Environmental Risk Management, Market Value and Performance." *Corporate Social Responsibility and Environmental Management* 31, no. 1: 122–132. https://doi.org/10.1002/csr.2556.

Daspit, J. J., J. J. Chrisman, T. Ashton, and N. Evangelopoulos. 2021. "Family Firm Heterogeneity: A Definition, Common Themes, Scholarly Progress, and Directions Forward." *Family Business Review* 34, no. 3: 296–322. https://doi.org/10.1177/08944865211008350.

Dhaliwal, D. S., O. Z. Li, A. Tsang, and Y. G. Yang. 2011. "Voluntary Nonfinancial Disclosure and the Cost of Equity Capital: The Initiation of Corporate Social Responsibility Reporting." *Accounting Review* 86: 59–100. https://doi.org/10.2308/accr.00000005.

Di Tommaso, C., and M. Mazzuca. 2023. "The Stock Price of European Insurance Companies: What Is the Role of ESG Factors?" *Finance Research Letters* 56: 104071. https://doi.org/10.1016/j.frl.2023.104071.

Do, T. K., and V. V. Xuan. 2023. "Is Mandatory Sustainability Disclosure Associated With Default Risk? Evidence From Emerging Markets." *Finance Research Letters* 55: 103818. https://doi.org/10.1016/j.frl.2023.103818.

Du, M., Y. Chen, and S. Liu. 2026. "The Impact Mechanism of ESG Ratings on Firm Value: An Empirical Study Based on the Multi-Period Difference-In-Differences Approach." *Sustainable Futures* 11: 101564. https://doi.org/10.1016/j.sftr.2025.101564.

Eccles, R. G., I. Ioannou, and G. Serafeim. 2014. "The Impact of Corporate Sustainability on Organizational Processes and Performance." *Management Science* 60, no. 11: 2835–2857.

Eling, M. 2024. "Is the Insurance Industry Sustainable?" *Journal of Risk Finance* 25, no. 4: 684–703. https://doi.org/10.1108/JRF-12-2023-0314.

Eling, M., and S. D. Marek. 2014. "Corporate Governance and Risk Taking: Evidence From the UK and German Insurance Markets." *Journal of Risk and Insurance* 81, no. 3: 653–682. https://doi.org/10.1111/j.1539-6975.2012.01510.x.

Espinosa-Méndez, C., and M. Jara. 2021. "International Diversification and Performance in Family Firm: Exploring Non-Linear Relationships With the Governance Structure in an Emerging Economy." *Spanish Journal of Finance and Accounting / Revista Española de Financiación y Contabilidad* 50, no. 4: 441–468. https://doi.org/10.1080/02102412.2021.1886453.

Farooq, M., and A. Noor. 2021. "The Impact of Corporate Social Responsibility on Financial Distress: Evidence From Developing Economy." *Pacific Accounting Review* 33, no. 3: 376–396. https://doi.org/10.1108/PAR-10-2020-0196.

Feng, G. F., H. Long, H. J. Wang, and C. P. Chang. 2022. "Environmental, Social and Governance, Corporate Social Responsibility, and Stock Returns: What Are the Short- and Long-Run Relationships?" *Corporate Social Responsibility and Environmental Management* 29, no. 5: 1884–1895. https://doi.org/10.1002/csr.2334.

Firdaus, M., and E. Endri. 2025. "The Impact of Financial Factors on Financial Distress in Life Insurance Companies: The Moderating Role of ESG." *International Journal of Economics and Financial Issues* 15, no. 6: 514. https://doi.org/10.32479/ijefi.21387.

Foster, B. P., T. J. Ward, and J. Woodroof. 1998. "An Analysis of the Usefulness of Debt Defaults and Going Concern Opinions in Bankruptcy Risk Assessment." *Journal of Accounting, Auditing and Finance* 13: 351–371. https://doi.org/10.1177/0148558X9801300311.

Friede, G., T. Busch, and A. Bassen. 2015. "ESG and Financial Performance: Aggregate Evidence From More Than 2000 Empirical Studies." *Journal of Sustainable Finance & Investment* 5, no. 4: 210–233. https://doi.org/10.1080/20430795.2015.1118917.

Giráldez-Puig, P., I. Moreno, L. Perez-Calero, and J. Guerrero Villegas. 2025. "ESG Controversies and Insolvency Risk: Evidence From the Insurance Industry." *Management Decision* 63, no. 2: 610–639. https://doi.org/10.1108/MD-10-2023-2002.

Goel, C., P. Bassi, and Pankaj. 2023. "A Systematic Review of ESG Investing and Climate Change as a Sustainable Practice in the Insurance Industry." In *The Impact of Climate Change and Sustainability Standards on the Insurance Market*, 221–235. Wiley. https://doi.org/10.1002/9781394167944.ch14.

Hart, S. L. 1995. "A Natural-Resource-Based View of the Firm." *Academy of Management Review* 20, no. 4: 986–1014. https://doi.org/10.5465/amr.1995.9512280033.

Ho, K.-C., H.-P. Yen, Y. Gu, and L. Shi. 2020. "Does Societal Trust Make Firms More Trustworthy?" *Emerging Markets Review* 42: 100674. https://doi.org/10.1016/j.ememar.2019.100674.

Hong, H., and M. Kacperczyk. 2009. "The Price of Sin: The Effects of Social Norms on Markets." *Journal of Financial Economics* 93, no. 1: 15–36. https://doi.org/10.1016/j.jfineco.2008.09.001.

Kamalirezaei, H., A. A. Anvary Rostamy, A. Saeedi, and M. Khodaei Valeh Zaghard. 2020. "Corporate Social Responsibility and Bankruptcy Probability: Exploring the Role of Market Competition, Intellectual Capital, and Equity Cost." *Journal of Corporate Accounting and Finance* 31, no. 1: 53–63. https://doi.org/10.1002/jcaf.22417.

Karwowski, M., and M. Raulinajtys-Grzybek. 2021. "The Application of Corporate Social Responsibility (CSR) Actions for Mitigation of Environmental, Social, Corporate Governance (ESG) and Reputational Risk in Integrated Reports." *Corporate Social Responsibility and Environmental Management* 28, no. 4: 1270–1284. https://doi.org/10.1002/csr.2137.

Khan, M. A. 2022. "ESG Disclosure and Firm Performance: A Bibliometric and Meta-Analysis." *Research in International Business and Finance* 61: 101668. https://doi.org/10.1016/j.ribaf.2022.101668.

Koenker, R. 2005. *Quantile Regression*. Vol. 38. Cambridge University Press. https://doi.org/10.1017/CBO9780511754098.

Korzeb, Z., R. Karkowska, A. Matysek-Jędrych, and P. Niedziółka. 2025. "How Do ESG Challenges Affect Default Risk? An Empirical Analysis From the Global Banking Sector Perspective." *Studies in Economics and Finance* 42, no. 1: 89–114. https://doi.org/10.1108/SEF-09-2023-0540.

KPMG. 2011. *KPMG International Survey of Corporate Responsibility Reporting 2011*. KPMG International.

Krueger, P., Z. Sautner, D. Y. Tang, and R. Zhong. 2024. "The Effects of Mandatory ESG Disclosure Around the World." *Journal of Accounting Research* 62, no. 5: 1795–1847. https://doi.org/10.1111/1475-679X.12548.

Laeven, L., and R. Levine. 2009. "Bank Governance, Regulation and Risk Taking." *Journal of Financial Economics* 93, no. 2: 259–275. https://doi.org/10.1016/j.jfineco.2008.09.003.

Li, H., X. Zhang, and Y. Zhao. 2022. "ESG and Firm's Default Risk." *Finance Research Letters* 47: 102713. https://doi.org/10.1016/j.frl.2022.102713.

Lins, K. V., H. Servaes, and A. Tamayo. 2017. "Social Capital, Trust, and Firm Performance: The Value of Corporate Social Responsibility During the Financial Crisis." *Journal of Finance* 72, no. 4: 1785–1824. https://doi.org/10.1111/jofi.12505.

Liu, B., and X. Zhang. 2024. "The Impact of ESG and Executive Structure on the Default Risk of Family Businesses: Evidence From China." *Finance Research Letters* 61: 104956. https://doi.org/10.1016/j.frl.2023.104956.

Maquieira, C. P., J. T. Arias, and C. Espinosa-Méndez. 2024. "The Impact of ESG on the Default Risk of Family Firms: International Evidence." *Research in International Business and Finance* 67: 102136. https://doi.org/10.1016/j.ribaf.2023.102136.

Mbanyele, W., H. Huang, Y. Li, L. T. Muchenje, and F. Wang. 2022. "Corporate Social Responsibility and Green Innovation: Evidence From Mandatory CSR Disclosure Laws." *Economics Letters* 212: 110322. https://doi.org/10.1016/j.econlet.2022.110322.

Meles, A., D. Salerno, G. Sampagnaro, V. Verdoliva, and J. Zhang. 2023. "The Influence of Green Innovation on Default Risk: Evidence From Europe." *International Review of Economics and Finance* 84: 692–710. https://doi.org/10.1016/j.iref.2022.11.036.

Meral, H., B. Ersoy, and M. Dogan. 2025. "Enhancing Sustainability: The Impact of ESG Factors in Global Insurance Performance." *Borsa Istanbul Review* 26, no. 1: 100757. https://doi.org/10.1016/j.bir.2025.10.030.

Moreno, I., P. Parrado-Martínez, and A. Trujillo-Ponce. 2022. "Using the *Z*-Score to Analyze the Financial Soundness of Insurance Firms." *European Journal of Management and Business Economics* 31, no. 1: 22–39. https://doi.org/10.1108/EJMBE-09-2020-0261.

Palmieri, E., G. B. Ferilli, Y. Altunbas, V. Stefanelli, and E. F. Geretto. 2024. "Business Model and ESG Pillars: The Impacts on Banking Default Risk." *International Review of Financial Analysis* 91: 102978. https://doi.org/10.1016/j.irfa.2023.102978.

Rego, L., M. Billett, and N. Morgan. 2009. "Consumer-Based Brand Equity and Firm Risk." *Journal of Marketing* 73: 47–60. https://doi.org/10.1509/jmkg.73.6.47.

Sood, K., and E. Özen. 2024. "A Systematic Review of ESG in the Insurance Industry: Navigating the Path to Sustainability." *International Journal of Sustainable Development and Planning* 19, no. 3: 190301. https://doi.org/10.18280/ijsdp.190301.

Stechemesser, K., J. Endrikat, N. Grasshoff, and E. Guenther. 2015. "Insurance Companies' Responses to Climate Change: Adaptation,

Dynamic Capabilities and Competitive Advantage." *Geneva Papers on Risk and Insurance Issues and Practice* 40: 557–584. https://doi.org/10.1057/gpp.2015.1.

Sun, W., and K. Cui. 2014. "Linking Corporate Social Responsibility to Firm Default Risk." *European Management Journal* 32: 275–287. https://doi.org/10.1016/j.emj.2013.04.003.

Thistlethwaite, J., and M. O. Wood. 2018. "Insurance and Climate Change Risk Management: Rescaling to Look Beyond the Horizon." *British Journal of Management* 29, no. 2: 279–298. https://doi.org/10.1111/1467-8551.12302.

Vassalou, M., and Y. Xing. 2004. "Default Risk in Equity Returns." *Journal of Finance* 59, no. 2: 831–868. https://doi.org/10.1111/j.1540-6261.2004.00650.x.

Wakker, P., R. Thaler, and A. Tversky. 1997. "Probabilistic Insurance." *Journal of Risk and Uncertainty* 15: 7–28. https://doi.org/10.1023/A:1007799303256.

Wooldridge, J. M. 2010. *Econometric Analysis of Cross Section and Panel Data*. MIT Press.

Zimmer, A., C. Schade, and H. Gründl. 2009. "Is Default Risk Acceptable When Purchasing Insurance? Experimental Evidence for Different Probability Representations, Reasons for Default, and Framings." *Journal of Economic Psychology* 30, no. 1: 11–23. https://doi.org/10.1016/j.joep.2008.09.001.