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ESG Performance as a Buffer against Market Volatility: Quantitative Evidence from Global Equity Markets

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Abstract

Background: The integration of Environmental, Social, and Governance (ESG) criteria into investment decision-making has accelerated considerably in the post-pandemic era, driven by both regulatory mandates and growing investor awareness of non-financial risks. Despite this proliferation, empirical evidence on whether superior ESG performance systematically attenuates market volatility remains fragmented, methodologically heterogeneous, and regionally uneven. **Objective:** This study investigates the relationship between firm-level ESG performance and stock return volatility, with particular emphasis on whether high-ESG portfolios serve as a structural buffer against market-wide and idiosyncratic volatility shocks. We additionally examine whether this buffering effect is moderated by market conditions, firm size, leverage, and regional market development. **Methods:** Using a balanced panel dataset of 3450 firm-year observations drawn from 22 countries across North America, Europe, and Asia-Pacific over the period 2018-2023, we employ a multi-method quantitative strategy combining i) two-way fixed-effects panel regressions, ii) Dynamic Conditional Correlation GARCH (DCC-GARCH) modeling for volatility connectedness, iii) System Generalized Method of Moments (GMM) to address endogeneity, and iv) quantile regression to capture heterogeneous effects across the volatility distribution. ESG scores are sourced from Refinitiv Eikon, MSCI, and Sustainalytics, with composite scores constructed via Principal Component Analysis (PCA) to mitigate provider divergence. **Results:** High-ESG-performing firms exhibit statistically significant reductions in idiosyncratic volatility ($\beta = -0.147$, $p < 0.001$) and conditional return variance (DCC coefficient $= -0.089$, $p < 0.01$) relative to low-ESG peers. The buffering effect is most pronounced during periods of elevated market stress (VIX > 25), in developed markets, and for the Environmental and Governance pillars specifically. Systematic (market) beta is not significantly reduced by ESG performance, suggesting the mechanism operates primarily through firm-specific risk channels. GMM estimates confirm robustness to endogeneity, and quantile regressions reveal that the protective effect intensifies in the upper tail of the volatility distribution. **Conclusions:** ESG performance functions as a meaningful, though partial, hedge against market volatility, primarily operating through idiosyncratic risk reduction. Investors, portfolio managers, and regulators should recognize ESG integration not merely as an ethical imperative but as a quantifiable risk-management instrument. These findings carry direct implications for ESG disclosure frameworks, portfolio construction methodologies, and regulatory stress-testing protocols.

Keywords

ESG Performance, Market Volatility, Idiosyncratic Risk, DCC-GARCH, Panel Data, Sustainable Investing, Portfolio Risk, Quantitative Finance

1. Introduction

The global financial landscape has undergone a fundamental reorientation over the past decade. Institutional investors, asset managers, sovereign wealth funds, and retail participants have increasingly embedded Environmental, Social, and Governance (ESG) criteria into their capital allocation frameworks, moving sustainability considerations from the periphery of portfolio construction to its very core (Giese, 2025; Onomakpo, 2025). As of 2024, global ESG-labeled assets under management exceeded USD 40 trillion, representing approximately one-third of total professionally managed assets worldwide. This trajectory reflects not only normative shifts in investment philosophy but also a growing empirical literature suggesting that non-financial performance dimensions carry material implications for financial risk and return (Dash & Rout, 2025; Sudirman et al., 2025).

The theoretical case for ESG performance as a risk-reduction mechanism rests on several interconnected arguments. From a stakeholder theory perspective, firms that maintain strong relationships with employees, suppliers, communities, and regulators are better insulated against reputational shocks, regulatory penalties, and supply chain disruptions that could precipitate sharp stock price declines (Freeman, 1984; Beloskar & Rao, 2022). From a signaling theory standpoint, high ESG disclosure signals superior managerial quality, governance discipline, and long-horizon orientation, all of which reduce information asymmetry and, consequently, the risk premium demanded by investors (Xu, 2023; Xu, 2024). Agency theory further suggests that robust governance structures—a core dimension of ESG—align managerial incentives with shareholder interests, reducing the probability of value-destroying decisions that amplify stock price volatility (Fung et al., 2024; Iannone et al., 2025).

Empirically, however, the evidence is far from settled. A growing body of quantitative research documents that the relationship between ESG performance and market volatility is heterogeneous, contingent on the market environment, the ESG rating provider, the time horizon, the sector, and the specific risk dimension under examination (Shaik & Rehman, 2022; Cai, 2025; Bouteska et al., 2023). Studies examining the COVID-19 pandemic period provide particularly instructive natural experiments: Beloskar and Rao (2022) find that Indian ESG-rated firms offered meaningful downside protection during the crisis, while other investigations of European markets during the same period reveal more nuanced, statistically weaker effects (Iannone et al., 2025). Similarly, research on Chinese A-share firms documents that ESG performance significantly reduces stock price volatility through mediating channels of analyst attention and corporate reputation (Xu, 2023), while studies of ASEAN-5 markets find that ESG's effect on financial performance is conditional on sector and governance quality (Sudirman et al., 2025).

These contradictions in the literature arise from several methodological sources. First, ESG rating divergence across providers—Refinitiv, MSCI, Sustainalytics, and others—creates measurement inconsistency that inflates standard errors and obscures true underlying relationships (Bouteska et al., 2023; Giese, 2025). Second, the failure to distinguish between systematic (market-wide) and idiosyncratic (firm-specific) risk conflates conceptually distinct mechanisms through which ESG might operate. Third, the predominance of linear regression specifications may obscure nonlinear, threshold, or tail-specific effects that are particularly relevant for risk management applications (Dash & Rout, 2025). Fourth, endogeneity—arising from reverse causality between financial performance and ESG investment—is frequently inadequately addressed in cross-sectional designs (Onomakpo, 2025).

This study addresses these limitations through a comprehensive, multi-method quantitative investigation. Our primary research questions are as follows:

RQ1: Does superior ESG performance systematically reduce firm-level stock return volatility, and through which risk channel (systematic vs. idiosyncratic) does this effect primarily operate?

RQ2: Is the ESG volatility-buffering effect moderated by market stress conditions, firm characteristics, and regional market development?

RQ3: Are the effects of individual ESG pillars (E, S, G) on volatility reduction heterogeneous, and which pillar contributes most to the buffering mechanism?

RQ4: Do high-ESG portfolios exhibit lower volatility connectedness with global market indices during stress periods relative to low-ESG portfolios?

Our contributions to the literature are fourfold. First, we construct a composite ESG score using PCA across three major providers to mitigate rating divergence, thereby improving measurement reliability. Second, we employ a multi-method estimation strategy—combining panel fixed effects, DCC-GARCH, System GMM, and quantile regression—that allows us to triangulate findings across methodologies and address endogeneity. Third, we provide one of the most geographically comprehensive analyses to date, spanning 23 countries across three major regions over a six-year window that encompasses both the COVID-19 crisis and the subsequent inflationary-volatility period of 2022-2023. Fourth, we decompose the ESG effect by pillar, market condition, and volatility quantile, offering granular insights for portfolio construction and regulatory policy.

The remainder of this paper is organized as follows. Section 2 reviews the extant literature on ESG performance and market volatility. Section 3 presents the theoretical framework. Section 4 describes the methodology. Section 5 details the data and variables. Section 6 presents empirical results. Section 7 discusses findings in the context of prior literature and policy implications. Section 8 concludes.

2. Literature Review

2.1. ESG Performance and Stock Return Volatility

The relationship between ESG performance and stock return volatility has attracted substantial scholarly attention, particularly in the wake of the COVID-19 pandemic, which served as a high-frequency stress test for ESG investment theses. The preponderance of evidence from this period supports the proposition that ESG performance is associated with reduced volatility, although the magnitude and robustness of this association vary considerably across studies.

Xu (2023) provides one of the most direct examinations of this relationship in the Chinese context, analyzing A-share listed companies from 2011 to 2021. Using panel regression with firm and year fixed effects, the study finds that corporate ESG performance significantly reduces stock price volatility, with the effect mediated through analyst attention and corporate reputation. The finding that ESG's volatility-reducing effect operates through information-based channels is consistent with the signaling hypothesis: firms that invest in ESG disclosure provide more information to analysts, reducing forecast dispersion and, consequently, the uncertainty premium embedded in stock prices. Xu (2024) extends this analysis to a broader international sample, confirming that ESG performance exerts a statistically significant negative effect on stock market volatility and that this effect is amplified during periods of elevated market uncertainty.

In the Indian context, Beloskar and Rao (2022) exploit the COVID-19 crisis as a quasi-natural experiment, finding that ESG-rated firms exhibited superior downside protection and lower return volatility during the market crash of February–March 2020. Their event-study framework controls for pre-crisis firm characteristics and confirms that the ESG effect on downside risk is not merely a reflection of size or sector composition. This finding aligns with the "good management hypothesis," which posits that ESG-oriented management practices reduce the probability of catastrophic value-destroying events (Waddock & Graves, 1997, as cited in Beloskar & Rao, 2022).

European evidence presents a more complex picture. Iannone et al. (2025) apply EGARCH-in-mean and Mixed Gaussian Normal Distribution (MGND) models to European ESG portfolios, identifying distinct volatility regimes and finding that ESG investments demonstrate resilience during turmoil periods, though the statistical significance of ESG's protective effect weakens when controlling for sector composition and market capitalization. Similarly, an analysis of the Hang Seng ESG Index by Fung et al. (2024) finds that weight-tilted ESG portfolios exhibit higher mean returns and lower return volatility than their parent index, but notes that these differences are largely statistically insignificant at conventional confidence levels, suggesting that while directional effects are consistent with theory, economic magnitudes may be modest.

For ASEAN-5 economies, Sudirman et al. (2025) examine the effect of ESG scores on financial performance and stock volatility using panel data methods, finding that ESG scores negatively associate with volatility but that the effect varies significantly across the five member countries, reflecting differences in market maturity, institutional quality, and ESG disclosure standards. Hapsari et al. (2025) compare volatility dynamics between LQ45 and ESG-screened stocks on the Indonesian Stock Exchange using GARCH models, finding that ESG stocks exhibit somewhat lower conditional volatility, particularly during crisis periods.

2.2. ESG and Systematic versus Idiosyncratic Risk

A critical distinction in the ESG-risk literature concerns whether ESG performance reduces systematic (market) risk, idiosyncratic (firm-specific) risk, or both. This distinction has significant implications for portfolio construction: reductions in idiosyncratic risk can be exploited through ESG-tilted stock selection, while reductions in systematic risk would suggest that ESG portfolios offer genuine market-wide hedging benefits.

The weight of evidence suggests that ESG performance primarily operates through the idiosyncratic risk channel. Multiple studies across different markets find that high-ESG firms exhibit lower firm-specific return volatility after controlling for market factors, while the effect on market beta is either statistically insignificant or economically small (Sudirman et al., 2025; Fung et al., 2024). This is theoretically consistent with the stakeholder and signaling arguments: ESG practices reduce the probability of firm-specific negative events—regulatory penalties, reputational crises, governance failures—that generate idiosyncratic volatility spikes, but they do not insulate firms from macroeconomic shocks that drive systematic risk.

Shaik and Rehman (2022) offer a complementary perspective through their DCC-GARCH analysis of volatility connectedness across major S&P ESG indexes across different regions. They find that while ESG indexes are not immune to volatility spillovers from global markets, the pattern of connectedness differs from conventional indexes, with Middle East & Africa and Latin American ESG indexes acting as net transmitters of volatility while US and Asia-Pacific indexes function as net receivers. This finding suggests that the systemic risk implications of ESG portfolios are regionally heterogeneous and that diversification benefits from ESG investing may be geographically contingent.

Bouteska et al. (2023) address the systemic risk dimension more directly, using

QL-CoVaR methodology to quantify the contribution of ESG performance to systemic financial risk across EU and US firms. They find that high-ESG firms exhibit lower systemic risk contributions, particularly in the financial sector, suggesting that ESG practices may contribute to broader financial stability by reducing the probability of correlated distress among highly interconnected firms.

2.3. ESG, Portfolio Performance, and the Risk-Adjusted Return Debate

Beyond volatility reduction, a substantial literature examines whether ESG integration improves risk-adjusted portfolio returns, with implications for the question of whether ESG represents a genuine factor or merely a risk-reduction screen. Giese (2025) provides a long-term review of ESG ratings in global equity markets, finding that high-ESG portfolios have historically delivered competitive risk-adjusted returns relative to low-ESG peers, though the alpha diminishes after controlling for factor exposures (quality, low-volatility, momentum). This finding is consistent with the hypothesis that ESG performance partially proxies for known risk factors rather than representing an independent source of alpha.

Dash and Rout (2025) examine the moderating role of volatility in the ESG-financial performance relationship for Indian companies using dynamic panel GMM. Their findings reveal that market volatility significantly moderates the ESG-performance nexus: during high-volatility periods, ESG's positive effect on return on capital employed (ROCE) is dampened, while its negative effect on Tobin's Q (potentially reflecting the cost of ESG investment) is partially offset. This nonlinear, context-dependent relationship underscores the importance of accounting for market conditions when evaluating ESG's financial consequences.

Onomakpo (2025) focuses specifically on the renewable energy sector, employing a multi-method analysis including GARCH, fixed-effects panel regression, and quantile regression to examine heterogeneous ESG-performance relationships. The study finds that ESG performance associates with higher excess returns and lower downside risk in the renewable energy sector, but that these effects are highly heterogeneous across ESG tiers, with mid-ESG firms sometimes outperforming high-ESG firms on risk-adjusted metrics. This nonlinearity suggests that the relationship between ESG investment and financial outcomes is not monotonic, potentially reflecting diminishing marginal returns to ESG investment beyond a threshold level.

2.4. ESG Rating Divergence and Measurement Challenges

A persistent challenge in ESG research concerns the substantial divergence in ESG ratings across major providers. Berg et al. (2022) document that correlations between major ESG rating providers range from 0.38 to 0.71, far lower than the near-perfect correlations observed for credit ratings. This divergence arises from differences in scope (which ESG attributes are measured), measurement (how attributes are quantified), and weights (how attributes are aggregated). The consequence for empirical research is that findings may be sensitive to the choice of

ESG data provider, creating a form of measurement error that attenuates estimated coefficients and inflates p-values.

Bouteska et al. (2023) address this challenge directly by constructing composite Environmental scores using PCA across Refinitiv Eikon, RobecoSAM, and Sustainalytics, finding that after controlling for rating disagreements, high-ESG portfolios exhibit persistent negative alphas relative to low-ESG peers when climate transition risk exposures are incorporated. This finding suggests that some of the apparent financial benefits of ESG integration documented in earlier studies may reflect inadequate control for ESG rating provider effects rather than genuine ESG-driven outperformance. Giese (2025) similarly notes that ESG rating inconsistencies and climate transition exposures materially affect observed performance patterns in global equity markets.

2.5. ESG and Market Volatility during Crisis Periods

Crisis periods provide particularly informative contexts for evaluating ESG's buffering properties, as they generate exogenous volatility shocks that allow researchers to assess whether ESG performance provides genuine downside protection or merely reflects pre-existing differences in firm quality. The COVID-19 pandemic (2020), the 2022 inflationary shock, and the 2023 banking sector stress have each generated research examining ESG's crisis-period behavior.

The evidence from the COVID-19 period is broadly supportive of ESG's buffering role. Beloskar and Rao (2022) document significant downside protection for Indian ESG firms. Iannone et al. (2025) identify distinct volatility regimes in European ESG portfolios and find that ESG investments demonstrate relative resilience during turmoil periods, though with heterogeneous magnitudes across ESG tiers and sectors. Cai (2025) examines the role of ESG news sentiment—extracted via natural language processing—in investment portfolio performance, finding that positive ESG sentiment signals reduce portfolio volatility and improve Sharpe ratios, particularly during periods of market stress.

The 2022 inflationary shock presents a more challenging environment for ESG investing, as the energy sector—typically underweighted in ESG portfolios due to fossil fuel exclusions—dramatically outperformed during this period. Giese (2025) acknowledges this headwind but argues that over longer horizons, the ESG quality premium reasserts itself, suggesting that crisis-period underperformance is transient rather than structural.

2.6. Regional and Sectoral Heterogeneity

Emerging market evidence on ESG and volatility diverges substantially from developed market findings, reflecting differences in institutional quality, regulatory environments, ESG disclosure standards, and investor composition. In China, Xu (2023) and subsequent studies document significant ESG-volatility relationships mediated by analyst coverage and corporate reputation, suggesting that in markets with lower baseline transparency, ESG disclosure provides particularly valuable information that reduces uncertainty premia. Sudirman et al. (2025) find similar patterns in ASEAN-5 markets, with ESG effects strongest in Singapore and Malaysia—the most institutionally developed markets in the region—and weakest in Indonesia and Vietnam.

Sectoral heterogeneity is equally pronounced. Onomakpo (2025) finds that ESG's risk-reduction properties are strongest in the renewable energy sector, where ESG performance aligns closely with operational efficiency and regulatory compliance. Cai (2025) documents that ESG sentiment effects on portfolio performance are most pronounced in technology and financial services sectors, where intangible assets—human capital, data governance, cybersecurity—are most directly reflected in ESG scores. Conversely, in capital-intensive industries like mining and utilities, ESG's volatility-reducing effect is weaker, potentially because physical transition risks dominate firm-specific ESG improvements.

2.7. ESG and Tail Risk

Beyond conventional volatility metrics, a growing strand of the literature examines whether ESG performance reduces tail risk—the probability of extreme negative return events that are not well captured by variance-based measures. De Spiegeleer et al. (2023) argue that ESG represents a new dimension of risk that is only partially captured by traditional financial metrics, and that ESG incidents—governance failures, environmental disasters, social controversies—generate fat-tailed return distributions that are systematically more severe for low-ESG firms. Glossner (2023) documents that ESG incident recidivism—the tendency of firms with prior ESG incidents to experience repeated incidents—is associated with persistent underperformance and elevated tail risk, suggesting that ESG performance has path-dependent effects on risk that are not captured by cross-sectional analyses.

Jensen and van der Laan (2023) examine the relationship between ESG integration and portfolio tail risk using Expected Shortfall (ES) and Conditional Value-at-Risk (CVaR) measures, finding that ESG-integrated factor portfolios exhibit significantly lower tail risk than conventional factor portfolios, with the effect most pronounced for the 5th percentile of the return distribution. This finding is consistent with our quantile regression results and suggests that ESG's volatility-buffering role extends to the extreme tails of the return distribution, where conventional volatility measures understate actual risk. Ilhan et al. (2022) document that carbon tail risk—the risk of sudden regulatory interventions targeting carbon-intensive firms—is priced in equity options markets, with carbon-intensive firms exhibiting elevated implied volatility and skewness that is not captured by historical volatility measures.

2.8. ESG Disclosure, Mandatory Reporting, and Market Efficiency

The regulatory landscape for ESG disclosure has evolved rapidly since 2022, with mandatory disclosure requirements introduced or strengthened in major jurisdictions including the European Union (Corporate Sustainability Reporting Directive, CSRD), the United States (SEC climate disclosure rules), and the United Kingdom (Task Force on Climate-related Financial Disclosures, TCFD). Krueger et al. (2023) provide the first large-scale empirical analysis of the effects of mandatory ESG disclosure around the world, finding that mandatory disclosure significantly reduces information asymmetry, increases analyst coverage, and reduces idiosyncratic volatility for affected firms—direct evidence that disclosure-driven improvements in the information environment translate into measurable risk reductions.

Bofinger et al. (2022) examine the relationship between ESG performance and market efficiency, finding that high-ESG firms exhibit lower levels of mispricing and faster price discovery, consistent with the signaling hypothesis. They argue that ESG disclosure reduces the cost of information acquisition for investors, improving market efficiency and reducing the volatility premium associated with information uncertainty. Serafeim and Yoon (2023) document that ESG-related news events generate significant market reactions, with positive ESG news associated with volatility compression and negative ESG news (controversies, scandals) associated with volatility spikes—direct evidence that ESG performance affects the information environment in ways that translate into return volatility dynamics (El Ghoul et al., 2022).

3. Theoretical Framework

3.1. Stakeholder Theory

The foundational theoretical lens through which ESG-risk relationships are most frequently examined is Freeman's (1984) stakeholder theory, which posits that firm value is a function of the quality of relationships maintained with all relevant stakeholder groups—employees, customers, suppliers, communities, and regulators—rather than shareholders alone. From this perspective, ESG performance serves as a proxy for the depth and durability of these relationships: firms with high ESG scores have invested in stakeholder capital that generates resilience during adverse conditions (Beloskar & Rao, 2022; Sudirman et al., 2025).

The volatility-buffering mechanism under stakeholder theory operates through several channels. First, firms with strong employee relations experience lower turnover and higher productivity, reducing operational risk and the probability of labor-related disruptions. Second, firms with robust supplier and community relationships are better positioned to navigate supply chain shocks. Third, firms that proactively manage environmental and regulatory risks reduce the probability of sudden, large-magnitude negative events—regulatory penalties, environmental liabilities, product recalls—that generate idiosyncratic volatility spikes. Fourth, firms with strong governance structures are less susceptible to managerial misconduct and accounting irregularities that precipitate sharp stock price declines (Xu, 2023; Fung et al., 2024).

Yu and Xiao (2022) apply stakeholder theory explicitly to Chinese listed firms, finding that ESG performance enhances firm value through the stakeholder mechanism, with the effect strongest for firms facing higher stakeholder scrutiny. This finding supports the proposition that stakeholder theory's predictions are not limited to developed market contexts but extend to emerging economies where institutional enforcement may be weaker but reputational mechanisms remain operative.

3.2. Signaling Theory

Signaling theory (Spence, 1973) provides a complementary mechanism through which ESG performance reduces volatility. Under this framework, ESG disclosure functions as a credible signal of managerial quality and long-term orientation, reducing information asymmetry between firms and investors. Lower information asymmetry reduces the uncertainty premium demanded by investors, translating into lower required returns and, consequently, lower stock price volatility.

The signaling mechanism is particularly relevant for understanding the mediating role of analyst attention documented by Xu (2023). When firms invest in ESG disclosure, they attract greater analyst coverage, which reduces forecast dispersion and earnings surprise magnitudes—both well-established predictors of stock return volatility. Cai (2025) extends this logic to ESG news sentiment, finding that positive ESG sentiment signals extracted from natural language processing of news articles reduce portfolio volatility by improving the information environment for investors.

The signaling hypothesis also helps explain why the ESG volatility-buffering effect is stronger in markets with lower baseline transparency (China, ASEAN-5) than in markets with already high disclosure standards (US, UK). In high-transparency markets, the marginal information value of ESG disclosure is lower, reducing the signaling-driven component of the volatility reduction (Giese, 2025; Sudirman et al., 2025).

3.3. Agency Theory

Agency theory (Jensen & Meckling, 1976) provides a third theoretical pillar for understanding ESG-volatility relationships, particularly through the Governance dimension of ESG. The agency problem—the divergence of interests between managers (agents) and shareholders (principals)—generates volatility through several mechanisms: managerial entrenchment, earnings management, excessive risk-taking, and empire-building acquisitions. Strong governance structures—independent boards, robust audit committees, transparent remuneration policies, anti-corruption programs—reduce agency costs by aligning managerial incentives with shareholder value maximization (Fung et al., 2024; Iannone et al., 2025).

Empirically, the Governance pillar of ESG is frequently found to be the most consistent predictor of reduced volatility, consistent with agency theory's emphasis on governance as the primary mechanism through which non-financial practices affect financial outcomes (Dash & Rout, 2025; Onomakpo, 2025). The finding that systematic risk is not significantly reduced by ESG performance—while idiosyncratic risk is—is also consistent with agency theory: governance improvements reduce the probability of firm-specific governance failures but do not insulate firms from macroeconomic shocks.

3.4. Legitimacy Theory

Legitimacy theory (Suchman, 1995) argues that firms operate within a social contract with their host societies, and that maintaining legitimacy—the perception that firm activities are desirable, proper, or appropriate—is a prerequisite for long-term survival and value creation. ESG performance can be understood as a legitimacy-seeking strategy: by demonstrating commitment to environmental stewardship, social responsibility, and ethical governance, firms reduce the risk of legitimacy crises—regulatory interventions, consumer boycotts, investor divestment campaigns—that generate sudden, large-magnitude stock price declines.

Legitimacy theory is particularly relevant for understanding the sectoral heterogeneity in ESG's volatility-buffering effects. In industries with high social and environmental salience—fossil fuels, mining, chemicals, financial services—the legitimacy stakes are higher, and ESG performance provides greater protection against legitimacy-driven volatility spikes. Conversely, in industries with lower social visibility, the legitimacy channel is weaker, and ESG's volatility-buffering effect is correspondingly attenuated (Onomakpo, 2025; Cai, 2025).

3.5. Integrated Framework

This study integrates these four theoretical perspectives into a unified conceptual framework. We posit that ESG performance reduces stock return volatility through four primary channels: i) stakeholder resilience (reduced probability of stakeholder-driven negative events), ii) information quality (reduced information asymmetry through ESG disclosure), iii) governance discipline (reduced agency costs and probability of governance failures), and iv) legitimacy maintenance (reduced probability of regulatory and social legitimacy crises). These channels operate primarily at the firm-specific level, explaining why ESG's buffering effect is concentrated in idiosyncratic rather than systematic risk. The buffering effect is moderated by market conditions (stronger during high-volatility periods), regional institutional quality (stronger in less transparent markets), and sector characteristics (stronger in high-salience industries).

4. Methodology

4.1. Research Design Overview

This study employs a multi-method quantitative research design to investigate the relationship between ESG performance and stock return volatility. The multi-method approach is motivated by the need to address three distinct but interrelated empirical challenges: i) the endogeneity of ESG performance with respect to financial outcomes, ii) the time-varying nature of volatility, which requires dynamic rather than static modeling, and iii) the potential nonlinearity and tail-specificity of ESG's buffering effect. We employ four primary estimation strategies: two-way fixed-effects panel regression, DCC-GARCH modeling, System GMM, and quantile regression.

4.2. Two-Way Fixed-Effects Panel Regression

The baseline specification for our panel regression analysis is:

$$\sigma_{it} = \alpha + \beta_1 ESG_{it-1} + \beta_2 X_{it-1} + \mu_i + \lambda_t + \varepsilon_{it}$$

where σ_{it} denotes the annualized idiosyncratic volatility of firm *i* in year *t*, measured as the annualized standard deviation of daily residuals from a Fama-French five-factor model estimated over rolling 12-month windows using daily return data (consistent with the variable construction in Section 5.1); ESG_{it-1} is the composite ESG score lagged one period to mitigate reverse causality; X_{it-1} is a vector of firm-level control variables (detailed in Section 5); μ_i represents firm fixed effects capturing time-invariant unobserved heterogeneity; λ_t represents year fixed effects capturing common macroeconomic shocks; and ε_{it} is the idiosyncratic error term.

Standard errors are clustered at the firm level to account for within-firm serial correlation in residuals. We additionally estimate specifications with industry-by-year fixed effects to control for time-varying industry-level shocks. The coefficient of primary interest is β_1, which captures the within-firm association between ESG performance and idiosyncratic volatility after controlling for time-invariant firm characteristics and common temporal shocks.

We also estimate a specification using total stock return volatility (annualized standard deviation of daily returns) as the dependent variable, and a specification using market beta as the dependent variable to distinguish systematic from idiosyncratic effects. Pillar-level analyses replace the composite ESG score with separate Environmental (E), Social (S), and Governance (G) scores to identify pillar-specific effects.

4.3. DCC-GARCH Modeling

To capture the dynamic, time-varying nature of ESG-volatility relationships, we employ the Dynamic Conditional Correlation GARCH (DCC-GARCH) framework of Engle (2002). This approach allows us to model time-varying conditional volatility and correlations between ESG-sorted portfolio returns and market index returns, providing insight into how ESG performance affects volatility connectedness during different market regimes. Although the 2018-2023 sample spans only 72 monthly observations, the DCC-GARCH(1,1) specification is well-suited to short samples: it requires estimation of only two additional scalar parameters (α and β) beyond the univariate GARCH parameters, and simulation evidence confirms reliable convergence with as few as 60 observations (Engle, 2002). After removing months with missing portfolio returns, the effective sample used in DCC-GARCH estimation comprises 71 monthly time points (January 2018 - November

2023), which is sufficient for stable parameter identification given the parsimony of the DCC(1,1) specification.

Following Shaik and Rehman (2022), we construct quartile-sorted ESG portfolios (Q1 = lowest ESG, Q4 = highest ESG) and estimate the DCC-GARCH model:

$$r_t = \mu + \varepsilon_t, \varepsilon_t = H_t^{1/2} z_t$$

$$H_t = D_t R_t D_t$$

where r_t is the vector of portfolio returns, H_t is the conditional covariance matrix, D_t is a diagonal matrix of conditional standard deviations from univariate GARCH(1,1) models, and R_t is the time-varying conditional correlation matrix. The DCC parameters α and β capture the persistence of dynamic correlations, and we test whether high-ESG portfolios exhibit lower average conditional correlations with the market benchmark during stress periods (VIX > 25).

We additionally compute the Diebold & Yilmaz (2012) spillover index to quantify directional volatility connectedness between ESG-sorted portfolios and global market indexes, allowing us to assess whether high-ESG portfolios are net receivers or net transmitters of volatility shocks (Shaik & Rehman, 2022).

4.4. System Generalized Method of Moments (GMM)

A central concern in ESG research is endogeneity: firms with superior financial performance may invest more in ESG activities (reverse causality), and unobserved firm characteristics (managerial quality, corporate culture) may simultaneously drive both ESG performance and low volatility (omitted variable bias). While the lagged specification and firm fixed effects in our panel regression mitigate these concerns, they do not fully eliminate them.

To address endogeneity more rigorously, we employ the System GMM estimator of Blundell and Bond (1998), which uses lagged levels and differences of endogenous variables as instruments. Following Dash and Rout (2025), we treat ESG scores as endogenous and use instruments dated $t-2$ and $t-3$ to ensure instrument validity. The Arellano-Bond AR(2) test confirms the absence of second-order serial correlation in residuals, and the Hansen J-test of overidentifying restrictions confirms instrument validity. The System GMM specification is:

$$\sigma_{it} = \alpha + \beta_1 ESG_{it-1} + \beta_2 \sigma_{it-1} + \beta_3 X_{it-1} + \mu_i + \lambda_t + \varepsilon_{it}$$

The inclusion of lagged volatility (σ_{it-1}) as a regressor captures the persistence of volatility, and the System GMM estimator accounts for the resulting dynamic panel bias.

4.5. Quantile Regression

To capture heterogeneous effects of ESG performance across the volatility distribution—particularly the tail effects most relevant for risk management—we employ quantile regression (Koenker & Bassett, 1978). This approach estimates the effect of ESG performance at different quantiles (τ = 0.10, 0.25, 0.50, 0.75, 0.90) of the conditional volatility distribution, allowing us to assess whether ESG's buffering effect is concentrated in the tails (high-volatility firms) or uniformly distributed across the distribution. Following Onomakpo (2025), we apply bootstrap standard errors with 1000 replications to account for heteroskedasticity.

4.6. Robustness Checks

We conduct several robustness checks to validate our baseline findings. First, we replace the composite PCA-based ESG score with individual provider scores (Refinitiv, MSCI, Sustainalytics) to assess sensitivity to provider choice. Second, we employ alternative volatility measures: realized volatility (sum of squared intraday returns), downside deviation, and the Garman & Klass (1980) range-based volatility estimator. Third, we split the sample into pre-COVID (2018-2019), COVID (2020-2021), and post-COVID (2022-2023) subperiods to assess temporal stability. Fourth, we apply propensity score matching to construct a control sample of low-ESG firms matched on pre-treatment firm characteristics, mitigating selection bias. Fifth, we test for the presence of a nonlinear (U-shaped) ESG-volatility relationship by including ESG squared in the baseline regression.

5. Data and Variables

5.1. Sample Construction

Our sample is drawn from the intersection of firms covered by Refinitiv Eikon ESG, MSCI ESG Ratings, and Sustainalytics ESG Risk Ratings databases as of December 2023. We restrict the sample to firms listed on major stock exchanges in 22 countries across North America (US, Canada), Europe (UK, Germany, France, Netherlands, Sweden, Switzerland, Spain, Italy, Denmark, Norway, Finland), and Asia-Pacific (Japan, Australia, China, South Korea, Hong Kong, Singapore, India, Taiwan, New Zealand). We exclude financial firms (SIC codes 6000-6999) from the main analysis due to the different nature of financial risk in this sector, though we include them in robustness checks.

After requiring at least three consecutive years of ESG data and non-missing financial data from Compustat Global and Worldscope, the final sample comprises 3450 firm-year observations from 575 unique firms over the period 2018-2023. The sample is balanced, with each of the 575 firms contributing exactly six annual observations over 2018-2023, yielding 3450 firm-year observations ($575 \times 6 = 3450$). Firms are distributed across 11 Global Industry Classification Standard (GICS) sectors, with the largest concentrations in Industrials (18.4%), Consumer Discretionary (14.2%), Information Technology (13.7%), and Materials (11.8%).

5.2. ESG Score Construction

ESG scores are sourced from three providers: Refinitiv Eikon (formerly Thomson Reuters ESG), MSCI ESG Ratings, and Sustainalytics ESG Risk Ratings. To mitigate provider-specific measurement error and rating divergence—a critical methodological concern highlighted by Bouteska et al. (2023) and Giese (2025)—we construct a composite ESG score using Principal Component Analysis (PCA) on the standardized scores from all three providers. The first principal component, which explains 67.3% of the common variance across providers, serves as our primary ESG measure. We also retain individual provider scores and pillar-level scores (E, S, G) for sensitivity analyses. The PCA factor loadings for all three providers, along with the proportion of variance explained by each component, are reported in **Appendix B** (Table B1) to facilitate replication and transparency.

Raw ESG scores are standardized to a 0 - 100 scale within each provider-year combination before PCA to ensure comparability. Importantly, Sustainalytics scores reflect ESG risk exposure (higher = greater risk), so they are reversed (i.e., multiplied by −1 and rescaled) before standardization to ensure that all three providers are directionally aligned such that higher scores uniformly indicate better ESG performance prior to PCA construction. The composite score is then normalized to have zero mean and unit standard deviation within each year to facilitate interpretation of regression coefficients. Firms are assigned to ESG quartiles (Q1 = lowest 25%, Q4 = highest 25%) for portfolio-level analyses.

5.3. Volatility Measures

Our primary dependent variable is annualized idiosyncratic volatility (IV_{it}), measured as the annualized standard deviation of daily residuals from a Fama-French five-factor model estimated over rolling 12-month windows using daily return data from Datastream. The five-factor model controls for market (MKT-RF), size (SMB), value (HML), profitability (RMW), and investment (CMA) factors sourced from Kenneth French's data library. We use the global Fama-French five-factor portfolios to ensure cross-country comparability. All stock returns and factor returns are converted to a common currency (US dollars, USD) using end-of-period exchange rates from Datastream prior to factor model estimation, ensuring that idiosyncratic volatility measures are comparable across countries.

Secondary volatility measures include: i) total return volatility (annualized standard deviation of daily returns), ii) downside volatility (annualized standard deviation of negative daily returns below the mean), iii) market beta (52-week rolling OLS beta from the CAPM), and iv) the Garman & Klass (1980) range-based volatility estimator. For the DCC-GARCH analysis, we use monthly portfolio returns constructed from value-weighted ESG-quartile portfolios, with all returns expressed in USD to ensure cross-country comparability.

5.4. Control Variables

Following the established literature on firm-level volatility determinants (Sudirman et al., 2025; Dash & Rout, 2025; Onomakpo, 2025), we include the following firm-level control variables, all lagged one period:

- **Firm size (SIZE):** Natural logarithm of total assets (Compustat Global: AT). Larger firms typically exhibit lower idiosyncratic volatility due to diversification and analyst coverage.
- **Leverage (LEV):** Total debt divided by total assets. Higher leverage increases financial risk and volatility.

- **Profitability (ROA):** Return on assets (net income/total assets). More profitable firms exhibit lower volatility due to reduced financial distress risk.
- **Book-to-market ratio (BTM):** Book value of equity divided by market capitalization. Value firms typically exhibit higher idiosyncratic volatility.
- **Liquidity (LIQ):** Amihud (2002) illiquidity ratio (average absolute daily return divided by daily dollar volume). Less liquid stocks exhibit higher idiosyncratic volatility.
- **Analyst coverage (ANALY):** Natural logarithm of the number of analysts following the firm (I/B/E/S). Greater analyst coverage reduces information asymmetry and idiosyncratic volatility.
- **Asset growth (GROWTH):** Year-over-year percentage change in total assets. High-growth firms exhibit higher volatility due to greater uncertainty about future cash flows.
- **Dividend yield (DIV):** Annual dividends per share divided by share price. Dividend-paying firms exhibit lower volatility due to the signaling effect of dividend commitment.
- **VIX:** Annual average of the CBOE Volatility Index, included as a time-varying measure of market-wide uncertainty.

5.5. Descriptive Statistics

Table 1 presents descriptive statistics for the full sample. The mean composite ESG score is 52.4 (SD = 18.7), with substantial cross-sectional variation reflecting the heterogeneity of ESG performance even within the large-cap universe. Mean annualized idiosyncratic volatility is 24.6% (SD = 12.3%), consistent with prior literature on large-cap firm-level volatility. The correlation between composite ESG score and idiosyncratic volatility is −0.31 ($p < 0.001$), providing preliminary univariate support for the ESG-volatility buffering hypothesis.

Table 1. Descriptive statistics.

Variable	N	Mean	SD	Min	P25	Median	P75	Max
Composite ESG Score	3450	52.4	18.7	8.2	38.6	53.1	67.4	94.8
Idiosyncratic Volatility (%)	3450	24.6	12.3	5.1	15.8	22.1	30.7	78.4
Total Return Volatility (%)	3450	27.8	13.9	6.2	17.4	24.9	35.2	89.6
Market Beta	3450	1.04	0.47	0.12	0.72	0.98	1.31	3.24
Size (log total assets)	3450	9.84	1.62	5.93	8.71	9.82	10.97	14.23
Leverage	3450	0.31	0.18	0.00	0.17	0.29	0.43	0.89
ROA (%)	3450	6.8	7.4	−32.1	3.1	6.2	10.7	38.4
Book-to-Market	3450	0.48	0.39	0.02	0.21	0.38	0.64	2.87
Analyst Coverage (log)	3450	2.94	0.87	0.00	2.30	2.99	3.56	4.89
Asset Growth (%)	3450	8.4	19.7	−41.2	0.8	5.6	13.2	142.8
Dividend Yield (%)	3450	2.1	2.4	0.0	0.0	1.4	3.3	14.7

Note: Composite ESG Score is the first principal component of Refinitiv, MSCI, and Sustainalytics scores, normalized to 0 - 100 scale within each year. Idiosyncratic Volatility is the annualized standard deviation of residuals from a Fama-French five-factor model.

6. Empirical Results

6.1. Baseline Panel Regression Results

Table 2 presents the baseline two-way fixed-effects panel regression results for the full sample. Column (1) reports the bivariate relationship between composite ESG score and idiosyncratic volatility, Column (2) adds firm-level controls, and Column (3) includes industry-by-year fixed effects. Columns (4)-(6) repeat this structure with total return volatility as the dependent variable, and Columns (7)-(9) use market beta.

Table 2. Fixed-effects panel regression: ESG performance and volatility.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Variable	IV	IV	IV	TV	TV	TV	Beta	Beta	Beta
ESG Score	−0.183***	−0.147***	−0.131***	−0.196***	−0.158***	−0.139***	−0.024	−0.018	−0.015
	(0.021)	(0.019)	(0.022)	(0.024)	(0.021)	(0.024)	(0.018)	(0.017)	(0.019)
Size		−0.089***	−0.082***		−0.094***	−0.087***		−0.031***	−0.028***
Leverage		0.124***	0.118***		0.131***	0.124***		0.047**	0.044**
ROA		−0.214***	−0.208***		−0.221***	−0.215***		−0.038**	−0.035**
Book-to-Market		0.076***	0.071***		0.081***	0.076***		0.022*	0.019
Analyst Coverage		−0.061***	−0.057***		−0.065***	−0.060***		−0.012	−0.010
Asset Growth		0.043***	0.041***		0.047***	0.044***		0.008	0.007
Dividend Yield		−0.038**	−0.035**		−0.041**	−0.038**		−0.009	−0.008
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No
Industry × Year FE	No	No	Yes	No	No	Yes	No	No	Yes
N	3450	3450	3450	3450	3450	3450	3450	3450	3450
R^2 (within)	0.124	0.318	0.341	0.131	0.327	0.349	0.042	0.089	0.097

Note: All specifications include firm and year fixed effects unless otherwise indicated. Standard errors clustered at the firm level in parentheses. ESG Score is the standardized composite PCA score. IV = Idiosyncratic Volatility; TV = Total Return Volatility; Beta = Market Beta. $^*p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

The results provide strong support for the ESG-volatility buffering hypothesis with respect to idiosyncratic and total volatility. A one-standard-deviation increase in composite ESG score is associated with a reduction in annualized idiosyncratic volatility of 1.47 percentage points (Column 2, $\beta = -0.147$, $p < 0.001$) and a reduction in total return volatility of 1.58 percentage points (Column 5, $\beta = -0.158$, $p < 0.001$). These effects are economically meaningful: relative to the mean idiosyncratic volatility of 24.6%, the ESG effect represents a 6.0% reduction, consistent with the magnitude documented by Xu (2023) for Chinese firms and Onomakpo (2025) for the renewable energy sector.

Critically, the ESG coefficient for market beta is statistically insignificant in all specifications (Columns 7-9), confirming that ESG's buffering effect operates exclusively through the idiosyncratic risk channel, consistent with the predictions of stakeholder theory and agency theory and with the findings of Sudirman et al. (2025) and Fung et al. (2024). This finding has important portfolio construction implications: ESG integration reduces firm-specific risk but does not provide systematic market hedging.

6.2. Pillar-Level Analysis

Table 3 presents pillar-level regressions, replacing the composite ESG score with individual Environmental (E), Social (S), and Governance (G) scores. All three pillars are negatively associated with idiosyncratic volatility, but the magnitudes and significance levels differ substantially.

Table 3. Pillar-level analysis (idiosyncratic volatility).

	(1) E Pillar	(2) S Pillar	(3) G Pillar	(4) All Pillars
Environmental Score	−0.118***			−0.087***
	(0.022)			(0.024)
Social Score		−0.094***		−0.071**
		(0.021)		(0.023)
Governance Score			−0.139***	−0.108***
			(0.019)	(0.021)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	3450	3450	3450	3450
R^2 (within)	0.301	0.289	0.312	0.334

Note: Standard errors clustered at the firm level in parentheses. All specifications include the same firm-level controls as Column (2) of Table 2. *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.

The Governance pillar exhibits the largest coefficient (β = −0.139, $p < 0.001$), followed by the Environmental pillar (β = −0.118, $p < 0.001$) and the Social pillar (β = −0.094, $p < 0.001$). When all three pillars are included simultaneously (Column 4), the Governance pillar retains the largest independent effect (β = −0.108, $p < 0.001$), consistent with agency theory's emphasis on governance as the primary mechanism through which non-financial practices affect financial risk. The Environmental pillar's significant effect (β = −0.087, $p < 0.001$) reflects the increasing materiality of environmental risk management for firm-level volatility, particularly in the context of growing climate transition risk (Bouteska et al., 2023; Giese, 2025).

6.3. DCC-GARCH Results

Table 4 presents selected results from the DCC-GARCH analysis of volatility connectedness between ESG-quartile portfolios and the MSCI World Index. The DCC parameters confirm time-varying conditional correlations, with the persistence parameter ($\alpha+\beta$) close to unity, indicating highly persistent dynamic correlations.

Table 4. DCC-GARCH results: ESG quartile portfolios.

Portfolio	Mean Cond. Corr. (Full)	Mean Cond. Corr. (Stress)	GARCH α	GARCH β	Spillover (Net)
Q1 (Lowest ESG)	0.742	0.831	0.089	0.887	+4.8%
Q2	0.718	0.804	0.082	0.893	+2.1%
Q3	0.694	0.778	0.076	0.901	−1.3%
Q4 (Highest ESG)	0.653	0.741	0.071	0.908	−5.6%

Note: Stress periods defined as months with VIX > 25 (n = 31 months over 2018-2023). Spillover (Net) is the net directional volatility spillover from the Diebold & Yilmaz (2012) index; positive values indicate net transmitter of volatility to global markets. Conditional correlations estimated using DCC-GARCH(1,1) on 71 effective monthly time points (January 2018 - November 2023). The short sample is addressed by the parsimony of the DCC(1,1) specification (two scalar parameters), which has been shown to converge reliably with $T \geq 60$ observations.

High-ESG portfolios (Q4) exhibit significantly lower mean conditional correlations with the MSCI World Index during both normal (0.653 vs. 0.742 for Q1) and stress (0.741 vs. 0.831 for Q1) periods. The difference in conditional correlations widens during stress periods (Δ = 0.090 during stress vs. Δ = 0.089 during normal periods), providing modest support for the proposition that ESG portfolios offer enhanced diversification benefits during market turmoil, consistent with Iannone et al. (2025) and Shaik and Rehman (2022).

The Diebold-Yilmaz spillover results reveal that high-ESG portfolios are net receivers of volatility shocks (net spillover = −5.6%), while low-ESG portfolios are net transmitters (+4.8%), consistent with the finding that ESG performance reduces the contribution of individual firms to systemic market volatility (Bouteska et al., 2023).

6.4. System GMM Results

Table 5 presents System GMM results addressing endogeneity. The lagged ESG coefficient remains negative and statistically significant ($\beta = -0.128$, $p < 0.01$), confirming that the ESG-volatility relationship is not an artifact of reverse causality or omitted variable bias. The Hansen J-test p-value of 0.312 confirms instrument validity, and the Arellano-Bond AR(2) test p-value of 0.418 confirms the absence of second-order serial correlation.

Table 5. System GMM results.

Variable	Coefficient	SE	p-value
ESG Score ($t-1$)	−0.128	0.041	0.002
Idiosyncratic Volatility ($t-1$)	0.387	0.052	<0.001
Size	−0.074	0.028	0.008
Leverage	0.108	0.039	0.006

Continued

ROA	−0.189	0.047	<0.001
Analyst Coverage	−0.049	0.021	0.020
Constant	0.421	0.147	0.004
Observations	3450		
Firms	575		
Instruments	48		
Hansen J-test (*p*-value)			0.312
AR(2) test (*p*-value)			0.418

Note: Two-step System GMM with Windmeijer (2005) finite-sample correction. ESG Score treated as endogenous; instruments are lags $t - 2$ and $t - 3$.

6.5. Quantile Regression Results

Quantile regression results (**Table 6**) reveal that ESG's buffering effect is heterogeneous across the volatility distribution, with the strongest effects concentrated in the upper tail (high-volatility firms). The ESG coefficient at the 90th quantile ($\beta = -0.241$, $p < 0.001$) is more than twice the magnitude of the coefficient at the 10th quantile ($\beta = -0.098$, $p < 0.01$), indicating that ESG performance provides the greatest protection for the most volatile firms—precisely those for which volatility reduction is most valuable from a risk management perspective (Onomakpo, 2025).

Table 6. Quantile regression results: ESG score and idiosyncratic volatility.

Quantile (τ)	ESG Coefficient	Bootstrap SE	*p*-value
τ = 0.10	−0.098	0.031	0.002
τ = 0.25	−0.119	0.028	<0.001
τ = 0.50	−0.143	0.024	<0.001
τ = 0.75	−0.189	0.029	<0.001
τ = 0.90	−0.241	0.038	<0.001

Note: All specifications include the same firm-level controls as **Table 2**, Column (2). Bootstrap standard errors based on 1000 replications.

6.6. Subperiod and Stress-Period Analysis

To assess the temporal stability of our findings and the specific dynamics during crisis periods, we split the sample into three subperiods: pre-COVID (2018-2019), COVID (2020-2021), and post-COVID/inflationary period (2022-2023). The ESG-volatility buffering effect is statistically significant in all three subperiods, but is strongest during the COVID period ($\beta = -0.198$, $p < 0.001$), followed by the post-COVID period ($\beta = -0.162$, $p < 0.001$) and the pre-COVID period ($\beta = -0.121$, $p < 0.01$). This pattern is consistent with Beloskar and Rao (2022) and Iannone et al. (2025), who document enhanced ESG protection during periods of elevated market stress.

The interaction of ESG score with VIX (Table 7, Column 1) confirms that the buffering effect is amplified during high-volatility market environments: the interaction coefficient is negative and significant (β = −0.043, $p < 0.01$), indicating that a one-unit increase in VIX amplifies the ESG-volatility reduction by an additional 0.043 percentage points per standard deviation of ESG score. This finding directly addresses RQ2 and confirms that ESG's buffering role is most valuable precisely when volatility protection is most needed (Dash & Rout, 2025; Cai, 2025).

Table 7. Moderation analysis—ESG × market conditions.

	(1) ESG × VIX	(2) ESG × Developed	(3) ESG × High-Salience
ESG Score	−0.147***	−0.098***	−0.112***
	(0.019)	(0.022)	(0.021)
ESG × VIX	−0.043**		
	(0.014)		
ESG × Developed Market		−0.089***	
		(0.027)	
ESG × High-Salience Sector			−0.074**
			(0.026)
Controls	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
N	3450	3450	3450
R^2 (within)	0.327	0.334	0.331

Note: Developed Market = 1 for North America and Europe, 0 for Asia-Pacific. High-Salience Sector = 1 for Energy, Materials, Utilities, and Financial Services. Standard errors clustered at the firm level. *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.*

7. Discussion

7.1. ESG as an Idiosyncratic Risk Buffer: Mechanisms and Implications

The most robust finding of this study is that ESG performance significantly reduces firm-level idiosyncratic volatility but does not meaningfully affect systematic (market) beta. This distinction is theoretically coherent and practically important. The idiosyncratic volatility reduction is consistent with the four theoretical channels identified in our framework: stakeholder resilience reduces the probability of stakeholder-driven negative events; ESG disclosure reduces information asymmetry and forecast uncertainty; governance quality reduces agency costs and the probability of governance failures; and legitimacy maintenance reduces the probability of regulatory and social legitimacy crises (Xu, 2023; Beloskar & Rao, 2022; Fung et al., 2024; Iannone et al., 2025).

The null finding for market beta is equally important. It implies that ESG integration does not provide a hedge against macroeconomic shocks—recessions, inflationary surges, interest rate cycles—that drive systematic risk. Investors who view ESG as a comprehensive market hedge are likely to be disappointed; the protection ESG provides is firm-specific, not market-wide. This finding aligns with Shaik and Rehman (2022), who find that ESG indexes remain highly connected to global market volatility through DCC-GARCH analysis, and with Sudirman et al. (2025), who find that ESG's effect on market beta is inconsistent across ASEAN-5 markets.

The quantile regression results add important nuance to this picture. The ESG buffering effect is strongest for the most volatile firms ($\tau = 0.90$: $\beta = -0.241$), suggesting that ESG integration is most valuable as a risk-management tool for firms at the upper tail of the volatility distribution—precisely the firms for which volatility reduction matters most from a portfolio construction perspective. This tail-specific amplification is consistent with the legitimacy theory channel: firms with high baseline volatility are often those facing the greatest legitimacy challenges (environmental controversies, governance failures, social conflicts), and ESG improvements that address these challenges generate the largest volatility reductions (Onomakpo, 2025; Cai, 2025).

7.2. The Governance Premium: Agency Theory in Action

The pillar-level analysis reveals that the Governance dimension of ESG is the strongest and most consistent predictor of volatility reduction across all specifications. This finding is consistent with agency theory and aligns with a substantial prior literature documenting that corporate governance quality is a primary determinant of firm-level volatility (Dash & Rout, 2025; Fung et al., 2024). Strong governance structures—independent boards, audit committee effectiveness, executive compensation transparency, anti-corruption programs—reduce the probability of governance failures (accounting fraud, insider trading, empire-building acquisitions) that generate idiosyncratic volatility spikes.

The Environmental pillar's significant independent effect ($\beta = -0.087$ in the full pillar specification) reflects the growing materiality of environmental risk management. In the post-Paris Agreement era, firms that proactively manage carbon exposure, water risk, and biodiversity dependencies are better positioned to avoid sudden regulatory penalties, stranded asset write-downs, and reputational crises that generate volatility. Bouteska et al. (2023) document that climate transition risk exposures are increasingly priced in equity markets, and our findings suggest that proactive environmental management reduces the volatility implications of this pricing.

The Social pillar's effect, while statistically significant, is the smallest of the three ($\beta = -0.071$ in the full pillar specification). This may reflect the greater difficulty of quantifying social performance—labor practices, human rights, community relations—in a way that translates directly to financial risk reduction, or it may reflect the more diffuse and longer-horizon nature of social risk relative to environmental and governance risks (Sudirman et al., 2025; Giese, 2025).

7.3. Market Conditions and the Amplification of ESG Protection

The finding that ESG's buffering effect is amplified during high-volatility market environments (ESG × VIX interaction: $\beta = -0.043$, $p < 0.01$) is one of the most practically significant results of this study. It implies that ESG integration provides a form of crisis insurance: during normal market conditions, the volatility reduction from ESG is modest (approximately 1.5 percentage points per standard deviation of ESG score), but during periods of market stress (VIX > 25), the protection is substantially larger. This dynamic is consistent with the stakeholder resilience mechanism: during crises, firms with strong stakeholder relationships are better able to mobilize support, maintain operational continuity, and avoid the cascading negative events that amplify volatility for less resilient firms (Beloskar & Rao, 2022; Iannone et al., 2025).

This finding also has important implications for the debate about ESG performance during the 2022 inflationary shock, when ESG portfolios underperformed due to their underweight in the energy sector. Our results suggest that while ESG portfolios may underperform on a return basis during commodity-driven market rallies, they continue to offer volatility reduction benefits even in these challenging environments. The energy sector exclusion that drove 2022 underperformance is a factor exposure issue rather than a fundamental failure of ESG's risk-reduction mechanism (Giese, 2025).

7.4. Regional Heterogeneity and Institutional Context

The moderation analysis reveals that ESG's buffering effect is significantly stronger in developed markets (ESG × Developed Market: $\beta = -0.089$, $p < 0.001$) than in emerging markets. This finding appears to contradict the signaling hypothesis—which predicts stronger effects in less transparent markets—but is consistent with an alternative interpretation: the volatility-reducing mechanisms of ESG require institutional infrastructure (analyst coverage, regulatory enforcement, investor activism) to operate effectively (Sudirman et al., 2025; Xu, 2023).

In developed markets, the institutional ecosystem that amplifies ESG's risk-reduction mechanisms is well-developed: large numbers of ESG-focused institutional investors create demand for ESG disclosure; robust regulatory frameworks enforce disclosure standards; active analyst communities translate ESG information into earnings forecasts; and well-functioning legal systems enforce contractual commitments to stakeholders. In emerging markets, these amplifying mechanisms are less developed, attenuating the financial consequences of ESG performance differences (Beloskar & Rao, 2022; Sudirman et al., 2025).

This finding has important policy implications: to realize the full risk-reduction potential of ESG performance, emerging market regulators should invest in disclosure infrastructure, analyst capacity, and institutional investor development. The growing ESG regulatory initiatives in China (mandatory ESG disclosure for A-share listed companies), India (SEBI's Business Responsibility and Sustainability Reporting framework), and ASEAN (ASEAN Taxonomy for Sustainable Finance) represent steps in this direction (Xu, 2023; Sudirman et al., 2025).

7.5. ESG Rating Divergence and Measurement Robustness

Our robustness checks confirm that the ESG-volatility buffering effect is robust to the choice of ESG data provider, though the magnitude varies: the Refinitiv-based specification yields the largest coefficient (β = −0.163), followed by the composite PCA score (β = −0.147) and the MSCI-based specification (β = −0.131), with the Sustainalytics-based specification yielding the smallest but still significant coefficient (β = −0.112). This variation is consistent with Bouteska et al. (2023) and Giese (2025), who document that provider-specific measurement choices affect the magnitude of observed ESG-performance relationships.

The fact that our composite PCA score yields results intermediate between individual providers, and that all provider-specific results point in the same direction, provides confidence that the ESG-volatility buffering effect is a genuine phenomenon rather than an artifact of a specific rating methodology. The PCA composite approach effectively averages out provider-specific idiosyncrasies, yielding a more reliable measure of the underlying ESG construct (Bouteska et al., 2023).

7.6. Portfolio Construction and Policy Implications

Our findings carry several direct implications for investment practice and regulatory policy. For portfolio managers, the results suggest that ESG integration can meaningfully reduce portfolio idiosyncratic volatility, improving Sharpe ratios without necessarily sacrificing returns—particularly for portfolios with high baseline idiosyncratic risk exposure. The tail-specific amplification of ESG protection (quantile regression results) suggests that ESG screens are most valuable for identifying and excluding the most volatile firms, consistent with a negative-screening rather than a best-in-class approach (Cai, 2025; Onomakpo, 2025). Portfolio optimization frameworks that explicitly incorporate ESG scores as constraints or objectives—such as the multi-objective minimax approaches described in recent literature—can systematically exploit ESG's volatility-reducing properties to construct efficient frontiers that dominate conventional mean-variance portfolios on a risk-adjusted basis (Pastor et al., 2022; Pedersen et al., 2022).

For risk managers and regulators, the finding that ESG performance reduces idiosyncratic but not systematic risk suggests that ESG integration should be viewed as a complement to, rather than a substitute for, traditional market risk management tools (beta hedging, factor exposure management). Regulatory stress-testing frameworks should incorporate ESG performance as a determinant of idiosyncratic risk in their models, alongside traditional financial metrics (leverage, liquidity, profitability). The Basel IV and Solvency II frameworks would benefit from explicit ESG risk adjustments in their internal model approval processes. The finding that high-ESG portfolios are net receivers of volatility shocks (Diebold-Yilmaz spillover analysis) further suggests that ESG integration may contribute to broader financial system stability by reducing the systemic risk contributions of individual firms (Antoncic & Herring, 2022; Bouteska et al., 2023).

For policymakers, the finding that ESG's buffering effect is stronger in developed markets underscores the importance of building institutional infrastructure—disclosure standards, analyst capacity, institutional investor development—to enable ESG performance to translate into financial risk reduction in emerging economies. International regulatory convergence on ESG disclosure standards (ISSB, CSRD, SEC climate disclosure rules) will be critical for realizing the global financial stability benefits of ESG integration. Krueger et al. (2023) demonstrate that mandatory disclosure requirements significantly reduce information asymmetry and idiosyncratic volatility, providing direct empirical support for the proposition that regulatory mandates can accelerate the translation of ESG performance into financial risk reduction. Our findings suggest that the financial stability rationale for mandatory ESG disclosure—reducing idiosyncratic volatility and improving market efficiency—is at least as compelling as the sustainability rationale.

7.7. Limitations and Future Research Directions

While our multi-method approach and comprehensive sample provide robust evidence for ESG's volatility-buffering role, several limitations merit acknowledgment. First, despite our use of System GMM to address endogeneity, the possibility of residual endogeneity cannot be fully eliminated in observational data. Ideal causal identification would require exogenous variation in ESG performance—such as regulatory shocks that force ESG improvements for a subset of firms—analogous to the natural experiment exploited by Krueger et al. (2023) in their mandatory disclosure study. Second, our composite ESG score, while mitigating provider-specific measurement error, may still fail to capture the full multidimensionality of ESG performance, particularly with respect to forward-looking transition risk exposures that are increasingly material for equity valuation and volatility (Ilhan et al., 2022; Hong et al., 2023).

Third, the sample period (2018-2023) encompasses unusual macroeconomic conditions—the COVID-19 pandemic, the 2022 inflationary shock, and the 2023 banking sector stress—that may not be representative of long-run ESG-volatility dynamics. Dimson et al. (2022) note that the performance of ESG strategies is highly sensitive to the evaluation period, and longer-horizon analyses are needed to establish the durability of ESG's risk-reduction properties across complete business cycles. Fourth, our focus on large-cap firms with ESG coverage introduces a survivorship bias that may overstate the volatility-reducing benefits of ESG for the broader universe of listed firms. Small and mid-cap firms—which constitute the majority of listed companies and are increasingly subject to ESG disclosure requirements—represent an important but understudied population for ESG-volatility research.

Future research should address these limitations by exploiting regulatory shocks for causal identification, extending analyses to small and mid-cap firms, incorporating forward-looking climate risk metrics (physical and transition risk scores) alongside backward-looking ESG performance measures, and examining whether ESG's volatility-buffering properties extend to debt markets (credit spreads, bond yield volatility) and derivatives markets (implied volatility surfaces). The growing availability of high-frequency ESG data—from satellite imagery, supply chain analytics, and natural language processing of corporate communications (Cai, 2025; Serafeim & Yoon, 2023)—opens new avenues for examining the real-time information content of ESG performance for financial risk dynamics.

8. Conclusion

This study provides comprehensive quantitative evidence that ESG performance functions as a meaningful buffer against firm-level stock return volatility, operating primarily through the idiosyncratic risk channel. Using a multi-method estimation strategy—two-way fixed-effects panel regression, DCC-GARCH modeling, System GMM, and quantile regression—applied to a panel of 575 firms across 22 countries over 2018-2023, we establish several key findings.

First, a one-standard-deviation increase in composite ESG score is associated with a statistically significant reduction in annualized idiosyncratic volatility of approximately 1.47 percentage points (6.0% relative to the mean), robust to endogeneity correction, alternative volatility measures, and alternative ESG rating providers. Second, ESG performance does not significantly reduce systematic (market) beta, confirming that the buffering mechanism operates at the firm-specific rather than market-wide level. Third, the Governance pillar is the strongest predictor of volatility reduction, followed by the Environmental pillar, with the Social pillar exhibiting the smallest but still significant effect.

Fourth, ESG's buffering effect is amplified during periods of market stress (VIX > 25), in developed markets, and in high-salience sectors, consistent with the theoretical prediction that ESG's risk-reduction mechanisms require institutional infrastructure and elevated legitimacy stakes to operate most effectively. Fifth, DCC-GARCH analysis confirms that high-ESG portfolios exhibit lower conditional correlations with global market indexes and are net receivers rather than net transmitters of volatility shocks. Sixth, quantile regression reveals that ESG's protective effect is strongest for the most volatile firms, making it most valuable as a risk-management tool for high-risk portfolios.

These findings have important implications for investment practice, risk management, and regulatory policy. ESG integration should be recognized not merely as an ethical or reputational imperative but as a quantifiable risk-management instrument that reduces firm-specific volatility, improves portfolio efficiency, and contributes to broader financial stability. Portfolio managers should incorporate ESG performance into volatility forecasting models; risk managers should treat ESG quality as a determinant of idiosyncratic risk in stress-testing frameworks; and regulators should invest in the institutional infrastructure needed to realize the full risk-reduction potential of ESG performance in emerging markets.

Several limitations of this study suggest avenues for future research. First, the six-year sample period, while encompassing multiple market stress episodes, may be insufficient to fully characterize the long-term dynamics of ESG-volatility relationships across complete business cycles. Second, our focus on large-cap firms with ESG coverage may limit the generalizability of findings to small and mid-cap companies, which constitute the majority of listed firms globally. Third, the endogenous nature of ESG investment decisions—even after GMM correction—means that causal interpretation of our findings requires continued caution. Fourth, the rapidly evolving regulatory and disclosure landscape for ESG means that the information environment in which ESG performance is assessed is changing rapidly, potentially altering the mechanisms through which ESG translates into financial risk reduction.

Future research should examine ESG's volatility-buffering properties in the context of emerging regulatory frameworks (ISSB, CSRD), explore the role of ESG news flow and sentiment (Cai, 2025) as real-time volatility predictors, and investigate whether ESG performance reduces the probability of extreme loss events (tail risk) beyond the conditional volatility measures examined here. The integration of alternative data sources—satellite imagery, supply chain analytics, natural language processing of corporate communications—into ESG scoring may also improve the predictive power of ESG measures for financial risk outcomes.

Data availability

ESG data sourced from Refinitiv Eikon, MSCI ESG Ratings, and Sustainalytics. Financial data from Compustat Global, Worldscope, and Datastream. Factor data from Kenneth French's data library.

Conflicts of Interest

The authors declare no conflicts of interest.

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Appendix A: Summary of Robustness Checks

This appendix summarizes the four categories of robustness checks referenced in Section 4.6. Full tabular results are available from the corresponding author upon request.

A.1 Provider-Specific ESG Scores

To assess sensitivity to ESG rating provider choice, we re-estimate the baseline two-way fixed-effects panel regression (Equation 1) replacing the composite PCA score with individual provider scores from Refinitiv Eikon, MSCI ESG Ratings, and Sustainalytics (post-reversal). All three provider-specific specifications yield negative and statistically significant coefficients on ESG score in the idiosyncratic volatility regression. The Refinitiv-based specification produces the largest effect ($\beta = -0.163$, $p < 0.001$), followed by the composite PCA score ($\beta = -0.147$), the MSCI-based specification ($\beta = -0.131$), and the Sustainalytics-based specification ($\beta = -0.112$, $p < 0.01$). The directional consistency across all providers supports the robustness of the main finding.

A.2 Alternative Volatility Measures

We replace the primary idiosyncratic volatility measure with three alternative specifications: i) realized volatility computed as the square root of the sum of squared intraday returns; ii) downside deviation (annualized standard deviation of negative daily returns below the sample mean); and iii) the Garman-Klass (1980) range-based volatility estimator. In all three alternative specifications, the coefficient on composite ESG score remains negative and statistically significant at the 5% level or better, with magnitudes ranging from $\beta = -0.119$ (downside deviation) to $\beta = -0.138$ (Garman-Klass estimator). These results confirm that the ESG-volatility buffering effect is not specific to the primary volatility measure.

A.3 Propensity Score Matching

To mitigate selection bias arising from the non-random distribution of ESG performance across firms, we apply propensity score matching (PSM) to construct a control sample. High-ESG firms (Q4) are matched to low-ESG firms (Q1) on the basis of pre-treatment firm characteristics: log total assets, leverage, profitability (ROA), book-to-market ratio, and industry classification (one-to-one nearest-neighbor matching with caliper = 0.02). The matched sample comprises 214 firm pairs. The ESG coefficient in the matched-sample regression remains negative and significant ($\beta = -0.128$, $p < 0.01$), confirming that the baseline result is not driven by systematic differences in observable firm characteristics between high- and low-ESG firms.

A.4 Nonlinear ESG-Volatility Relationship

To test for a potential nonlinear (U-shaped or inverted-U-shaped) relationship between ESG performance and idiosyncratic volatility, we augment the baseline regression with the squared composite ESG score (ESG^2). The coefficient on the linear ESG term remains negative and significant (β = −0.141, $p < 0.001$), while the coefficient on ESG^2 is small and statistically indistinguishable from zero (β = 0.003, $p = 0.61$), providing no evidence of a nonlinear relationship. The ESG-volatility buffering effect appears to be approximately linear across the range of ESG performance observed in our sample.

Appendix B: PCA Factor Loadings and Variance Decomposition

Table B1 reports the PCA factor loadings for the composite ESG score construction. Prior to PCA, Sustainalytics ESG Risk Scores were reversed (multiplied by −1 and rescaled to 0 - 100) so that all three providers are directionally aligned (higher = better ESG performance).

Table B1. PCA Loadings for composite ESG score construction.

Provider	PC1 Loading	PC2 Loading	PC3 Loading
Refinitiv Eikon ESG	0.614	−0.521	0.592
MSCI ESG Ratings	0.589	0.803	0.091
Sustainalytics (reversed)	0.525	−0.291	−0.801
Eigenvalue	2.019	0.621	0.360
% Variance Explained	67.3%	20.7%	12.0%
Cumulative %	67.3%	88.0%	100.0%

Note: PC1 is used as the composite ESG score throughout the analysis. All loadings are positive for PC1, confirming directional alignment across providers after Sustainalytics score reversal. The first principal component explains 67.3% of the common variance across the three providers.