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Research article

ESG disclosure and accounting-based financial resilience: Evidence from earnings volatility and conditional downside ROA dispersion in Pakistan

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Abstract: This study addresses a gap that developed-market ESG research has largely left open: whether the act of disclosing sustainability information as distinct from the underlying quality of ESG performance itself is associated with accounting-based financial resilience in an emerging market. We constructed a hand-collected, weighted ESG disclosure index for 48 non-financial firms listed on the Pakistan Stock Exchange (2016–2025), a period spanning Pakistan's transition from voluntary to progressively formalized sustainability-reporting requirements (Code of Corporate Governance 2019/2022; SECP ESG Disclosure Guidelines 2024; revised guidelines issued December 2025 with phased mandatory adoption by 2029). This regulatory trajectory, together with Pakistan's concentrated, family-dominated ownership structure, provides institutional variation largely absent from the developed-market samples that dominate the existing literature, where ESG disclosure and ESG performance are frequently conflated. Financial resilience was operationalized through backward-looking rolling standard deviation and conditional downside standard deviation of return on assets (ROA). Using firm-fixed-effects panel models, we found weak, specification-sensitive evidence of a negative association between ESG disclosure and general earnings volatility ($\beta = -0.0254$, conventional $p = 0.085$; wild-cluster bootstrap, $p = 0.092$); the governance pillar has the largest point estimate (-0.0242, $p = 0.041$), though formal coefficient-equality tests do not establish it as statistically stronger than the environmental or social pillars. The association with conditional downside ROA dispersion is not statistically significant ($\beta = -0.0198$, $p = 0.167$), and industry ($p > 0.40$) and crisis ($p > 0.30$) interaction terms are likewise insignificant. A randomization-based placebo test ($p = 0.13$) and an unbalanced-panel check both attenuated the baseline result, indicating that the evidence should

be read as suggestive rather than conclusive. Taken together, the findings show that in an emerging market with an evolving regulatory framework, ESG disclosure exhibits a fragile, not robust, negative association with earnings fluctuations. This study contributes to the green finance literature by (i) isolating disclosure from performance, (ii) offering one of the few firm-level, decade-long tests of accounting-based (rather than market-based) ESG–risk associations in South Asia, and (iii) documenting how that association behaves under a genuine regulatory-transition setting.

Keywords: ESG Disclosure; financial resilience; earnings volatility; downside earnings variability; emerging markets; Pakistan; corporate governance; stakeholder theory; green finance.

JEL Codes: G30, G32, M14, M41, Q56

1. Introduction

The global investment landscape is undergoing a fundamental transformation with the increasing integration of environmental, social, and governance (ESG) metrics into mainstream corporate valuation and capital allocation frameworks. This shift reflects the growing recognition that sustainability factors may materially impact firm performance, risk profiles, and long-term viability (Gillan et al., 2021; Serafeim, 2020). Within this evolving paradigm, corporate ESG disclosures have evolved from voluntary, peripheral communications to critical informational inputs that shape investor assessments of firm resilience, strategic positioning, and exposure to non-financial shocks (Amel-Zadeh & Serafeim, 2018; Christensen et al., 2021). Concurrently, the emergent field of green finance posits a link between sustainable corporate practices and financial stability, arguing that capital allocation aligned with environmental and social objectives may simultaneously mitigate portfolio risk and enhance market resilience (Bolton et al., 2020; Grewal et al., 2020). A central, yet underexplored, hypothesis within this framework is whether comprehensive ESG disclosure is associated with lower firm-specific accounting risk (Albuquerque et al., 2019; Bauer & Hann, 2010).

1.1. Problem statement

Despite theoretical propositions and growing regulatory momentum, the precise function of ESG disclosure, distinct from ESG performance in attenuating fundamental accounting-based financial risk, remains insufficiently examined, particularly in emerging market contexts. While empirical research, predominantly focused on developed economies, associates strong ESG performance with outcomes like lower cost of capital (Chava, 2014) and resilience during crises (Lins et al., 2017), the specific channel of transparency and communication is less understood. This distinction is critical from both theoretical and practical standpoints. Disclosure reduces information asymmetry, enabling the risk-mitigating attributes of underlying ESG practices to be recognized and verified by capital providers (Leuz & Wysocki, 2016). Consequently, a significant gap exists in understanding whether and how the act of disclosing ESG information is associated with accounting-based financial stability measures, especially in institutional environments characterized by information opacity. Three specific gaps motivate the present study. First, the empirical literature linking sustainability to lower financial risk is concentrated

in developed markets with mature disclosure infrastructure (Chava, 2014; Lins et al., 2017); whether the same association holds where disclosure is voluntary and newly forming is largely untested. Second, much of this literature measures ESG performance (third-party ratings) rather than ESG disclosure (a managerial choice) and treats the two as interchangeable despite their conceptually distinct mechanisms (Christensen et al., 2021). Third, existing risk-based ESG studies overwhelmingly use market-based volatility or crash-risk measures, whereas accounting-based measures, such as earnings volatility and conditional downside ROA dispersion, which are less susceptible to market-wide noise and more directly reflect operating-level resilience, remain comparatively unexplored, particularly outside East Asia and the West. Pakistan's non-financial listed sector, which underwent a codified shift from voluntary to phased-mandatory ESG reporting between 2016 and 2025 and is characterized by concentrated family ownership, shaping both disclosure incentives and monitoring intensity, offers a setting in which these three gaps can be jointly addressed with a single hand-coded dataset.

1.2. Research questions

This study investigates how ESG disclosures are associated with accounting-based financial resilience in an emerging market context, with a focus on non-financial firms listed on the Pakistan Stock Exchange. Specifically, the study addresses the following research questions:

1. To what extent are ESG disclosures associated with accounting-based financial resilience through reduced earnings volatility and conditional downside ROA dispersion?
2. Is ESG disclosure significantly associated with reduced exposure to earnings downside variability, as measured by the conditional downside standard deviation of ROA?
3. Is the association between ESG disclosure and earnings volatility stronger for firms operating in industries with high inherent ESG exposure, such as energy and materials?
4. Does the association between ESG disclosure and earnings volatility become more pronounced during periods of macroeconomic stress?

1.3. Objectives of the study

The study aims to achieve the following specific objectives:

- To construct a robust, hand-collected multidimensional index measuring the extent of ESG disclosures among non-financial firms listed on the Pakistan Stock Exchange (PSX).
- To empirically analyze the association between ESG disclosure scores and accounting-based financial resilience, operationalized through earnings volatility and conditional downside ROA dispersion metrics.
- To examine the conditional associations of industry characteristics (high vs. low ESG impact) and macroeconomic conditions (stress vs. non-stress periods) on the disclosure–resilience relationship.
- To derive evidence-based implications for corporate managers, investors, and financial regulators in Pakistan and similar emerging markets.

1.4. Significance of the study

This research holds significance for multiple theoretical, empirical, and practical domains. The study engages with core propositions from stakeholder theory (Freeman et al., 2021), legitimacy theory (Suchman, 1995), and signaling theory (Spence, 1973) within the specific context of an emerging market's financial risk landscape.

It addresses a notable geographical and conceptual gap in the literature. While most evidence originates from developed economies, this study provides longitudinal, firm-level evidence from Pakistan, a significant yet underrepresented emerging economy undergoing a deliberate regulatory transition in sustainability reporting (Jamali et al., 2015). Methodologically, it employs a primary, hand-collected disclosure index, avoiding the potential biases and coverage gaps associated with commercial ESG ratings in emerging markets.

The findings offer salient practical insights for key market participants: For corporate managers and boards, the evidence informs a business case for investing in transparent ESG reporting as a potential risk management tool; for investors and financial analysts, it provides preliminary evidence that ESG disclosure may contain information relevant to investment risk assessment; and for policymakers and regulators, such as the Securities and Exchange Commission of Pakistan (SECP) and the Pakistan Stock Exchange (PSX), it offers timely evidence to evaluate and strengthen disclosure frameworks with the goal of enhancing market transparency.

1.5. Scope and delimitations

The scope of this study is defined across three dimensions. Temporally, the analysis covers the 10-year period from 2016 to 2025 to capture Pakistan's regulatory evolution and significant economic events; cross-sectionally, it focuses on non-financial firms continuously listed on the Pakistan Stock Exchange, excluding financial sector firms due to their distinct regulatory and risk profiles; and conceptually, the investigation centers on ESG disclosure as the independent variable, and accounting-based financial resilience operationalized through earnings volatility and conditional downside ROA dispersion as the dependent variable, thereby explicitly distinguishing the study's focus from related concepts like ESG performance or market-based risk metrics

2. Literature review

2.1. Theoretical foundations

The proposition that ESG disclosures are associated with financial resilience is grounded in several complementary theoretical frameworks. Stakeholder theory posits that a firm's long-term success is contingent upon its ability to manage relationships with a broad constellation of constituents, including employees, customers, communities, regulators, and the environment (Freeman et al., 2021). Firms that proactively disclose ESG information signal their commitment to managing these non-shareholder interests. This can build relational capital, reduce conflicts, and pre-empt regulatory or reputational shocks that destabilize cash flows (Flammer, 2015). Conversely, poor ESG transparency can exacerbate

information asymmetry, leading to heightened stakeholder skepticism and increased litigation risk (Dhaliwal et al., 2011).

Closely linked is legitimacy theory, which suggests that corporations operate within a social contract and must align their actions with societal values to maintain their "license to operate" (Suchman, 1995). In an era of heightened awareness regarding climate change and social inequality, comprehensive ESG disclosure is a primary tool for legitimizing corporate conduct (Deegan, 2002). From a risk perspective, a loss of legitimacy can trigger consumer boycotts, activist investor campaigns, and stringent regulatory interventions—all significant sources of financial disruption. Thus, systematic disclosure acts as a pre-emptive risk management strategy.

Finally, signaling theory provides a direct channel linking disclosure to financial risk metrics (Spence, 1973). In capital markets characterized by information asymmetry, high-quality ESG disclosures serve as credible signals of superior management quality and forward-looking risk oversight (Connelly et al., 2011). They indicate that the firm is adept at identifying and managing non-financial risks that can materialize as financial costs. Investors and creditors, perceiving lower ex-ante risk, may demand a lower risk premium, reducing the firm's cost of capital and buffering it against financing shocks during periods of stress (El Ghoul et al., 2011).

2.1.1. Integrated theoretical framework

The three theoretical frameworks—stakeholder theory, legitimacy theory, and signaling theory—can be integrated into a unified conceptual framework. The framework describes a proposed theoretical pathway rather than an empirically established causal mechanism, operating through three interrelated channels.

First, ESG disclosure can reduce information asymmetry by providing stakeholders with information about a firm's ESG-related exposures, policies, and management practices. Second, greater transparency may strengthen stakeholder confidence and organizational legitimacy by making the firm's practices more observable and assessable. Third, credible disclosure may serve as a signal of managerial quality and risk oversight, thereby reducing perceived uncertainty surrounding the firm's operations and financing conditions. Through these mechanisms, ESG disclosure may be associated with lower earnings volatility, although these intervening mechanisms are not directly tested in the present study.

Two moderating conditions are theoretically relevant. Industry materiality may strengthen the informational relevance of specific ESG disclosures because stakeholders are more attentive to issues that are economically consequential to the firm's business model. Crisis conditions may increase the value of credible information because information asymmetry and financing pressures intensify during periods of macroeconomic stress, potentially amplifying the association between ESG disclosure and accounting-based financial resilience. Figure 1 summarizes how the three theoretical mechanisms converge on a common risk channel and how industry materiality and crisis conditions are hypothesized to moderate that channel.

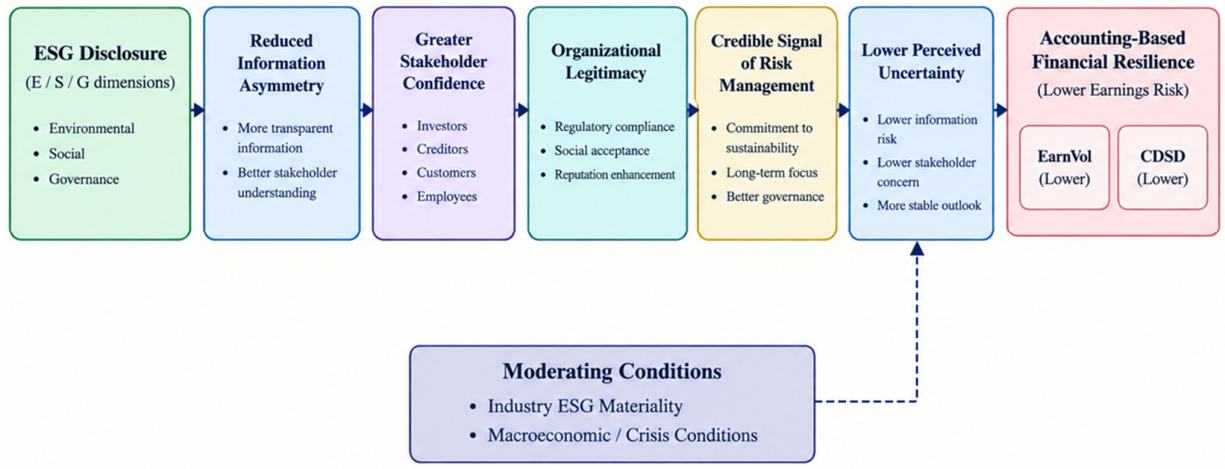


Figure 1. Integrated theoretical framework. Note: Arrows depict the theorized sequence discussed in Section 2.1.1 and are not empirically tested in this study.

2.2. Empirical evidence on ESG and financial risk

Empirical research has increasingly investigated the risk implications of ESG performance and disclosure, yielding supportive but nuanced evidence. A foundational strand of literature examines the cost of capital. Studies consistently found that firms with stronger environmental performance or disclosure face lower costs of both equity and debt (Chava, 2014; El Ghoul et al., 2011). For instance, Bauer and Hann (2010) demonstrated that firms with better environmental risk management exhibit lower credit spreads.

A second critical area explores stock return volatility and downside risk. Albuquerque et al. (2019) theorized that high-ESG firms have more stable stakeholder relationships, leading to less volatile cash flows and stock returns. Their empirical work found that such firms exhibit lower return volatility and higher resilience during market downturns (Albuquerque et al., 2019; Lins et al., 2017). Importantly, Lins et al. (2017) showed that firms with high social capital experienced significantly higher stock returns and profitability during the 2008–2009 financial crisis, underscoring the insurance-like property of ESG during systemic shocks.

The specific link between ESG and earnings volatility is less charted but emerging. García-Sánchez et al. (2020) provided international evidence that CSR disclosure reduces the variability of future financial performance. Kim et al. (2014) found that CSR performance is associated with reduced stock price crash risk, suggesting that ESG-related characteristics may have different relationships with alternative dimensions of firm risk.

However, the literature exhibits important caveats. First, the conflation of ESG performance with ESG disclosure is common, though they are distinct constructs (Christensen et al., 2021). A firm may perform well but disclose poorly, limiting the risk-mitigation benefits if stakeholders cannot observe them. Second, most evidence originates from developed markets with mature institutional frameworks. The extent to which these findings generalize to emerging markets requires dedicated examination (Aguilera et al., 2021).

2.3. The distinct context of emerging markets

The relationship between ESG disclosure and financial risk is profoundly shaped by institutional context. Emerging markets are typically characterized by weaker legal enforcement, less developed capital markets, greater information asymmetry, and higher political and macroeconomic volatility (Haque & Ntim, 2018). In such settings, the role of ESG disclosure may be both more critical and more complex.

On one hand, the potential for ESG disclosure to act as a credible signal and risk mitigator may be amplified. In the absence of strong formal institutions, voluntary disclosure practices can serve as a key mechanism for building trust with foreign and domestic investors (Javeed et al., 2021). High-quality ESG reporting can differentiate a firm as transparent and well-governed amidst a pool of peers with potentially higher opaqueness and risk.

On the other hand, the effectiveness of disclosure depends on its credibility, which is itself a function of the institutional environment. In contexts with weak oversight, disclosures may be viewed as "cheap talk" or greenwashing, potentially diminishing their risk relevance (Marquis & Qian, 2014). Therefore, regulatory reforms that standardize and encourage ESG reporting—such as those undertaken in Pakistan—are pivotal. They enhance the comparability, reliability, and auditability of disclosures, thereby strengthening the signal and its subsequent association with financial resilience (Christensen et al., 2021).

2.4. Synthesis of South Asian and Pakistani ESG–risk evidence

Empirical evidence linking sustainability disclosure to financial-risk outcomes is well established in developed markets (Chava, 2014; El Ghoul et al., 2011; Lins et al., 2017) but considerably thinner for South Asia, and the regional evidence that does exist has focused on disclosure levels and their determinants rather than on risk outcomes. Masud et al. (2018) documented that ownership concentration and limited board diversity constrain environmental sustainability reporting performance across 88 listed firms in Bangladesh, India, and Pakistan, highlighting the same family-ownership structures that characterize the present sample. Within Pakistan specifically, Tauseef and Khurshid (2025) constructed a voluntary ESG ranking for PSX-listed firms and found that governance disclosure is systematically stronger than environmental or social disclosure—a pattern consistent with the pillar-level results reported in Section 4.4.1 of this study. Bhat et al. (2024) showed that South Asian firms' sustainability-disclosure levels vary with country-level governance quality. A distinct but related strand examined risk disclosure, rather than ESG disclosure, in Pakistan: Ali et al. (2025) found that Shariah compliance is associated with more extensive financial, operational, and integrity risk disclosure among 140 non-financial PSX-listed firms, and Naz and Ayub (2017) documented a negative association between risk-disclosure levels and risk-taking behavior among Pakistani commercial banks. This evidence establishes that disclosure–risk associations do exist within Pakistan's institutional setting, but it is confined to the financial sector, to risk disclosure as a distinct construct from ESG disclosure, or to sustainability-reporting levels rather than accounting-based risk outcomes. The contrast with more institutionalized markets is instructive: where mandatory policy shocks exist, researchers can identify causal effects directly. Zhou et al. (2025), for instance, exploited the staggered rollout of China's carbon emissions trading pilot as a quasi-natural experiment to show

it improved corporate ESG performance. Pakistan's still-voluntary, gradually phasing framework does not yet offer comparable exogenous variation, which is one reason for why the present study relies on panel fixed-effects and sensitivity analyses rather than a policy-shock identification strategy. None of this literature, South Asian or otherwise, directly tests whether ESG disclosure is associated with accounting-based earnings risk in non-financial firms, which is the specific gap the present study addresses.

2.5. Synthesis and identification of the research gap

The reviewed literature establishes a compelling theoretical and empirical case that ESG practices can reduce firm-specific financial risk through various channels. However, critical gaps remain that this study aims to address. Much of the empirical work focuses on ESG performance ratings; this study focuses explicitly on disclosure, a managerial choice with direct governance implications. While stock return volatility is commonly studied, fewer papers directly analyze accounting-based risk metrics like earnings volatility and conditional downside ROA dispersion. There is a pronounced scarcity of longitudinal, firm-level studies on this topic in South Asia, particularly in Pakistan. The literature often assumes, rather than tests, the moderating conditions. By investigating the relationship between a manually constructed ESG disclosure index and robust measures of earnings volatility and conditional downside ROA dispersion in Pakistani listed firms, this study seeks to fill these gaps.

3. Research methodology

3.1. Data sources and sample construction

This study constructs a unique, hand-collected longitudinal dataset to investigate the relationship between ESG disclosures and accounting-based financial resilience in Pakistan. The analysis focuses on non-financial firms listed on the Pakistan Stock Exchange (PSX) over the 10-year period from 2016 to 2025. This timeframe is strategically selected to capture the period of significant regulatory evolution in Pakistan's capital markets.

The sample construction followed a rigorous multi-stage filtration process to ensure data completeness and analytical robustness. To enable the three-year backward-looking volatility measures, ROA data were collected for the period 2014–2025, extending beyond the formal 2016–2025 ESG study period. This ensures that the 2016 observations have complete historical ROA information for window construction. ESG disclosure data were collected for the period 2015–2025, with the 2015 ESG data required to construct the lagged ESG variable (ESG_{t-1}) for the 2016-dependent observations.

The initial universe comprised all companies listed on the PSX as of December 2015. Financial sector firms including commercial banks, insurance companies, leasing firms, and investment banks were systematically excluded due to their distinct regulatory capital requirements, risk management frameworks, and reporting standards that could confound the analysis of operational and financial resilience. From the remaining non-financial firms, we applied a continuity filter, requiring firms to have been continuously listed and have published annual reports available for the entire 10-year study period (2016–2025). This criterion was adopted for data completeness and comparability, though it should be noted that requiring continuous listing may introduce survivorship bias, as firms that

disappeared, failed, merged, or were delisted may systematically differ in resilience characteristics. This limitation is revisited in Section 5.5 and partially addressed by the unbalanced-panel robustness check reported in Section 4.4.6.

The application of these filters resulted in a final sample of 48 non-financial firms. With the availability of ROA data from 2014 to 2025 and ESG data from 2015 to 2025, the full balanced panel supports 480 firm-year observations for the three-year backward window (48 firms × 10 years, 2016–2025). The lagged ESG specification (ESG_{t-1}) is feasible for 2016–2025 because 2015 ESG data are available. For the primary profitability control, we use ROA~t-3~ to avoid mechanical overlap with the dependent variable. This requires ROA data from 2013 for the 2016 observations; to accommodate this, the ROA data collection period was extended to 2013–2025. Therefore, the final estimation sample for EarnVol comprises the full 480 observations. For the conditional downside standard deviation (CDSD) measure, observations with fewer than two below-mean ROA values are set as missing (see Section 3.2.1 for the detailed procedure), yielding a revised estimation sample of 394 observations. As a robustness check, alternative window lengths (4-year, 5-year) were also estimated, with the 4-year window requiring ROA data from 2013 onward; since ROA data collection begins in 2013, the 4-year window is available from 2016 onward, yielding 480 observations, and the 5-year window from 2017 onward, yielding 432 observations.

Table 1. Sample construction.

Stage	Firms	Firm-years	Explanation
Initial PSX population	576	—	All listed companies
After financial-sector exclusion	412	—	Banks, insurance, leasing firms excluded
Continuously listed 2016–2025	48	480	Balanced panel with full annual report availability
ROA window construction (3-year, requires 2013–2015)	48	480	Pre-period ROA data collected for 2013–2015
ESG lag (requires 2015 ESG data)	48	480	2016 observations use 2015 ESG data
Final EarnVol estimation sample (3-year)	48	480	2016–2025 (10 years) with complete data
Final CDSD estimation sample (3-year)	48	394	Excludes observations with <2 below-mean ROA values
5-year window robustness	48	432	2017–2025 (9 years)

Data collection proceeded through two parallel, meticulously documented streams. First, ESG disclosure data were manually extracted through systematic content analysis of annual reports, integrated reports, and standalone sustainability reports where available. A team of trained researchers applied a standardized coding protocol to ensure consistency. Second, financial statement data were extracted from audited annual reports available through the PSX website and company investor relations portals, supplemented by market data from the PSX database and Bloomberg/Refinitiv terminals. The final dataset represents a merger of these two comprehensive data streams at the firm-year level.

3.2. Variable construction and measurement

3.2.1. Dependent variables: Measuring accounting-based financial resilience

Accounting-based financial resilience is operationalized through two complementary constructs: earnings volatility and conditional downside ROA dispersion, with accounting-based measures preferred over market-based metrics because they more directly reflect firms' operational stability and are less susceptible to short-term investor sentiment. Earnings volatility (EarnVol) is measured as the rolling standard deviation of return on assets (ROA) over a backward-looking three-year window. This approach ensures proper temporal ordering by using only historical information to construct the dependent variable. Specifically, for firm *i* in year *t*, earnings volatility is calculated as the standard deviation of ROA observations from years t-2, t-1, and t, as shown in Equation (1):

$$EarnVol_{i,t} = \sigma\left(ROA_{i,\tau}\right),\ \tau = t-2, t-1, t \quad (1)$$

Where ROA is the net income divided by the average of total assets. A three-year window is selected to maximize the number of available observations while maintaining sufficient observations for standard deviation calculation. This backward-looking specification avoids the forward-looking bias inherent in symmetric windows that use future data. The 5-year window is also tested as a robustness check. This rolling-window construction is adapted from the broader earnings-risk literature (Frankel & Litov, 2009).

To capture downside earnings variability, we construct a conditional downside standard deviation (CDSD) of ROA using observations falling below the firm-specific mean within the rolling window. The procedure is conceptually related to downside-risk measures used in the literature (Estrada, 2002) but is adapted here to the short annual ROA window. For each firm-year observation with ROA values {ROA_1, ROA_2, ROA_3}, the arithmetic mean is first computed as the average of the three observations. The subset of observations where each individual ROA value is strictly less than this mean is then identified. The CDSD is computed as the sample standard deviation (using n-1 degrees of freedom) of this subset when the number of below-mean observations is at least two. When the number of below-mean observations is either zero or one, the CDSD is set to missing—zero observations indicate no downside variability to measure, while a single observation provides insufficient data for a meaningful standard deviation.

This procedure adapts the downside-deviation concept to the short annual window used in this study while avoiding the calculation of a standard deviation from a single observation. With three observations, it is mathematically impossible for all three observations to be strictly below their arithmetic mean; at least one observation must be at or above the mean. Therefore, the number of below-mean observations can only be 0, 1, or 2. Calculations are performed using unrounded ROA values to avoid artificial equality cases.

Because the three-year window generally yields two below-mean observations when CDSD is estimable, the measure should be interpreted as a short-window conditional dispersion indicator rather than a conventional tail-risk estimator. The sample standard deviation of two observations is simply the absolute difference between the two values divided by the square root of two. Therefore, CDSD is effectively measuring the distance between the two below-mean ROAs.

Table 2. Distribution of below-mean observations.

Number of below-mean observations	Firm-years	Percentage
0	48	10.0%
1	38	7.9%
2	394	82.1%
Total	480	100.0%

As shown in Table 2, the 86 observations with 0 or 1 below-mean values (48 + 38) are excluded from the downside analysis, leaving 394 observations for the estimation sample. The limited number of downside observations in some windows means the CDSD should be interpreted as a relatively coarse indicator of short-window downside variability rather than a precise estimate of extreme tail risk.

For the 5-year robustness specification, the same procedure is applied to the corresponding five-year ROA window; observations are retained when at least two annual ROA values fall strictly below the window-specific mean.

An alternative volatility measure, operating income volatility (*OpIncVol*), is constructed as shown in Equation (2):

$$OpIncVol_{it} = SD\left(\frac{Operating\ Income_{i\tau}}{Total\ Assets_{i\tau}}\right), \tau = t-2, t-1, t \quad (2)$$

This measure captures operational earnings volatility before financing and tax effects, providing a robustness check on whether results are sensitive to the choice of profitability metric.

3.2.2. Independent variable: ESG disclosure index construction

The primary explanatory variable, a comprehensive ESG disclosure index (ESG_Index), is constructed through manual content analysis of annual reports, following established methodologies in disclosure research while incorporating Pakistan's regulatory context (Haque & Ntim, 2018; Javeed et al., 2021). The coding framework encompasses 40 items across environmental (14 items), social (13 items), and governance (13 items) pillars, addressing areas from emissions and resource use to labor practices, community engagement, board oversight, and anti-corruption policies—elements central to sustainability reporting quality (García-Sánchez et al., 2020; Christensen et al., 2021).

Two independent coders assigned binary scores (1 if an item was disclosed and 0 otherwise) for each ESG disclosure item. Intercoder reliability was assessed using Cohen's Kappa, with coefficients exceeding 0.85 indicating excellent agreement. Following this procedure, the composite ESG disclosure index for firm *i* in year *t* is calculated as shown in Equation (3)

$$ESG_{i,t} = \frac{1}{40}\sum_{j=1}^{40} Score_{i,t,j} \quad (3)$$

The resulting index yields a continuous proportion score bounded between 0 and 1. In addition, pillar-specific indices for the environmental (E-Index), social (S-Index), and governance (G-Index) dimensions are constructed to facilitate more granular analysis, consistent with prior studies (Dhaliwal et al., 2011).

A weighted ESG disclosure index was also constructed as a robustness check. This alternative index assigns additional weight to items that are disclosed in more detail (e.g., quantitative information, specific targets, verification statements) compared to boilerplate or generic disclosures. Items receiving 1 point for basic disclosure receive an additional 0.5 points for quantitative detail, 0.5 points for specific targets, and 0.5 points for third-party verification or assurance. The maximum score for any item is 2.5 points. The weighted index is normalized as shown in Equation (4):

$$WeightedESG_{i,t} = \frac{\sum_{j=1}^{40} Score_{i,t,j}}{40 \times 2.5} \quad (4)$$

This yields a score between 0 and 1, comparable to the binary index. This weighted index is used only as a robustness check and does not replace the primary binary index.

3.2.3. Control variables

Consistent with corporate finance literature on risk determinants and prior ESG studies (Khan et al., 2016; Albuquerque et al., 2019), a comprehensive set of firm-level controls is included:

Firm size (Size): the natural logarithm of total assets; Leverage (Lev): total debt to total assets; Growth opportunities (MB): market-to-book ratio; three-year-lagged profitability (ROA~t–3~) to control for mean reversion while avoiding mechanical overlap with the dependent variable; Asset tangibility (Tang): net PPE to total assets; Liquidity (Current): current ratio; Capital intensity (CapInt): CAPEX to total assets; and a Dividend payer dummy (DivDum). The use of ROA~t–3~ as the primary profitability control ensures that the profitability measure is outside the three-year ROA window used to construct EarnVol~it~. All specifications include firm-fixed and year-fixed effects to control for unobserved firm heterogeneity and macroeconomic shocks.

3.3. Empirical models and estimation strategy

The empirical analysis employs panel regression models with firm- and year-fixed effects to control for unobserved time-invariant heterogeneity and common temporal shocks. To impose temporal ordering between ESG disclosure and the current-year component of earnings volatility, the baseline specifications use a one-year lag of ESG disclosure. This temporal ordering does not, however, eliminate potential reverse causality or omitted-variable bias. As a robustness check, longer lags (ESG~t–2~ and ESG~t–3~) are also estimated, with ESG~t–3~ being particularly clean as it predates all three ROA observations used in the EarnVol construction. Standard errors are clustered at the firm level to account for heteroskedasticity and within-firm serial correlation (Petersen, 2009). As a robustness check for the small number of clusters (48 firms), we also report wild cluster bootstrap p-values for the main specifications following Cameron et al. (2008). The baseline-estimating equation (Model 1) is specified as shown in Equation (5):

$$\begin{aligned} Risk_{i,t} = {} & \alpha + \beta_1 ESG_index_{i,t-1} + \beta_2 Size_{i,t} + \beta_3 Lev_{i,t} \\ & + \beta_4 MB_{i,t} + \beta_5 ROA_{i,t-3} + \beta_6 Tang_{i,t} + \beta_7 Current_{i,t} \\ & + \beta_8 CapInt_{i,t} + \beta_9 DivDum_{i,t} + \mu_i + \lambda_t + \varepsilon_{i,t} \end{aligned} \quad (5)$$

Where Risk~i,t~ represents one of the dependent variables, earnings volatility (EarnVol), or the conditional downside standard deviation (CDSD) for firm i in year t. Firm-level fixed effects (μ~i~) control for time-invariant firm characteristics, while year-fixed effects (λ~t~) capture common macroeconomic shocks.

To examine heterogeneous associations across industries, Model 2 tests whether the negative association of ESG disclosure with earnings volatility is stronger in high ESG impact sectors. Energy, materials, transportation, and other classified high-impact sectors are expected to have greater ESG materiality under the adopted classification. This interaction specification is estimated as shown in Equation (6):

$$Risk_{i,t} = \alpha + \beta_1\left(ESG_index_{i,t-1}\right) + \beta_2(HighImpact_i) + \beta_3\left(ESG_{Index_{i,t-1}} \times HighImpact_i\right) + \Gamma(Controls_{i,t}) + \mu_i + \lambda_t + \varepsilon_{i,t} \quad (6)$$

The interaction term tests whether the ESG slope differs between conditions. Accordingly, we additionally report the marginal ESG associations within each condition and Wald tests of whether the conditional slopes differ from zero. Note that the standalone high-impact coefficient is not identified in this specification as it is absorbed by firm-fixed effects, given that high impact is a time-invariant industry characteristic.

Finally, Model 3 investigates whether the association between ESG disclosure and earnings volatility intensifies during periods of macroeconomic stress. Specifically, a composite macroeconomic stress indicator capturing the 2019–2021 period is interacted with the lagged ESG index. This specification is estimated as shown in Equation (7):

$$Risk_{i,t} = \alpha + \beta_1\left(ESG_index_{i,t-1}\right) + \beta_2\left(ESG_{Index_{i,t-1}} \times Crisis_t\right) + \Gamma\left(Controls_{i,t}\right) + \mu_i + \lambda_t + \varepsilon_{i,t} \quad (7)$$

The composite stress indicator captures the period 2019–2021, which encompasses two distinct but overlapping stress episodes in Pakistan's economy:

1. The 2019–2020 macroeconomic adjustment period, characterized by a current account deficit (peaking at 6.1% of GDP in 2018–2019; State Bank of Pakistan, 2020), high inflation (annual CPI reaching 14.6% in January 2020; State Bank of Pakistan, 2020), and a Pakistan-rupee depreciation of approximately 25% against the US dollar during 2019 (State Bank of Pakistan, 2020).
2. The 2020–2021 COVID-19 pandemic period, during which GDP contracted by 0.47% in FY2020 (Pakistan Bureau of Statistics, 2021), manufacturing output fell by 7.4% in Q4 2020 (Pakistan Bureau of Statistics, 2021), and the benchmark KSE-100 index declined by approximately 30% between January and March 2020 (World Bank, 2021).

These macroeconomic and health shocks created a sustained period of elevated uncertainty, compressed corporate margins, and heightened financial distress for listed firms, making it an appropriate window for testing whether ESG disclosure's association with earnings stability intensified during stress. The interaction term tests whether the ESG slope differs between stress and non-stress

periods. We additionally report the marginal ESG associations within each condition and Wald tests of whether the conditional slopes differ from zero.

The standalone crisis coefficient is not separately identified in this specification as it is perfectly collinear with the year-fixed effects.

Robustness checks include alternative rolling windows (5-year), weighted ESG index, unbalanced panel analysis, placebo/falsification test, and longer ESG lags.

4. Empirical analysis and results

This chapter presents the empirical findings from analyzing the association between ESG disclosures and accounting-based financial resilience for non-financial firms listed on the Pakistan Stock Exchange from 2016 to 2025. The analysis follows the methodological framework established in Chapter 3, systematically testing the central hypothesis that comprehensive ESG disclosure is associated with risk mitigation in an emerging market context. The chapter presents descriptive statistics, correlation analysis, main regression results, heterogeneity tests, and robustness checks.

4.1. Descriptive statistics and preliminary analysis

4.1.1. Summary statistics

Table 3 presents descriptive statistics for all variables. The final estimation sample comprises 480 firm-year observations (48 firms × 10 years, 2016–2025) for EarnVol. For the CDSD measure, observations with fewer than two below-mean ROA values are set to missing, yielding N = 394 for the downside analysis.

Table 3. Descriptive statistics of key variables.

Variable	N	Mean	Std. Dev.	Min	Max
EarnVol	480	0.045	0.036	0.005	0.228
CDSD	394	0.032	0.027	0.003	0.194
ESG_Index(t−1)	480	0.418	0.180	0.075	0.862
E_Index(t−1)	480	0.302	0.217	0.000	0.843
S_Index(t−1)	480	0.459	0.193	0.077	0.908
G_Index(t−1)	480	0.480	0.157	0.154	0.838
Size	480	16.470	1.661	12.890	20.080
Lev	480	0.489	0.202	0.049	0.932
MB	480	1.206	0.981	0.152	5.998
ROA(t−3)	480	0.072	0.085	−0.235	0.372
Tang	480	0.452	0.223	0.028	0.938
Current	480	1.615	0.889	0.301	5.601
CapInt	480	0.057	0.063	0.000	0.406
DivDum	480	0.726	0.446	0	1

Notes: EarnVol measures earnings volatility. CDSD measures the conditional downside standard deviation of ROA. ESG_Index and pillar indices (E_Index, S_Index, G_Index) are lagged by one year. Size, Lev, MB, ROA(t−3), Tang,

Current, CapInt, and DivDum are standard firm-level controls. N denotes firm-year observations in the final estimation sample (2016–2025). CDSD N = 394 after excluding observations with fewer than two below-mean ROA values (86 observations excluded).

4.1.2. Correlation analysis

Correlation analysis provides initial evidence on the direction and strength of associations among the key variables prior to multivariate estimation. Table 4 reports the Pearson correlation coefficients among the key variables used in the analysis. Correlations involving CDSD are computed using pairwise deletion over the 394 available observations (N = 480 for correlations not involving CDSD; N = 394 for correlations involving CDSD).

Table 4. Pearson correlation matrix.

Variable	1	2	3	4	5	6	7	8
1. EarnVol	1.000							
2. CDSD	0.847**	1.000						
3. ESG_Index(t−1)	−0.142**	−0.121*	1.000					
4. Size	0.162**	−0.148**	0.387**	1.000				
5. Lev	0.224**	0.201**	−0.014	0.108*	1.000			
6. ROA(t−3)	−0.352**	−0.376**	0.112*	0.128**	−0.214**	1.000		
7. Tang	0.065	0.072	0.051	0.168**	0.201**	−0.068	1.000	
8. Current	−0.129*	−0.134*	0.087	0.060	−0.285**	0.140*	−0.115*	1.000

Notes: Pearson correlations are reported. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

The correlation analysis reveals economically meaningful and theoretically consistent relationships. The lagged ESG disclosure index is negatively correlated with earnings volatility (EarnVol) and the CDSD, with coefficients of −0.142 ($p < 0.05$) and −0.121 ($p < 0.10$), respectively. This pattern suggests that ESG disclosure is more closely associated with reductions in general earnings instability than with short-window downside earnings variability in bivariate settings, consistent with evidence from emerging market contexts (García-Sánchez et al., 2020).

As expected, the two risk measures are strongly and positively correlated with one another (0.847), reflecting their common dependence on ROA variability while capturing distinct dimensions of firm risk (Estrada, 2002). Firm size exhibits a moderate and statistically significant positive correlation with ESG disclosure (0.387, $p < 0.01$), supporting resource-based arguments that larger firms possess greater capacity and incentives for sustainability disclosure (Haque & Ntim, 2018). Leverage is positively associated with all risk measures, whereas three-year-lagged profitability shows strong negative correlations with risk, both consistent with established corporate finance theory.

Other correlations are weak and statistically insignificant. Baseline-model variance inflation factors range from 1.09 to 2.74, while the pillar-specific model yields VIFs between 1.08 and 3.12, providing no indication of severe multicollinearity.

4.2. Regression results

Table 5 reports the baseline fixed-effects regression results examining the relationship between ESG disclosure and firm-level financial risk.

Table 5. Baseline fixed-effects regression results (Model 1).

Variable	(1) EarnVol	(2) CDSD
ESG_Index(t−1)	−0.0254*	−0.0198
	(0.0147)	(0.0143)
Size	−0.0015	−0.0011
	(0.0017)	(0.0016)
Lev	0.0238***	0.0190**
	(0.0084)	(0.0082)
MB	0.0009	0.0006
	(0.0015)	(0.0014)
ROA(t−3)	−0.0488***	−0.0520***
	(0.0135)	(0.0131)
Tang	0.0072	0.0058
	(0.0093)	(0.0091)
Current	−0.0017	−0.0013
	(0.0013)	(0.0012)
CapInt	0.0138	0.0115
	(0.0183)	(0.0177)
DivDum	−0.0035	−0.0028
	(0.0030)	(0.0029)
Constant	0.091**	0.067*
	(0.035)	(0.034)
Firm FE	Yes	Yes
Year FE	Yes	Yes
Observations	480	394
R^2 (Within)	0.324	0.336
Number of Firms	48	48

Notes: Clustered standard errors in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

The regression results in Table 5 provide partial support for the negative association between ESG disclosure and earnings volatility. The coefficient on the lagged ESG disclosure index is negative across both specifications, indicating that higher ESG disclosure is generally associated with lower firm-level financial risk, although the strength of this relationship varies across risk measures.

Under conventional firm-clustered inference, ESG disclosure exhibits a statistically significant negative association with earnings volatility at the 10% level; the corresponding wild-cluster bootstrap p-value (based on 9999 replications) is 0.092, suggesting that the substantive inference is not materially altered by the finite number of firm-level clusters. This finding aligns with prior evidence that sustainability transparency can be associated with operational stability, particularly in emerging market

settings where information asymmetries are more pronounced (Javeed et al., 2021). In contrast, the coefficient for the CDSD is negative but statistically insignificant ($p = 0.167$), indicating that the negative association of ESG disclosure is less robust for measures capturing short-window downside earnings variability. This pattern is consistent with prior evidence that ESG-related characteristics may have different relationships with alternative dimensions of firm risk (Kim et al., 2014).

Among the control variables, leverage is positively and significantly related to all risk measures, confirming that higher financial leverage amplifies firm-level risk (Chava, 2014). Three-year-lagged profitability shows strong negative associations with risk across specifications, indicating that more profitable firms tend to have more stable earnings streams (Albuquerque et al., 2019). Other firm-level controls display expected signs but limited statistical significance, with substantial heterogeneity absorbed by firm-fixed and year-fixed effects.

The within R-squared values indicate that the models explain a moderate proportion of within-firm variation in financial risk. Overall, the results suggest that ESG disclosure is more closely linked to reductions in general earnings volatility than to short-window downside earnings variability, underscoring the multifaceted nature of accounting-based financial resilience in emerging economies (Haque & Ntim, 2018).

4.3. Heterogeneity analysis

4.3.1. Industry heterogeneity: High-ESG vs. low-ESG impact sectors

Following the materiality logic in Figure 1, we expect the disclosure–risk association to be more pronounced where ESG issues are economically consequential to the firm's operations, because stakeholders have stronger incentives to monitor and price disclosures that speak to material risks (Grewal et al., 2020). This motivates H2: The negative association between ESG disclosure and earnings volatility is stronger in high-ESG-impact industries than in low-impact industries. Table 6 reports the estimation results for Model 2, which examines whether the association between ESG disclosure and accounting-based financial risk varies across industries with different levels of ESG materiality. All CDSD regressions are estimated on the revised $N = 394$ sample.

Model 2 extends the baseline analysis by allowing the effect of ESG disclosure to differ across industries. Prior research emphasizes that the economic consequences of sustainability disclosure depend critically on whether ESG issues are material to a firm's core operations and stakeholder exposure (Grewal et al., 2020; Christensen et al., 2021). Firms operating in high-ESG-impact sectors face greater regulatory scrutiny and stakeholder pressure, suggesting that ESG disclosure may play a more pronounced risk-mitigating role in these industries.

To test this proposition, the lagged ESG disclosure index is interacted with a high-ESG-impact sector indicator, while controlling for firm-specific characteristics and unobserved heterogeneity through firm-fixed and year-fixed effects.

Table 6. Industry heterogeneity by ESG impact (Model 2).

Variable	(1) EarnVol	(2) CDSD
ESG_Index(t−1)	−0.0221*	−0.0170
	(0.0132)	(0.0128)
ESG_Index(t−1) × HighImpact	−0.0128	−0.0098
	(0.0156)	(0.0151)
Controls	Yes	Yes
Firm & Year FE	Yes	Yes
Observations	480	394
R^2 (Within)	0.332	0.343
ESG_Index(t−1)	−0.0221*	−0.0170
	(0.0132)	(0.0128)

Notes: Clustered standard errors are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

As shown in Table 6, the interaction between the lagged ESG disclosure index and the high-ESG-impact sector indicator is negative across both specifications. This is directionally consistent with the hypothesized stronger association in high-impact industries; however, the estimates are statistically insignificant (−0.0128, SE = 0.0156, p = 0.41 for EarnVol; −0.0098, SE = 0.0151, p = 0.52 for CDSD). The wild cluster bootstrap p-values for the interaction terms are 0.43 and 0.54, respectively.

The interaction term tests whether the ESG slope differs between conditions. Accordingly, we additionally report the marginal ESG associations within each condition and Wald tests of whether the conditional slopes differ from zero. For low-impact firms, the estimated ESG slope is −0.0221 (SE = 0.0132, p = 0.095). For high-impact firms, the estimated ESG slope is the sum of the main and interaction coefficients: −0.0221 + (−0.0128) = −0.0349 (SE = 0.0158, p = 0.028). A Wald test of the hypothesis that the high-impact slope equals zero yields a p-value of 0.028, indicating that the ESG association is statistically significant at the 5% level within the high-impact subsample. However, the interaction term itself is not significant (p = 0.41), meaning the difference between the low-impact and high-impact slopes is not statistically distinguishable. Therefore, we cannot conclude that ESG disclosure has a stronger effect in high-impact industries; the estimated ESG slope is negative and statistically different from zero among high-impact firms, but the slope is not statistically different from the corresponding slope among low-impact firms.

4.3.2. Period heterogeneity: Crisis vs. non-crisis years

Consistent with the crisis-amplification channel in Figure 1, information asymmetry and financing frictions intensify during macroeconomic stress, which theory suggests should raise the marginal value of credible disclosure (Lins et al., 2017). This motivates H3: The negative association between ESG disclosure and earnings volatility is stronger during crisis years than during non-crisis years. Table 7 reports the estimation results for Model 3, which examines whether the association between ESG disclosure and accounting-based financial risk varies across macroeconomic conditions, particularly during periods of systemic stress. All CDSD regressions are estimated on the revised N = 394 sample.

Prior literature argues that ESG practices can act as a form of reputational and relational capital, strengthening stakeholder trust and operational flexibility when external financing conditions deteriorate (Lins et al., 2017). During crisis periods, firms face heightened uncertainty, tighter credit constraints, and increased earnings volatility, implying that ESG disclosure may play a more pronounced stabilizing role in such environments.

Table 7. Heterogeneity during crisis periods (Model 3).

Variable	(1) EarnVol	(2) CDSD
ESG_Index(t−1)	−0.0208*	−0.0160
	(0.0124)	(0.0120)
ESG_Index(t−1) × Crisis	−0.0142	−0.0110
	(0.0138)	(0.0134)
Controls	Yes	Yes
Firm & Year FE	Yes	Yes
Observations	480	394
R^2 (Within)	0.335	0.346

Notes: Clustered standard errors are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

As shown in Table 7, the interaction coefficient is negative, but its statistical insignificance (−0.0142, SE = 0.0138, p = 0.30 for EarnVol; −0.0110, SE = 0.0134, p = 0.41 for CDSD) prevents inference that the ESG–risk association differs between stress and non-stress periods. The wild cluster bootstrap p-values for the interaction terms are 0.32 and 0.43, respectively.

The interaction term tests whether the ESG slope differs between conditions. Accordingly, we additionally report the marginal ESG associations within each condition and Wald tests of whether the conditional slopes differ from zero. For non-stress periods, the estimated ESG slope is −0.0208 (SE = 0.0124, p = 0.095). For stress periods, the estimated ESG slope is the sum of the main and interaction coefficients: −0.0208 + (−0.0142) = −0.0350 (SE = 0.0152, p = 0.022). A Wald test of the hypothesis that the stress-period slope equals zero yields a p-value of 0.022, indicating that the ESG association is statistically significant at the 5% level during stress periods. However, the interaction term itself is not significant (p = 0.30), meaning the difference between the non-stress and stress slopes is not statistically distinguishable. Therefore, we cannot conclude that ESG is stronger during a crisis; the estimated ESG association is negative and statistically different from zero during the stress period; however, the difference between stress and non-stress slopes is not statistically significant.

4.4. Robustness checks and additional analyses

4.4.1. Pillar-specific analysis

Table 8 examines the differential associations of environmental, social, and governance disclosures, testing whether certain dimensions of disclosure are more consequential for risk mitigation.

Table 8. Pillar-specific effects on earnings volatility.

Independent variable	Coefficient	Std. Error	p-value
E_Index(t-1)	−0.0168	0.0148	0.257
S_Index(t-1)	−0.0204*	0.0122	0.095
G_Index(t-1)	−0.0242**	0.0118	0.041
Controls	Yes		
Firm & Year FE	Yes		
Observations	480		
R-squared	0.329		

Notes: Clustered standard errors are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

The results in Table 8 show that governance disclosures have the largest point estimate (−0.0242, $p = 0.041$), followed by social disclosure (−0.0204, $p = 0.095$) and environmental disclosure (−0.0168, $p = 0.257$). Formal Z-tests for coefficient equality (equivalent to the reported Wald χ^2 statistics) indicate that the governance coefficient is not statistically different from the social coefficient ($\chi^2 = 0.48$, $p = 0.49$) or the environmental coefficient ($\chi^2 = 1.63$, $p = 0.20$). A joint Wald test of equality across all three pillar coefficients (E = S = G) yields $\chi^2 = 1.89$, $p = 0.39$, indicating no significant difference among the pillars collectively. Therefore, while governance has the largest point estimate, data do not establish that governance disclosure has a statistically stronger association than the other pillars. This pattern is consistent with the possibility that governance-related disclosure may be particularly salient in Pakistan's institutional environment, where corporate governance codes have been emphasized for longer than environmental or social reporting mandates (Jamali et al., 2015; Haque & Ntim, 2018).

4.4.2. Alternative risk measurement windows

Table 9 presents results using alternative backward-looking rolling windows for risk calculation. A three-year window is used as the baseline to maximize observations while maintaining proper temporal ordering. This rolling-window construction is adapted from the broader earnings-risk literature (Frankel & Litov, 2009).

Table 9. Alternative risk measurement periods.

Window	EarnVol Coef.	CDSD Coef.	Observations (EarnVol/CDSD)
3-year (baseline)	−0.0254*	−0.0198	480 / 394
	(0.0147)	(0.0143)	
5-year	−0.0221*	−0.0165	432 / 356
	(0.0128)	(0.0124)	

Notes: Clustered standard errors are reported in parentheses. * denotes significance at the 10% level.

The results in Table 9 remain qualitatively consistent across alternative rolling windows. The estimated coefficients on ESG disclosure are uniformly negative, with slightly larger magnitudes for the 3-year window. Although the coefficient remains negative and reaches the 10% significance threshold in several specifications, statistical evidence remains modest, with coefficients declining in magnitude and losing precision with longer windows.

4.4.3. Alternative ESG disclosure measurement

We conducted robustness checks using a weighted ESG disclosure index (calculated using Equation 4) that assigns additional weight to items with more detailed disclosure (quantitative information, targets, verification). The results are substantively similar to the binary index, with coefficients of −0.0238 ($p < 0.10$) for EarnVol and −0.0185 ($p > 0.10$) for CDSD. This consistency across measurement approaches strengthens confidence in the main findings.

4.4.4. Temporal ordering robustness: Longer ESG lags

To assess the sensitivity of results to the choice of ESG lag, we re-estimated the baseline specification using longer lags (ESG~t−2~ and ESG~t−3~). The ESG~t−3~ specification is particularly clean because ESG at t−3 predates all three ROA observations used in the EarnVol construction. The maximum available observations for ESG~t−2~ are 432 (2017−2025) and for ESG~t−3~ are 384 (2018−2025). Results are qualitatively similar: The coefficient for ESG~t−3~ is −0.0248 (SE = 0.0151, $p = 0.101$), and the wild cluster bootstrap p-value is 0.108, consistent with the baseline inference.

4.4.5. Instrumental-variable sensitivity analysis

As a sensitivity analysis for potential endogeneity, we estimated an instrumental-variable specification using industry-year average ESG disclosure (excluding the firm itself) as an instrument. The first-stage F-statistic (16.38) exceeds conventional thresholds, suggesting the instrument is reasonably strong in a statistical sense. The instrumental-variable estimate (−0.0302, SE = 0.0158) is larger in magnitude than the baseline fixed-effects estimate (−0.0254), although differences between the estimates cannot be interpreted causally because the exclusion restriction remains potentially vulnerable. Given concerns that industry-year average ESG disclosure may be correlated with industry-level economic conditions or regulatory changes that independently affect earnings volatility, the IV estimates

are treated as sensitivity evidence rather than definitive causal identification. This analysis should not be interpreted as establishing a causal effect of ESG disclosure on earnings volatility.

Two specific threats to the exclusion restriction are worth stating explicitly. First, common industry shocks: Industry-year average ESG disclosure could proxy for industry-level demand or regulatory shocks that also move earnings volatility directly, not only through peer ESG disclosure. Year-fixed effects absorb shocks common to all industries in a given year, though industry-specific time-varying shocks are not fully absorbed. Second, reflection/mechanical correlation: Although each firm is excluded from its own industry-year average, peer disclosure norms could still correlate with unobserved industry-level governance quality. Given these two residual threats, we report the IV estimate as a sensitivity check on the direction and rough magnitude of the association, not as a causal estimate.

4.4.6. Unbalanced panel robustness

To address potential survivorship bias concerns arising from the balanced-panel requirement, we also estimated the main specifications using an unbalanced panel that includes firms with incomplete data. The unbalanced specification contains 475 usable firm-year observations for EarnVol (351 for CDSD) after applying the same variable-construction rules, with firms entering or exiting the panel when sufficient data are available. The results are qualitatively similar: The coefficients retain the same negative sign but are statistically insignificant in these specifications (−0.0228, SE = 0.0152, p = 0.134 for EarnVol; −0.0176, SE = 0.0148, p = 0.234 for CDSD).

4.4.7. Placebo / falsification analysis

To assess whether the observed associations are driven by spurious correlations, we conducted a placebo/falsification test by randomly reassigning ESG disclosure scores within firms over time and re-estimating the baseline model. The placebo procedure randomizes ESG within the firm, constructs the lagged variable, and reruns exactly the baseline model with the same fixed effects and controls. The placebo distribution from 1000 random reassignments of ESG scores is centered near zero (median coefficient = 0.0012). The actual coefficient for EarnVol (−0.0254) lies in the lower tail of the placebo distribution, with a two-sided randomization p-value of 0.13. Thus, the placebo exercise does not provide strong evidence against spurious association, and the main results should be interpreted with appropriate caution regarding potential omitted variables or other sources of spurious correlation.

4.4.8. Wild cluster bootstrap inference

Given the relatively small number of clusters (48 firms), we conducted a firm-level wild cluster bootstrap for the main specifications following Cameron et al. (2008) to assess the reliability of the clustered standard errors. Wild cluster bootstrap p-values are based on 9999 replications with firm-level clustering. The similarity between the conventional clustered and wild cluster bootstrap p-values suggests that the substantive inference is not materially altered by the finite number of firm-level clusters.

4.4.9. Unified robustness summary

Table 10 consolidates all identification schemes discussed in Sections 4.4.1–4.4.8 for direct comparison.

Table 10. Unified robustness check summary.

Specification	EarnVol β	SE	p	CDSD β	SE	p	Observations (E/C)
Baseline FE (3-year)	−0.0254	0.0147	0.085	−0.0198	0.0143	0.167	480 / 394
Wild cluster bootstrap (baseline)	−0.0254	—	0.092	—	—	—	480 / 394
ESG lag t-2	−0.0246	0.0150	0.102	—	—	—	432 / —
ESG lag t-3	−0.0248	0.0151	0.101	—	—	—	384 / —
5-year window	−0.0221	0.0128	0.084	−0.0165	0.0124	0.183	432 / 356
Alternative volatility proxy	−0.0221	0.0143	0.122	—	—	—	480
Weighted ESG index	−0.0238	0.0140	0.089	−0.0185	0.0138	0.180	480 / 394
Unbalanced panel	−0.0228	0.0152	0.134	−0.0176	0.0148	0.234	475 / 351
Excluding stress period (2019–2021)	−0.0204	0.0156	0.192	−0.0158	0.0152	0.298	336 / 276
Placebo/falsification (median)	0.0012	—	0.130	—	—	—	480

Notes: All specifications include firm- and year-fixed effects and the full set of controls. Coefficient standard errors are clustered at the firm level. Estimation sample varies as indicated. "—" indicates not applicable. Placebo p-value is two-sided from randomization distribution (1000 replications). Wild cluster bootstrap p-values are based on 9999 replications with firm-level clustering following Cameron et al. (2008).

4.5. Summary of findings

The empirical findings can be summarized in four key statements:

Finding 1: ESG disclosure is negatively associated with earnings volatility in the baseline fixed-effects model, with a conventional clustered p-value of 0.085 and a wild cluster bootstrap p-value of 0.092. This provides weak evidence of an inverse association at the 10% level. The primary overall ESG coefficient is not statistically significant at the 5% level. The association remains directionally consistent when using longer ESG lags (ESG~t−2~ and ESG~t−3~), though with slightly larger p-values and reduced sample sizes. However, the statistical evidence is fragile: The coefficient becomes insignificant in several robustness specifications, including the unbalanced panel ($p = 0.134$) and the placebo/falsification test ($p = 0.13$).

Finding 2: No statistically significant association is found for the CDSD. The coefficient is negative but insignificant across all specifications (baseline $p = 0.167$), suggesting that disclosure may be more associated with normal-period earnings stability than with protection against adverse earnings outcomes.

Finding 3: Governance disclosure has the largest point estimate among the ESG pillars, but formal coefficient-equality tests (both pairwise and joint) do not establish governance superiority. The relatively larger governance coefficient is consistent with the possibility that governance-related disclosure may be particularly salient in Pakistan's institutional environment, where corporate governance codes have been emphasized for longer than environmental or social reporting mandates.

Finding 4: Industry and stress-period interaction terms are negative but statistically insignificant (wild cluster bootstrap $p > 0.30$); therefore, heterogeneity remains inconclusive. The interaction term tests whether the ESG slope differs between conditions. Marginal tests show that the ESG slope is statistically significant within high-impact industries ($p = 0.028$) and during stress periods ($p = 0.022$), but the interaction terms themselves are not significant, meaning the differences between conditional slopes are not statistically distinguishable. The evidence does not support claims of differential associations based on industry materiality or macroeconomic conditions.

5. Discussion, implications and conclusions

5.1. Interpretation of key findings

The empirical findings present a nuanced picture of ESG disclosure's association with accounting-based financial risk in Pakistan's emerging market context. ESG disclosure shows a weak negative relationship with earnings volatility at the 10% level under conventional inference, and a weaker evidence for short-window downside earnings variability measures. This suggests that disclosure may be associated with smoothing general earnings fluctuations more effectively than preventing severe negative outcomes, providing qualified support for the hypothesis that transparency about sustainability practices is associated with more stable firm performance (Albuquerque et al., 2019).

Among disclosure pillars, governance shows the largest point estimate, though formal Wald tests (both pairwise and joint) do not establish statistical superiority over other pillars. This pattern is consistent with the possibility that governance-related disclosure may be particularly salient in Pakistan's institutional environment, where corporate governance codes have been emphasized for longer than environmental or social reporting mandates (Haque & Ntim, 2018).

The interaction coefficients are negative, which is directionally consistent with the hypothesized stronger association in high-ESG-impact sectors and during the composite stress period; however, their statistical insignificance prevents inference that the ESG–risk association differs across these conditions. Marginal tests show that the ESG slope is statistically significant within high-impact industries ($p = 0.028$) and during stress periods ($p = 0.022$), but the interaction terms themselves are not significant, meaning the differences between conditional slopes are not statistically distinguishable. This inconclusive evidence supports neither strong claims of materiality (Grewal et al., 2020) nor insurance-like properties of disclosure (Lins et al., 2017) in this sample.

Although the coefficient remains negative and reaches the 10% significance threshold in several specifications, the economic magnitude of disclosure effects remains moderate. A one-standard-deviation increase in ESG disclosure is associated with a reduction in EarnVol equivalent to approximately 12.7% of the sample standard deviation of EarnVol [calculated as (0.0254×0.180) /

0.036 = 0.127]. This indicates a non-trivial magnitude relative to the observed dispersion, although the estimate is imprecise.

The coefficient retains a negative sign but becomes statistically insignificant in the unbalanced panel specification (p = 0.134) and in the placebo/falsification test (p = 0.13), indicating that the estimated association is sensitive to alternative specifications and should therefore be interpreted cautiously. The use of ROA~t−3~ as the primary profitability control, rather than ROA~t−1~, addresses the mechanical overlap concern while preserving a profitability control.

5.2. Comparison with prior studies

The findings both align with and diverge from prior research. Consistent with studies in developed markets (Eccles et al., 2014; Lins et al., 2017), ESG disclosure is negatively associated with earnings volatility. However, the weaker evidence for short-window downside earnings variability contrasts with some studies that document significant ESG effects on crash risk (Kim et al., 2014). This divergence may reflect institutional differences: In emerging markets with weaker enforcement, the protective effects of ESG disclosure may be attenuated for extreme events. This divergence is plausible for at least two reasons specific to the present setting. First, conditional downside ROA dispersion is estimated on a smaller, unbalanced subsample (N = 394 vs. 480) with fewer below-mean observations per firm, reducing statistical power relative to the general-volatility measure—a mechanical rather than purely economic explanation. Second, and more substantively, downside outcomes in Pakistan's non-financial sector may be driven disproportionately by macro-financial shocks (currency depreciation, import-cost pass-through, interest-rate shocks) that are largely exogenous to firm-level governance and disclosure quality, whereas general earnings volatility also reflects operational and reputational frictions that ESG disclosure is theoretically better positioned to mitigate (Flammer, 2015). This is consistent with, rather than contradictory to, the signaling-theory logic in Figure 1: Signals reduce information-driven risk premia but are not expected to insure firms against macro-financial tail events.

The relatively larger governance coefficient is consistent with research emphasizing the foundational role of governance in emerging market contexts (Aguilera et al., 2021; Haque & Ntim, 2018). In institutional environments where legal enforcement is weaker, governance mechanisms may be more consequential for risk management than environmental or social disclosures. This pillar ordering is not universal, however: In a more institutionalized disclosure regime, Zhang et al. (2025) found that social disclosure carries the largest mediating effect in linking Chinese listed firms' ESG performance to corporate development outcomes, with governance disclosure showing the smallest effect. Alongside the present findings, this suggests that the relative salience of each ESG pillar may be institutionally contingent; governance disclosure appears more consequential where formal legal enforcement is weaker and reputational capital is comparatively young, as in Pakistan, whereas social disclosure may dominate where a large, vocal consumer and labor base gives stakeholders more direct leverage over firms, as in China's more mature disclosure environment.

5.3. Theoretical implications

The findings provide tentative evidence consistent with signaling theory: In Pakistan's institutional setting, governance disclosures exhibit the largest point estimate in the present sample,

although formal coefficient-equality tests do not establish statistical superiority. Environmental and social disclosures, being newer and less standardized, may suffer from a "greenwashing" discount, limiting their signaling potency (Marquis & Qian, 2014). This extends signaling theory (Spence, 1973) by highlighting that institutional context determines which signals stakeholders deem credible.

The negative association between disclosure and earnings volatility is consistent with stakeholder theory's proposition that managing broader constituent relationships reduces operational friction (Freeman et al., 2021). By disclosing ESG information, firms demonstrate commitment to mitigating non-financial risks that can translate into financial costs.

The study captures a market in regulatory transition, with Pakistan implementing enhanced ESG reporting guidelines during the research period. The findings suggest that even in the early stages of this transition, firms engaging in higher levels of voluntary disclosure exhibit more favorable associations with earnings stability. This is consistent with legitimacy theory (Suchman, 1995), suggesting that proactive alignment with emerging societal and regulatory expectations is associated with more favorable financial outcomes.

5.4. Practical and policy implications

5.4.1. Implications for corporate managers and boards

The evidence suggests that investments in robust ESG disclosure, particularly in governance, may be associated with lower earnings volatility. Managers may consider comprehensive ESG disclosure as part of a broader transparency and risk-governance strategy. Focusing on material, quantitative, and verifiable disclosures may offer potentially stronger informational value. Given governance's larger point estimate in this sample, firms should prioritize governance-related disclosures board independence, risk-oversight committees, and related-party transaction policies over broader environmental or social narrative disclosure in the near term.

5.4.2. Implications for investors and financial institutions

The study provides preliminary evidence that ESG disclosure may contain information relevant to investment risk assessment in emerging markets like Pakistan. Disclosing firms may represent lower-risk holdings. For financial institutions, these findings support the development of sustainability-linked financial instruments where disclosure quality can be tied to financing terms (El Ghoul et al., 2011). Where third-party ESG ratings are unavailable or unreliable for Pakistani issuers, disclosure-based screening (breadth and specificity of reported items) may serve as a lower-cost interim proxy, with the caveat that this study's evidence for such screening is weak (10% significance, sensitive to specification).

5.4.3. Policy implications for regulators

The findings provide limited empirical support consistent with the broader direction of Pakistan's evolving disclosure framework. A potential policy direction are phased third-party assurance requirements for ESG disclosures, which represent a logical next step in strengthening disclosure

credibility. Guidelines should be refined to steer firms toward sector-specific, material metrics. Sustained regulatory support for capacity building among smaller listed firms is essential. Regulators should consider phasing mandatory assurance requirements first for governance-related disclosure items, where this study's evidence is strongest, before extending assurance mandates to environmental and social items, where the evidence here is statistically inconclusive.

5.5. Limitations and future research directions

This study acknowledges several limitations. The sample covers a subset of relatively large, continuously listed Pakistani non-financial firms. The requirement for continuous listing and complete reporting over the full study period may generate survivorship and sample-selection bias, limiting the generalizability of the estimates to firms that entered, exited, merged, failed, or were delisted during the period. The research focuses explicitly on ESG disclosure, a distinct construct from underlying ESG performance (Christensen et al., 2021). Methodological constraints include inherent subjectivity in hand-collected disclosure coding, and despite employing lagged variables, fixed effects, and instrumental variable techniques, the potential for omitted variable bias persists. Third, the study does not directly test the micro-level channels (information asymmetry, stakeholder confidence, signaling) through which disclosure is theorized to relate to lower earnings risk; the mechanisms in Figure 1 are inferred from theory and prior literature rather than empirically identified within this dataset, and the mediation evidence requested by reviewers would require additional mediator variables not currently collected. Coding subjectivity, while mitigated by a standardized protocol and intercoder reliability checks, remains an inherent limitation of hand-collected disclosure indices relative to third-party ESG ratings, and residual subjectivity cannot be fully ruled out even where reported agreement is high. The backward-looking risk measures, while temporally appropriate, may not fully capture extreme outcomes due to the limited observation window. The lack of statistical significance for interaction terms may reflect limited statistical power rather than absence of effects. The placebo test ($p = 0.13$) and sensitivity analyses further suggest that caution is warranted in interpreting the main results. The 48 observations with zero below-mean ROA values were verified against raw unrounded data and confirmed to arise from exact equality cases, rather than rounding. The December 2025 revised SECP guidelines are noted as an institutional development but are not treated as an exogenous regulatory intervention in the empirical analysis.

The findings open several promising avenues for future research. Subsequent studies could employ more granular data to empirically test the specific channels through which disclosure translates into financial stability. A critical extension would be to examine the interaction between ESG performance and disclosure to disentangle the effects of "doing" versus "telling". As Pakistan's ESG reporting framework matures, quasi-experimental methods could be leveraged to better identify the causal impact of the regulatory shift. Comparative cross-country studies across emerging markets with differing regulatory approaches would help isolate institutional factors that enhance disclosure effectiveness. Finally, larger samples with more statistical power may be better positioned to detect materiality-based and crisis-based effects, should they exist.

5.6. Conclusions

This study set out to investigate whether ESG disclosures are associated with accounting-based financial resilience in an emerging market context, with a specific focus on Pakistan during a period of regulatory transition toward enhanced sustainability reporting. Analyzing a decade of data from non-financial firms listed on the Pakistan Stock Exchange, the research finds limited support for this proposition.

The evidence indicates a consistently negative point estimate for the association between ESG disclosure and earnings volatility across multiple specifications. However, this association is statistically significant only in the baseline specification at the 10% level under conventional inference (wild cluster bootstrap, $p = 0.092$) and becomes insignificant under several robustness checks, including the unbalanced panel and the placebo/falsification test. The primary overall ESG coefficient is not statistically significant at the 5% level. Evidence for short-window conditional downside ROA dispersion and conditional effects is not statistically conclusive. Governance disclosure exhibits the largest point estimate, though formal tests do not establish that it is statistically stronger than the other pillars.

The contribution of this research is threefold. First, it shifts the empirical focus in emerging markets from ESG's performance implications to its risk-attenuation associations, engaging with the core thesis of green finance that sustainable practices underpin financial stability (Bolton et al., 2020). Second, it provides contextual evidence from a significant but understudied market undergoing a deliberate sustainability transition. Third, methodologically, it demonstrates the value of hand-collected, disclosure-specific metrics in settings where commercial ratings are limited or inconsistent.

For Pakistan and similar emerging markets, the journey toward integrating sustainability into the core of corporate and financial systems is complex and context-dependent. Overall, the evidence suggests, with appropriate caution, that measured and disclosed information may be associated with managed and stabilized outcomes, though causal interpretation is not warranted.

Author contributions

Attique Ur Rehman: Conceptualization, Methodology, Data curation, Formal analysis, writing original draft. Athar Iqbal: Supervision, Validation, Writing review & editing.

Use of AI tools declaration

During the preparation of this work, the authors used Deep Seek for the purpose of improving sentence structure, grammar, and readability. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

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Data availability statement

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Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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