

# The Effect Of ESG Disclosure On Corporate Risk: Mediating Role Of Financial Constraints

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**Abstract.** This study aims to examine the effect of ESG disclosure on corporate risk with funding constraints as a mediating variable in industrial companies listed on the Indonesia Stock Exchange (IDX) during the 2022–2024 period. This study uses a quantitative approach with secondary data obtained from annual reports and sustainability reports based on the Global Reporting Initiative (GRI) standards. The sample selection was conducted using a purposive sampling method, resulting in 180 observations from 60 industrial companies that met the predetermined criteria. The data analysis method used in this study is panel data regression analysis to examine the relationship between ESG disclosure, corporate risk, and funding constraints. The results indicate that ESG disclosure has an effect on corporate risk, suggesting that the quality of sustainability information disclosed by companies contributes to the assessment and management of corporate risk. Furthermore, funding constraints are proven to mediate the relationship between ESG disclosure and corporate risk, indicating that the company's ability to obtain funding plays an important role in explaining how ESG disclosure influences corporate risk. This study provides empirical evidence regarding the role of ESG disclosure and funding constraints in understanding corporate risk within industrial companies in Indonesia.

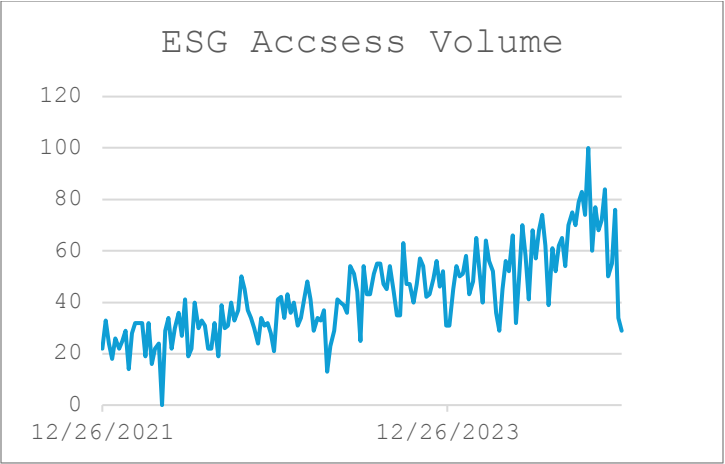
**Keywords:** ESG Disclosure; Corporate Risk; Funding Constraints; Industrial Companies; Mediation

## 1. Introduction

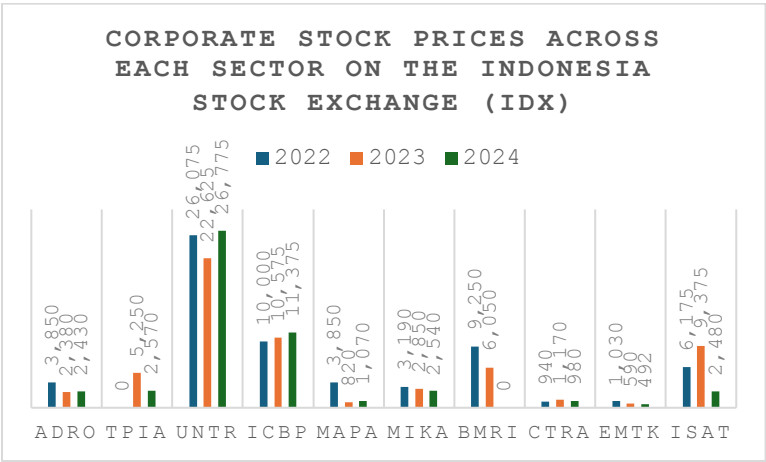
In the contemporary era of heightened macroeconomic volatility, corporate risk has emerged as a critical determinant of business stability, financial health, and long-term operational sustainability. Beyond conventional market fluctuations, modern corporate risks are increasingly driven by environmental pressures. High climate risk exposure compels firms to adopt more conservative financial and reporting strategies to buffer against uncertainty, particularly in environmentally sensitive industries (Tilat et al. 2024). This escalating risk environment heavily influences managerial decision-making, as firms frequently respond by hoarding liquid financial assets to mitigate impending financial distress and liquidity shocks (Xu et al., 2023). Fundamentally, corporate risk is shaped by an interplay of internal vulnerabilities such as aggressive debt structures, volatile cash flows, and poor internal risk-control systems and external pressures, including inflation, regulatory shifts, and economic policy uncertainty (Zhang et al., 2021).

In emerging markets like Indonesia, this issue has become highly urgent for the industrial sector during the 2022–2024 period. According to PwC Indonesia (2023), environmental risks and climate change have officially transitioned into primary hurdles for modern enterprises, driving unprecedented levels of operational, reputational, and financial uncertainty. For capital-intensive industrial companies in Indonesia, these environmental pressures are no longer detached ethical concerns; they act as direct catalysts for financial distress. Throughout 2022–2024, the combination of changing climate conditions and tightening global sustainability demands directly threatened the stability of corporate cash flows and increased the volatility of operational performance. Consequently, assessing how environmental issues affect corporate risk has become an immediate priority to prevent widespread financial distress within the Indonesian industrial landscape.

To address these growing vulnerabilities and manage stakeholder expectations, the Indonesian government has aggressively institutionalized corporate sustainability. A vital regulatory cornerstone is the Financial Services Authority Regulation, specifically **OJK No. 51/POJK.03/2017 concerning the Implementation of Sustainable Finance for Financial Services Institutions, Issuers, and Public Companies**. This regulation legally mandates listed companies on the Indonesia Stock Exchange (IDX) to enhance transparency and accountability by publishing comprehensive sustainability reports alongside their financial statements (Wijaya & Novianto, 2024). This strict regulatory framework serves as a solid legal basis for why ESG issues are mandatory in Indonesia, aligning with an exponential growth in public and market interest toward ESG practices, as reflected in Google Trends data from 2021 to 2024 (see Figure 1).



Although the IDX reported that 94% of issuers complied by submitting sustainability reports for the 2023 period (IDX Chanel 2023) empirical realities demonstrate a widening gap in the depth and quality of these disclosures(Sari 2025). This substantial variation exacerbates information asymmetry and distorts investor risk assessments particularly within the industrial sector. As shown in the stock price volatility comparison across different sectors (see Figure 2), the industrial sector is uniquely characterized by capital-intensive structures, high operational leverage, and a profound dependency on external financing, making it hyper-sensitive to both macroeconomic shifts and non-financial data quality.



Crucially, from a business logic perspective, financing constraints act as the primary, yet underexplored, transmission mechanism linking ESG disclosure to corporate risk. Industrial firms require massive capital injections to maintain operations. Under Signaling Theory, high-quality ESG disclosures act as positive market signals that reduce information asymmetry, thereby unlocking cheaper credit lines and reducing corporate risk. Conversely, under Legitimacy Theory, pursuing ESG excellence requires hefty structural green investments. For an Indonesian industrial firm during the 2022-2024 economic squeeze, allocating scarce cash flows to fund complex ESG compliance can deplete operational liquidity. If external investors perceive these green costs as an operational burden rather than a

strategic benefit, the firm faces sudden financing constraints an inability to secure affordable external capital which directly amplifies its risk of financial distress. Previous studies failed to identify this dual-edge mechanism because they mostly treated ESG as a costless reputation tool without considering the structural financing barriers faced by capital-intensive firms. This empirical fragmentation is highly evident in literature. Regarding the direct impact of ESG on corporate risk, (Peliu 2024) argues that ESG disclosure significantly reduces risk, whereas (Mayangsari 2024) finds no significant risk-reduction effect. Similarly, findings on ESG and financing constraints remain inconsistent. (Hao dan Wu 2024) demonstrate that ESG disclosure mitigates financing constraints by enhancing transparency. Conversely, (Wang et al., 2025) reveal that in heavily polluting industries, rigorous ESG compliance actually increases financing constraints due to staggering green compliance costs. Furthermore, while some studies show that easing financing constraints helps firms manage risk better (Huang et al. 2025) others argue this transmission pathway is highly volatile and conditional on localized institutional dynamics (Chen et al., 2023; Li et al., 2024).

To bridge these empirical, contextual, and logical gaps, this study analyzes data from industrial sector companies listed on the IDX between 2022 and 2024. By utilizing Legitimacy and Signaling theories, this research explicitly validates financing constraints as a mediating variable to uncover why and how sustainability reporting can either alleviate or inadvertently aggravate corporate risk within an emerging market framework.

The remainder of this paper is structured as follows: Section 2 reviews the literature and develops the hypotheses; Section 3 outlines the research design; Section 4 presents empirical results; and Section 5 concludes with policy implications.

## **2. Literature Review and Hypothesis Development**

### *2.1. Theoretical Background*

This study employs signaling theory and legitimacy theory to delve into the impact of Environmental, Social, and Governance (ESG) disclosure on corporate risk. These complementary theoretical frameworks provide a robust foundation for exploring the intricate mechanisms through which non-financial sustainability disclosures interact with financial constraints and ultimately shape a firm's financial and operational risk profile.

Signaling theory explains how companies convey private information to influence the behavior and decisions of external stakeholders in markets characterized by information asymmetry Spence (1973). Within the corporate landscape, management inherently possesses deeper and more comprehensive information regarding internal operations and risk management than external actors, such as investors and creditors. From this perspective, corporate disclosures serve as a primary mechanism to signal firm quality, operational capacity, and long-term prospects to the market. Specifically, Spence (1973) posits that a signal must be credible and costly to effectively differentiate high-quality firms from low-quality counterparts. In capital markets, transparent ESG disclosure functions as a powerful, positive signal demonstrating a firm's active commitment to managing environmental challenges, social responsibilities, and governance structures. By providing verifiable non-financial metrics, comprehensive ESG reporting significantly reduces information asymmetry between the company and capital providers. Conversely, a lack of transparency increases market uncertainty, which elevates investors' risk perceptions and potentially prompts creditors to impose severe barriers on external funding (Bofinger et al., 2022). Consequently, signaling theory implies that the quality of information provided by a firm alters the risk perception of capital providers, positioning financing constraints as a key transmission pathway linking ESG signals to corporate risk.

Legitimacy theory supplements this framework by asserting that a corporation's survival is deeply contingent upon social acceptance and its alignment with broader societal norms. According to Suchman (1995), legitimacy is a generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, and beliefs. Because companies operate within an interconnected network of stakeholders, their operational decisions must actively account for environmental and social impacts. Any severe mismatch between corporate actions and societal expectations creates a legitimacy gap, which severely threatens operational continuity. Under legitimacy theory, sustainability reporting is conceptualized as a strategic communication tool utilized by firms to bridge this gap and cultivate stakeholder trust (Tsang et al. 2023). By disclosing extensive ESG information, companies particularly capital-intensive industrial firms facing heavy eco-regulations demonstrate that their core operations adhere to sustainability mandates and social expectations. This perceived legitimacy enhances corporate reputation, builds positive market sentiments, and directly influences investors' evaluations of firm survival capabilities and access to capital sources (Khamisu dan Paluri 2024). Therefore, utilizing ESG disclosure as a strategy to secure institutional legitimacy directly alters a firm's capability to secure stable funding and mitigate systemic operational risks.

## 2.2. Hypotheses Development

### 2.2.1. ESG disclosure and corporate risk

ESG disclosure reflects a firm's level of transparency in communicating its sustainability practices, which encompass environmental, social, and governance aspects. Beyond functioning as a non-financial reporting mechanism, extensive sustainability disclosure serves to reduce information asymmetry between the company and external actors, directly influencing the market's perception of operational and financial risk. From a signaling theory perspective, robust ESG disclosure is viewed as a high-quality corporate signal transmitted to investors and creditors. High ESG disclosure scores indicate that the firm possesses superior risk management systems, sturdier internal governance, and strict compliance with sustainability mandates. This credible signaling apparatus minimizes the uncertainty faced by external evaluators, ultimately driving down overall corporate risk profiles. Under legitimacy theory, corporate sustainability actions are conceptualized as a strategic attempt to acquire and preserve socio-institutional acceptance. Publishing transparent ESG information aligns the firm's operations with societal expectations, thereby cultivating stakeholder trust, stabilizing corporate reputation, and insulating the business from risk.

Empirically, prior investigations into this transmission pathway yield fragmented insights. Wang et al (2024), demonstrate that ESG disclosure exerts a significant negative effect on corporate risk, indicating that advanced non-financial reporting functions as an effective long-term risk mitigation strategy that subdues both operational and financial distress. Conversely, Mayangsari (2024) finds that ESG disclosure does not affect corporate risk, arguing that corporate default probabilities are primarily governed by alternative parameters such as idiosyncratic firm characteristics, internal financial reporting quality, and broader macroeconomic factors. Because the prior documentation remains inconclusive, further empirical validation is necessary within emerging market frameworks. Based on these theoretical and empirical considerations, the following hypothesis is proposed:

**Hypothesis 1.** *ESG disclosure has a significant effect on corporate risk.*

### 2.2.2. ESG disclosure and financing constraints

ESG disclosure has received escalating attention from capital markets because modern enterprise valuations no longer rely solely on historical financial performance, but heavily integrate sustainability and governance metrics. From the standpoint of signaling theory, transparent ESG reporting transmits a powerful, positive signal to investors and creditors regarding managerial quality, operational longevity, and proactive risk control. This non-financial signal systematically mitigates information opacity and minimizes market valuation errors. Concurrently, legitimacy theory posits that comprehensive sustainability disclosures represent an organizational effort to secure and maintain social legitimacy. By cultivating an institutional license to operate, a firm builds a superior reputation before capital market participants, which expands its external funding channels. This transparent reporting layout enhances investor confidence and corporate credibility, thereby optimizing the firm's capacity to secure credit access.

From an empirical stance, the relationship between corporate transparency and financing barriers remains a subject of ongoing academic debate. Yuniawati et al (2024), confirm that comprehensive ESG disclosure exerts a significant negative impact on financing barriers, effectively lowering corporate financing constraints by drastically reinforcing the firm's external financial flexibility. However, (Amarna et al. 2024), document that ESG disclosure yields an insignificant impact on financing constraints, asserting that creditors and institutional investors prioritize baseline fundamental metrics and historical financial statements over non-financial narratives. Given these inconsistent findings, additional research within capital-intensive ecosystems is required. Based on these theoretical insights, the following hypothesis is proposed:

**Hypothesis 2.** *ESG disclosure has a significant effect on financing constraints.*

### 2.2.3. Financing constraints and corporate risk

Financing constraints represent a critical market condition where a firm faces severe friction or structural blockades when attempting to obtain external funding at a reasonable cost to satisfy its investment projects, business expansions, or operational capital requirements. This capital market imperfection restricts corporate operational mobility and compromises cash flow configurations, directly escalating financial and operational risk exposure. Under signaling theory, a severe financing constraint can be perceived by external market participants as a highly damaging negative signal regarding the firm's fundamental health. A firm trapped behind high financing barriers is frequently judged as possessing unstable operations or deficient financial structures, which worsens market valuation assessments. Under

legitimacy theory, a firm's long-term survival is bound by its capacity to sustain consistent performance and fulfill its socio-economic expectations. Encountering intense financial blockades impairs the firm's capacity to honor its implicit social contract, as it lacks the capital needed to maintain stable operations, thereby widening the institutional legitimacy gap and heightening default probabilities.

Empirically, L. Chen et al (2023), verify that financing constraints exert a significant positive impact on corporate risk, demonstrating that firms burdened by intense capital access friction are highly prone to experiencing liquidity crises and default. On the contrary, Tamanna dan Nurul (2023) present evidence that financing constraints do not significantly affect corporate risk, arguing that restricted access to external debt forces corporate management to adopt radical spending discipline and maximize internal resource allocation efficiency. To resolve this empirical fragmentation within the industrial sector, further inquiry is warranted. Based on these logical deductions, the following hypothesis is proposed:

**Hypothesis 3.** *Financing constraints have a significant effect on corporate risk.*

#### *2.2.4. The mediating role of financing constraints*

ESG disclosure indicates the level of transparency and non-financial commitment of a company in managing environmental, social, and sustainable governance aspects. Companies with a more comprehensive level of ESG disclosure tend to provide a positive signal to external parties regarding the quality and sustainability of corporate operations. Transparency of ESG information can reduce information asymmetry and uncertainty faced by investors and creditors in assessing the company, thereby increasing the ease of the company in obtaining external funding, which in turn can lower the level of financing constraints faced by the company.

Based on signaling theory and legitimacy theory, transparent ESG disclosure is able to increase stakeholder trust and strengthen corporate legitimacy in the eyes of investors and creditors. This trust encourages open access to a wider range of external funding sources so that corporate financing constraints can be reduced. Conversely, high financing constraints can limit the company's ability to meet investment needs, maintain liquidity, and face business uncertainty, which potentially increases operational risk, financial risk, and corporate bankruptcy risk. Financing constraints act as a mechanism that explains how ESG disclosure can affect corporate risk. Better ESG disclosure is expected to lower financing constraints, which subsequently contributes to a reduction in corporate risk. In line with this, research by Bao et al (2024), found that financing constraints are able to mediate ESG disclosure on corporate risk. However, these findings generally use an ESG rating approach, rather than specific ESG disclosure, so the information transparency mechanism captured may differ. Meanwhile, ESG disclosure practices in Indonesia are still in a developmental stage with varying levels of quality and consistency as well as a higher sensitivity to financing, which allows the mechanism of the effect of ESG disclosure on corporate risk through financing constraints to produce different results. In addition, research that simultaneously tests ESG disclosure, financing constraints, and corporate risk in companies in Indonesia is still limited, especially in the industrial sector. Based on this framework, the following hypothesis is proposed:

**Hypothesis 4.** *Financing constraints significantly mediate the effect of ESG disclosure on corporate risk.*

### **3. Research methodology**

#### *3.1. Sample Selection and Data Sources*

This study selects industrial sector companies listed on the Indonesia Stock Exchange (IDX) from 2022 to 2024 as the research sample, with data sourced from the official IDX website ([idx.co.id](http://idx.co.id)) and individual corporate websites. Adopting this secondary data approach offers extensive cost efficiency and structural reliability while systematically mitigating potential biases associated with primary data collection protocols (Kelly et al., 2024). To ensure the reliability of the research data, several filtering steps were applied based on specific purposive sampling criteria. First, companies must maintain continuous listing within the industrial sector throughout the 2022–2024 period. Second, firms facing incomplete financial documentation, annual reports, or sustainability reports were excluded from the sample, resulting in the removal of 1 company. Additionally, to mitigate the effect of extreme values that could distort the model estimation parameters, 4 companies identified as statistical outliers were removed during the initial data processing stage. After these adjustments, the final sample size consisted of 60 companies observed over a 3-year period, establishing a balanced panel data structure with a total of 180 firm-year observations. The data was then subjected to statistical analysis using Stata 14 software to ensure a rigorous evaluation of the hypotheses.

### 3.2. Variable Definition

#### 3.2.1. Dependent variable: corporate risk

Following the foundational financial distress frameworks, corporate risk is conceptualized as the uncertainty or potential exposure that impairs a firm's capacity to fulfill its strategic objectives and sustain operational stability (Sudaryanto 2012). This study measures corporate risk using the O-Score model developed by Ohlson (1980), a highly rigorous accounting-based algorithm utilized to evaluate default probabilities. The O-Score integrates nine fundamental financial and operational metrics, calculated through the following specification:

$$\text{oscore} = -1.32 - 0.407(X_1) + 6.03(X_2) - 1.43(X_3) + 0.0757(X_4) - 2.37(X_5) - 1.83(X_6) + 0.285(X_7) - 1.72(X_8) - 0.521(X_9)$$

Where:  $X_1$  (SIZE) =  $\ln(\text{Total Assets}/\text{GNP})$ ;  $X_2$  (TLTA) = Total Liabilities/Total Assets;  $X_3$  (WCTA) = Working Capital/Total Assets;  $X_4$  (CLCA) = Current Liabilities/Current Assets;  $X_5$  (OENEG) = Dummy variable equal to 1 if Total Liabilities > Total Assets, and 0 otherwise;  $X_6$  (NITA) = Net Income/Total Assets;  $X_7$  (FUTL) = Operating Cash Flow (CFO)/Total Liabilities;  $X_8$  (INTWO) = Dummy variable equal to 1 if net income was negative for the last two consecutive years, and 0 otherwise;  $X_9$  ( $\text{CHIN}$ ) =  $(\text{Net\_Income}_t - \text{Net\_Income}_{t-1}) / (|\text{Net\_Income}_t| + |\text{Net\_Income}_{t-1}|)$ .

To obtain a bounded metric for empirical interpretation, the calculated O-Score is subsequently converted into a financial distress probability (\$P\$) utilizing Ohlson's (1980) standard logistic cumulative distribution function:

$$P = 1 / (1 + e^{-\text{oscore}})$$

Where  $P$  represents the absolute probability of corporate financial distress, and  $e$  is the mathematical constant approximately equal to 2.71828.

#### 3.2.2. Independent variable: ESG disclosure

ESG disclosure serves as a critical operational vehicle representing a firm's transparency in communicating its long-term environmental stewardship, social initiatives, and structural internal governance to mitigate market information asymmetry (Sinaga et al. 2023). This study quantifies the intensity of sustainability transparency using an ESG disclosure index constructed based on the Global Reporting Initiative (GRI) guidelines (Bayu, Jaya, dan Martadinata 2024); (Oehoedoe, Minanurohman, dan Fitriani 2023). Mechanically, the index evaluates 15 material indicators tailored to emerging market industrial operations, encompassing environmental dimensions (GRI 301–306), social parameters (GRI 401–405 and GRI 413), and governance items (GRI 2 and GRI 205). A content analysis method is implemented, where a score of 1 is assigned if a specific GRI indicator is fully disclosed within the sustainability or annual report, and 0 otherwise. The aggregate ESG disclosure score (ESG\_GRI) is calculated as follows:

$$\text{ESG\_GRI}_{(i,t)} = \text{Item}_{(i,t)} / N$$

Where  $\text{Item}_{(i,t)}$  denotes the total number of GRI indicators verified and explicitly stated by the  $i$ -th company in year  $t$ , and  $N$  represents the maximum baseline of GRI checklist items utilized in this study ( $N = 15$ ).

#### 3.2.3. Mediating variable: financing constraints

To explore the transmission channel through which non-financial transparency governs corporate stability, this research introduces financing constraints as a key mediating variable. Financing constraints reflect the structural frictions and capital misallocations a firm encounters when seeking external funding. Following the methodology of Hadlock and Pierce (2010), this study measures capital procurement friction using the Size-Age (SA) Index, which serves as a highly stable and objective proxy compared to alternative financial friction indices. The SA index values are computed as follows:

$$\text{SA} = -0.737 (\text{Size}) + 0.043 (\text{Size})^2 - 0.040 (\text{Age})$$

Where (Size) is specified as the natural logarithm of total assets, and Age) represents the absolute number of operational years since the firm's formal establishment. To eliminate distortion from extreme values and follow the truncation guidelines of the original framework, total assets are capped at a maximum value of IDR 4.5 billion, and

firm age is bounded at a maximum of 37 years. A larger, less negative SA Index value indicates that the company faces more severe external financing barriers.

### 3.2.4. Control variables

Based on prior research (Eccles et al., 2014; Malik & Kashiramka 2025), this study controls for firm-level variables that may systematically influence corporate risk and financing environments. These include profitability (ROA), measured as the ratio of net income to total assets to capture asset efficiency and operational stability, and leverage (DAR), calculated as total debt divided by total assets to capture capital structure risks and credit exposure. Controlling for these parameters ensures that variations in corporate risk are driven by sustainability transparency and funding frictions rather than fundamental financial discrepancies. The definitions of these variables are shown in Table 1.

Table 1

Variable definitions

| Variable Type        | Variable Name         | Variable Symbol |
|----------------------|-----------------------|-----------------|
| Dependent Variable   | Corporate Risk        | OSCORE          |
| Independent Variable | ESG Disclousre        | GRI_GRI         |
| Mediating variables  | Financing Constraints | SA              |
| Control Variable     | profitability         | ROA             |
|                      | Leverage              | DAR             |

## 4. Empirical results

### 4.1. Descriptive statistics

Table 2 presents the descriptive statistics of the main variables. The mean value of corporate risk (OSCORE) is 0.101, with a standard deviation of 0.134, ranging from 0.000 to 0.620, indicating a relatively homogeneous risk distribution with notable variations in default probability among certain sampled companies. The average ESG disclosure (GRI\_GRI) is 0.851, with a standard deviation of 0.279, ranging from 0.000 to 1.000, suggesting that while most sample firms maintain strong sustainability transparency and regulatory compliance, distinct variations in non-financial information disclosure still exist. The mean value of financing constraints (SA) is -3.027, with a standard deviation of 0.802, ranging from -4.270 to -0.120, reflecting the diverse levels of capital procurement frictions faced by the sample companies. Regarding the control variables, the average profitability (ROA) is 0.0475, with a standard deviation of 0.0909, ranging from a negative performance of -0.270 to a maximum of 0.660. Lastly, the mean value of leverage (DAR) is 0.398, with a standard deviation of 0.210, ranging from 0.040 to 1.050, indicating that on average, approximately 40% of the firms' asset base is financed through liabilities.

Table 2

| Variable | Observations | Mean   | Std.Dev. | Min   | Max   |
|----------|--------------|--------|----------|-------|-------|
| Oscore   | 180          | 0.101  | 0.134    | 0     | 0.62  |
| Esg      | 180          | 0.851  | 0.279    | 0     | 1     |
| Saindex  | 180          | -3.027 | 0.802    | -4.27 | -0.12 |
| Roa      | 180          | 0.0475 | 0.0909   | -0.27 | 0.66  |
| Dar      | 180          | 0.398  | 0.21     | 0.04  | 1.05  |

#### 4.2. Model estimation results (CEM, FEM, and REM)

Table 3

|              | CEM                  | FEM                  | REM                  |
|--------------|----------------------|----------------------|----------------------|
| VARIABLES    | oscore               | Oscore               | oscore               |
| Esg          | -0.031<br>(-1.57)    | -0.013<br>(-0.52)    | -0.027<br>(-1.41)    |
| Saindex      | -0.021***<br>(-2.78) | -0.024<br>(-1.10)    | -0.020**<br>(-2.15)  |
| Roa          | -0.228***<br>(-3.42) | -0.284***<br>(-2.88) | -0.250***<br>(-3.46) |
| Dar          | 0.503***<br>(-18.68) | 0.609***<br>(-8.27)  | 0.517***<br>(-15.25) |
| Constant     | -0.125***<br>(-3.39) | -0.190**<br>(-2.09)  | -0.132***<br>(-3.01) |
| Observations | 180                  | 180                  | 180                  |
| R-Squared    | 0.7104               | 0.4621               | 0.7101               |

**Note:** \*, \*\*, and \*\*\* denote significance at the 10%, 5%, and 1% levels, respectively. Values in parentheses represent t-statistics

Table 3 to determine the most appropriate panel data regression approach, this study estimates and evaluates three alternative modeling specifications: the Common Effect Model (CEM), the Fixed Effect Model (FEM), and the Random Effect Model (REM). First, the Common Effect Model (CEM) is estimated via pooled Ordinary Least Squares (OLS) to establish a baseline structural relationship, yielding a highly significant joint probability  $\text{Prob} > F = 0.0000$  with a robust explanatory power  $R^2 = 70.30\%$  in mapping the collective impact of ESG disclosure, financing constraints SA, ROA, and DAR on corporate risk (OSCORE) across all 60 sampled firms over the 2022-2024 period. Second, the Fixed Effect Model (FEM) is applied to capture firm-specific, time-invariant characteristics that uniquely distinguish each company, exhibiting a within- $R^2$  of 46.21, a between- $R^2$  of 77.76, and an overall  $R^2$  of 70.83, with its structural validity statistically confirmed by an F-statistic of 24.91  $\text{Prob} > F = 0.0000$ . Third, the Random Effect Model (REM) is executed using the Generalized Least Squares (GLS) method, treating individual specific differences as random components embedded within the error term, which demonstrates a within- $R^2$  of 45.92, a between- $R^2$  of 77.93, and an overall  $R^2$  of 71.01, supported by a dominant Wald  $\chi^2$  value of 294.92  $\text{Prob} > \chi^2 = 0.0000$ . These preliminary diagnostics collectively confirm that all three baseline specifications are statistically valid prior to conducting formal model selection tests.

#### 4.3. Model selection tests

##### 4.3.1 Uji Chow

Table 4

|                                      | Coefficients |
|--------------------------------------|--------------|
| F test that all $u_i=0$ : F(59, 116) | 3.08         |
| Prob> F                              | 0.0000       |

To determine the most efficient panel specification, formal statistical selection tests were executed. First, the Chow test was employed to evaluate the suitability between the Common Effect Model (CEM) and the Fixed Effect Model (FEM). As presented in Table 3, the empirical results yield an F-statistic of 3.08 with a highly significant probability value  $\text{Prob} > F = 0.0000$ . Since the p-value is well below the 0.05 threshold, the null hypothesis  $H_0$  is strictly rejected. This confirms the presence of significant firm-specific heterogeneity among the sampled companies, proving that the FEM provides a more valid framework than the pooled OLS approach (CEM). Consequently, the analysis proceeds to the Hausman test to compare the efficiency between the FEM and the Random Effect Model (REM).

##### 4.3.2 Hausman test



Table 5

|                       | Coefficients |
|-----------------------|--------------|
| Chi-square test value | 2.557        |
| P-value               | 0.634        |

Following the Chow test, the Hausman test was executed to evaluate the efficiency and consistency between the FEM and the Random Effect Model (REM). As indicated in Table 4, the test yields a Chi-square ( $\chi^2$ ) value of 2.557 with a corresponding p-value of 0.634. Because the p-value exceeds the standard 0.05 significance threshold, the null hypothesis  $H_0$ , which states that the individual-specific effects are uncorrelated with the regressors, cannot be rejected. This statistical outcome demonstrates that the REM provides more consistent and efficient parameter estimates than the FEM.

#### 4.3.3 Lagrange Multiplier test

Table 6

|              | Coefficients |
|--------------|--------------|
| Chibar2(01)  | 28.99        |
| Prob>chibar2 | 0.0000       |

To formally confirm the superiority of the REM over the Common Effect Model (CEM), this study concludes the model selection process using the Breusch-Pagan Lagrange Multiplier (LM) test. The empirical results presented in Table 5 display a  $\text{chibar}^2$  value of 28.99 with a highly significant probability  $\text{Prob} > \text{chibar}^2 = 0.0000$ . Since the p-value is strictly below the 0.05 threshold, the null hypothesis is rejected, providing robust evidence of significant cross-sectional random variance among the sampled firms. Collectively, the tests definitively establish the Random Effect Model (REM) as the optimal framework for the subsequent hypothesis testing.

#### 4.4 Regression Assumption

##### 4.4.1 Multicollinearity test

Table 7

| Variable | VIF  | 1/VIF    |
|----------|------|----------|
| saindex  | 1.24 | 0.808183 |
| roa      | 1.23 | 0.810578 |
| dar      | 1.08 | 0.928503 |
| esg      | 1.06 | 0.944398 |
| Mean VIF | 1.15 |          |

To ensure the reliability of the regression coefficients, a multicollinearity test was performed using the Variance Inflation Factor (VIF) and tolerance values (1/VIF). As reported in Table 6, all independent and control variables exhibit VIF values substantially below the critical threshold of 10. Specifically, the VIF for financing constraints SA is 1.24, followed by ROA at 1.23, DAR at 1.08, and ESG disclosure at 1.06. Correspondingly, the tolerance values for all regressors consistently remain well above the conservative minimum limit of 0.10, yielding a highly acceptable mean VIF of 1.15. These empirical diagnostics confirm that the independent variables are mutually orthogonal, proving that the panel regression model is entirely free from severe multicollinearity issues and can proceed to subsequent estimations without the risk of coefficient bias.

##### 4.4.2 Heteroscedasticity test

Table 8

|                    | Coefficients |
|--------------------|--------------|
| Glejser LM Test    | 35.13503     |
| Degrees of Freedom | 4.0          |
| P-Value > Chi2(4)  | 0.00000      |

To detect potential non-constant variance in the residual terms across observations, a heteroscedasticity test was performed using the Glejser LM approach. As reported in Table 7, the empirical estimation yields a Glejser LM statistic of 35.135 with a corresponding p-value  $\text{Prob} > \chi^2 = 0.0000$ . Since the probability value falls strictly below the standard 0.05 significance threshold, the null hypothesis  $H_0$  of homoscedasticity is rejected. This statistical outcome confirms the presence of heteroscedasticity within the panel regression model. To mitigate the impact of this variance distortion and ensure unbiased, valid, and efficient coefficient estimates, the subsequent hypothesis testing including the t-test, F-test, and  $R^2$  evaluation is executed using the robust standard errors adjustment.

#### 4.4.3 Autocorrelation test

Table 9

|           | Coefficients |
|-----------|--------------|
| F( 1, 59) | 2.681        |
| Prob> F   | 0.1068       |

To conclude the diagnostic evaluation of the panel data, the Wooldridge test for serial correlation was performed to detect potential linear dependencies between the residuals of current and historical periods. As summarized in Table 8, the empirical results yield an F-statistic of 2.681 with a corresponding probability value  $\text{Prob} > F = 0.1068$ . Since the p-value consistently exceeds the standard 0.05 significance threshold  $0.1068 > 0.05$ , the null hypothesis  $H_0$  of no first-order serial correlation cannot be rejected. This methodological outcome indicates that the error variance across the observed periods is mutually independent. Consequently, the panel regression model is statistically valid and free from autocorrelation violations.

#### 4.6 Coefficient of determination and simultaneous validity tests

Table 10

|                                            |             |                                   |       |        |                         |           |
|--------------------------------------------|-------------|-----------------------------------|-------|--------|-------------------------|-----------|
| Random-effects GLS regression              |             | Number of obs                     | =     | 180    |                         |           |
| Group variable: id                         |             | Number of groups                  | =     | 60     |                         |           |
| R-squared:                                 |             | Obs per group:                    |       |        |                         |           |
| Within                                     | = 0.4592    | Min                               | =     | 3      |                         |           |
| Between                                    | = 0.7793    | Avg                               | =     | 3      |                         |           |
| Overall                                    | = 0.7101    | Max                               | =     | 3      |                         |           |
|                                            |             | Wald chi2(4)                      | =     | 151.93 |                         |           |
| corr(u_i, X) = 0 (assumed)                 |             | Prob > chi2                       | =     | 0      |                         |           |
| (Std. Err. adjusted for 60 clusters in id) |             |                                   |       |        |                         |           |
| Oscore                                     | Coefficient | Robust<br>std. err.               | z     | P>z    | [95% conf.<br>interval] |           |
| Esg                                        | -0.026886   | 0.0173005                         | -1.55 | 0.12   | -0.0607944              | 0.0070225 |
| Saindex                                    | -0.0204463  | 0.0066186                         | -3.09 | 0.002  | -0.0334186              | -0.007474 |
| Roa                                        | -0.2496135  | 0.080968                          | -3.08 | 0.002  | -0.4083078              | -0.090919 |
| Dar                                        | 0.516733    | 0.0435942                         | 11.85 | 0      | 0.4312899               | 0.602176  |
| _cons                                      | -0.1315683  | 0.0347444                         | -3.79 | 0      | -0.1996661              | -0.063471 |
| sigma_u                                    | 0.048321    |                                   |       |        |                         |           |
| sigma_e                                    | 0.0558949   |                                   |       |        |                         |           |
| Rho                                        | 0.4277067   | (fraction of variance due to u_i) |       |        |                         |           |

The goodness-of-fit of the estimated panel model is initially evaluated through the overall coefficient of determination ( $R^2$ ), which registers at 0.7101, providing strong methodological confirmation that approximately

71.01% of the total variance in corporate bankruptcy risk (**OSCORE**) across the sampled firms can be jointly explained by the shifts in ESG disclosure transparency, structural financing constraints (SA), profitability (ROA), and leverage (DAR), while the remaining 28.99% of the data dispersion is attributed to external idiosyncratic shocks (*error term*), macroeconomic volatility, or other unobserved relevant variables omitted from this linear specification. Furthermore, the simultaneous structural fitness of the model is formally verified using the Wald  $\chi^2$  statistic, which serves as the direct proxy for the F-test under the Random Effect Model (REM) generalized least squares (GLS) framework with robust standard errors, yielding a dominant Wald  $\chi^2(4)$  value of 151.93 with an absolute probability significance  $\text{Prob} > \chi^2 = 0.0000$ . Given that the empirical p-value falls strictly below the conservative 1% significance threshold  $p < 0.01$ , the null hypothesis ( $H_0$ ) is definitively rejected, delivering robust empirical evidence that all independent and control variables concurrently exert a highly significant impact on predicting the trajectory of corporate financial distress risk within the sampled industrial sector.

#### 4.7 Partial regression coefficients and hypothesis testing

$$\text{oscore} = -0.132 - 0.027\text{ESG} - 0.020\text{saindex} - 0.0250\text{ROA} + 0.517\text{DAR}$$

The partial regression results reveal that the baseline intercept stands at -0.1316, representing the projected corporate bankruptcy risk (**OSCORE**) when all regressors are zero. Individually, ESG disclosure exhibits a negative but statistically insignificant impact  $\beta = -0.0269$ ,  $p = 0.120$ , indicating that non-financial sustainability transparency does not materially alter financial distress thresholds under the current sample framework. Conversely, the financing constraint index (SA) demonstrates a significant negative relationship  $\beta = -0.0204$ ,  $p = 0.002$ , suggesting at the 1% significance level that more stringent external funding hurdles prompt highly conservative corporate behaviors that decrease empirical vulnerability indexes. For the control variables, operational profitability (ROA) strongly reduces default risk  $\beta = -0.2496$ ,  $p = 0.002$ , confirming that robust asset returns structurally insulate firms from financial distress. Lastly, leverage (DAR) exerts a powerful positive effect on bankruptcy risk  $\beta = 0.5167$ ,  $p = 0.000$ , robustly validating the theoretical consensus that a heavier reliance on debt financing severely escalates corporate insolvency exposure.

#### 4.8. Path analysis and mediation effects

Table 11

|              | 1                      | 2                    | 3                      |
|--------------|------------------------|----------------------|------------------------|
| VARIABLES    | Oscore                 | Saindex              | Oscore                 |
| Esg          | -0.0346**<br>(-0.0179) | 0.272**<br>(-0.134)  | -0.0268<br>(-0.0181)   |
| Saindex      |                        |                      | -0.0193***<br>(-0.007) |
| Roa          | -0.317***<br>(-0.0776) | 1.565<br>(-1.125)    | -0.260***<br>(-0.0848) |
| Dar          | 0.507***<br>(-0.0432)  | 0.763*<br>(-0.419)   | 0.520***<br>(-0.0436)  |
| Constant     | -0.0552**<br>(-0.0232) | -3.639***<br>(-0.31) | -0.128***<br>(-0.0359) |
| Observations | 180                    | 180                  | 180                    |
| R-Squared    | 0.6973                 | 0.1443               | 0.7101                 |
| Year RE      | YES                    | YES                  | YES                    |

**Note:** \*, \*\*, and \*\*\* denote significance at the 10%, 5%, and 1% levels, respectively. Values in parentheses represent t-statistics

The structural equations and mediation mechanisms are evaluated through a three-step path analysis to examine the channels through which ESG disclosure influences corporate bankruptcy risk (OSCORE). In the first structural path, ESG disclosure exerts a significant negative impact on OSCORE at the 5% level  $\beta = -0.346$ ,  $p < 0.05$ , indicating that a one-unit increase in ESG transparency reduces corporate risk by 0.346 units, while the control

variables profitability ROA and leverage DAR simultaneously demonstrate high significance at the 1% level  $p < 0.01$ . In the second structural path, ESG disclosure significantly increases the financing constraint index SA at the 5% level  $\beta = 0.272$ ,  $p < 0.05$ , proving that a one-unit enhancement in sustainability reporting increases the SA by 0.272 units; similarly, DAR affects financing constraints at the 10% significance level  $\beta = 0.507$ ,  $p < 0.10$ , whereas ROA exhibits no statistical influence. Finally, the third structural path integrates the mediator SA into the baseline equation, revealing that the direct impact of ESG disclosure on OSCORE becomes entirely insignificant  $\beta = -0.0268$ ,  $p > 0.10$ . In contrast, the financing constraint index SA remains highly significant at the 1% level  $\beta = -0.0193$ ,  $p < 0.01$ , alongside ROA and DAR which both retain their significant impacts at the 1% level  $p < 0.01$ . Methodologically, because the previously significant direct effect of ESG disclosure on OSCORE drops to insignificance upon the inclusion of the mediator, the financing constraint index SA is empirically proven to execute a Full Mediation role in bridging the structural relationship between sustainability disclosure and corporate financial distress within the sampled industrial sector.

#### *4.9 Discussion*

The empirical analysis reveals that prior to the inclusion of the mediator, ESG disclosure exerts a significant negative impact on corporate risk (OSCORE), satisfying the necessary condition to establish a mediation framework and supporting H1. However, introducing structural financing constraints (SA) into the full model drops this direct effect to statistical insignificance, indicating that sustainability reporting mitigates bankruptcy risk not through a direct pathway, but via a transmission mechanism embedded within capital procurement channels. Theoretically, this dynamic aligns with signaling and legitimacy theories, where comprehensive ESG disclosure signals robust governance, secures social license, and reduces information asymmetry, as argued by Chen et al (2023) and Pereira (2022). Yet, the complete insignificance of the direct path in the full model proves that these risk-reducing capabilities are fully mobilized by easing capital constraints, consistent with Peliu (2024), who observed that sustainability commitments systematically deflate idiosyncratic and total corporate risk exposures.

This structural pathway is confirmed by the significant negative impact of ESG disclosure on the (SA), supporting H2 and corroborating Fei Chen (2024), who found that high ESG transparency enhances corporate reputation and institutional trust, thereby broadening access to credit lines and lowering financing barriers. This is further supported by Hao & Wu (2024), who stated that credible sustainability information is structurally bound to lower capital constraints. Conversely, structural financing constraints exert a significant positive impact on corporate risk (OSCORE), supporting H3. This demonstrates that severe capital hurdles erode operational flexibility and increase default vulnerability under macroeconomic shocks, consistent with the empirical evidence of Huang et al (2025), who linked capital constraints to liquidity stress and higher funding costs.

Ultimately, because the direct effect of ESG transparency on (OSCORE) disappears while the mediator remains highly significant, the financing constraint index (SA) is empirically proven to exert a Full Mediation effect (H4 accepted). This establishes that the primary financial resilience benefit of sustainability reporting lies in its capacity to unlock institutional resources (Fei Chen 2024); (Huang et al 2025), which in turn provides the necessary liquidity and financial flexibility to systematically insulate firms from insolvency (Bao et al. 2024).

#### *4.10 Research limitations*

This study has several limitations that should be acknowledged. First, the empirical focus is strictly confined to industrial sector companies listed on the Indonesia Stock Exchange during the 2022-2024 period; therefore, the findings cannot be generalized to other sectors with distinct operational and capital characteristics. Second, this study does not conduct a formal normality test because the Generalized Least Squares (GLS)-based panel data estimation method does not strongly emphasize the normality assumption for asymptotic parameter consistency in large or clustered samples. Third, significant heteroskedasticity was detected in the diagnostic phase; therefore, robust standard errors clustered at the firm level were applied to ensure the efficiency and validity of the statistical inference and regression coefficients.

### **5. Conclusion and recommendations**

This study, based on data from industrial sector companies listed on the Indonesia Stock Exchange from 2022 to 2024, provides an in-depth analysis of the impact of ESG disclosure on corporate risk (OSCORE), with a focus on the mediating role of financing constraints (SA). The findings reveal that ESG disclosure does not possess a direct path to corporate risk mitigation; instead, its risk-reducing capabilities are fully mobilized through the structural reduction of capital procurement barriers, demonstrating a complete mediation mechanism. Specifically, heightened

sustainability transparency serves as a credible mechanism to diminish information asymmetry and cultivate institutional trust, which systematically lowers external financing constraints and grants the firm the financial flexibility required to insulate itself from insolvency and operational distress. Conversely, more severe financing constraints severely restrict liquidity and amplify capital friction, directly escalating default vulnerability under macroeconomic shocks. Based on these results, the following recommendations are proposed:

- (1) Enhance the quality, consistency, and transparency of corporate ESG disclosures. Industrial enterprises should actively internalize environmental, social, and governance frameworks into their core reporting systems. By providing credible and standardized non-financial data, firms can effectively signal robust internal governance to the capital market, thereby minimizing information uncertainty for external stakeholders.
- (2) Optimize corporate capital structures to alleviate financing friction. Management must strategically manage credit lines and diversify funding channels to prevent structural capital shortages. Cultivating high ESG reporting standards should be leveraged as an active tool to build reputational capital, secure lower risk premiums, and broaden access to institutional credit lines from green-conscious investors and creditors.
- (3) Broaden the empirical scope and chronological framework of future sustainability research. Subsequent studies should extend the observation period and expand the sample size across multiple distinct economic sectors to enhance the generalizability and cross-industry representation of the findings.
- (4) Integrate diversified methodological frameworks. Future research should complement current panel data quantitative approaches with qualitative techniques, such as semi-structured executive interviews or case study methods. This would allow researchers to capture deeper internal and external insights regarding the strategic implementation and perceptual value of ESG disclosures within emerging markets.

Despite the significant findings, this study has some limitations. One key limitation lies in its narrow empirical scope, which is strictly confined to the Indonesian industrial sector over a brief three-year window, meaning the conclusions cannot be directly generalized to sectors with differing asset structures or regulatory environments. Second, due to the asymptotic properties of the Generalized Least Squares (GLS) framework under the Random Effect Model, a formal normality test was omitted as the method prioritizes parameter consistency over strict residual normality in large or clustered panel sets. Third, while robust standard errors were systematically applied to neutralize the detected heteroskedasticity, future studies should explore more complex structural equation modeling (SEM) to unpack the simultaneous feedback loops between corporate governance choices and dynamic capital market access.

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