



Environmental, Social, and Governance Performance and Stock Investment Risk: The Distinct Role of the Environmental Dimension

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ABSTRACT

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This study aims to examine the effect of Environmental, Social, and Governance (ESG) performance on stock investment risk and to investigate the moderating role of market capitalization in the relationship between ESG performance and stock investment risk. Panel data regression analysis was employed using the Common Effect Model (CEM), Fixed Effect Model (FEM), and Random Effect Model (REM). Model selection was conducted through the Chow, Hausman, and Lagrange Multiplier tests, with the Random Effect Model identified as the most appropriate estimation model. The findings reveal that overall ESG performance has no significant effect on stock investment risk. Likewise, the interaction between ESG performance and market capitalization does not significantly moderate the relationship. Further analysis of ESG dimensions shows that the Environmental dimension has a negative and statistically significant effect on stock investment risk at the 10% significance level, while the Social and Governance dimensions do not exhibit significant effects. These findings imply that aggregate ESG performance has not yet become a strong determinant of stock investment risk, although environmental performance may contribute to reducing investment risk. The results provide insights for investors and corporate managers regarding the importance of strengthening environmental practices as part of long-term risk management strategies.

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INTRODUCTION

Global economic uncertainty, geopolitical tensions, and persistent financial market volatility have increased the urgency for investors and corporations to identify factors that can mitigate investment risk while sustaining long-term value creation (Cai, 2023). Traditional financial indicators are no

longer sufficient to explain corporate resilience because non-financial risks, including environmental degradation, social conflicts, and governance failures, increasingly influence market performance (Landi et al., 2022; Singhanian & Gupta, 2024). Consequently, Environmental, Social, and Governance (ESG) practices have evolved from voluntary corporate initiatives into strategic mechanisms for strengthening organizational resilience and improving investment quality (Schanzenbach & Sitkoff, 2020). In emerging capital markets, where information asymmetry remains relatively high, ESG disclosure provides additional information that enables investors to evaluate corporate sustainability beyond financial statements (Sulastri et al., 2025). Therefore, firms with stronger ESG performance are expected to signal superior risk management capabilities and greater resilience to external shocks, thereby supporting more stable investment decisions and sustainable capital market development.

The growing importance of ESG is particularly evident in industries characterized by substantial operational, environmental, and regulatory risks. Resource-intensive industries are highly exposed to climate-related challenges, environmental liabilities, stakeholder pressure, and volatile commodity markets, all of which may significantly affect corporate risk and investor confidence. In response to these challenges, investors increasingly consider ESG information as an important complement to conventional financial indicators because effective environmental management, responsible stakeholder engagement, and sound corporate governance can reduce uncertainty and strengthen corporate legitimacy (Gao et al., 2022; Zhao et al., 2023). Furthermore, sustainable finance regulations and increasing stakeholder expectations have encouraged companies to improve ESG disclosure and transparency (Afdhal & Andayani, 2024). Consequently, understanding the relationship between ESG performance and stock investment risk has become increasingly important for investors, managers, and policymakers seeking to promote sustainable investment and enhance capital market stability (Kartikowati et al., 2026).

The relationship between ESG performance and stock investment risk is primarily explained by Stakeholder Theory, Signaling Theory, and Portfolio Theory. Stakeholder Theory argues that firms creating value for multiple stakeholders are more likely to achieve operational stability and reduce financial and non-financial risks (Oraby Salah Ahmed, 2025). Signaling Theory explains that high-quality ESG disclosure conveys credible information regarding management quality, long-term commitment, and corporate sustainability, thereby reducing information asymmetry and improving investors' perceptions of corporate risk (Ferriani & Natoli, 2021). Meanwhile, Portfolio Theory emphasizes that investment decisions are based on the trade-off between expected return and risk, where stock return volatility represents a primary

indicator of investment uncertainty. Collectively, these theoretical perspectives suggest that effective ESG implementation can reduce firm-specific risk through stronger stakeholder relationships, enhanced transparency, and better governance practices, ultimately contributing to lower stock investment risk.

Despite the growing adoption of ESG practices, substantial uncertainty remains regarding whether ESG performance effectively reduces stock investment risk. Investors continue to encounter difficulties in interpreting ESG information because its relevance varies across industries, institutional environments, and market conditions. This challenge is particularly evident in high-risk industries, where operational performance is simultaneously influenced by environmental exposure, regulatory changes, commodity price volatility, and stakeholder pressure. Although ESG disclosure is expected to improve transparency and reduce information asymmetry, market participants may not interpret all ESG dimensions uniformly when assessing corporate risk. Consequently, uncertainty regarding the actual contribution of ESG to investment risk reduction remains a significant issue for investors, corporate managers, and policymakers seeking to promote sustainable investment decisions.

Previous studies have extensively examined the relationship between ESG performance and investment risk; however, the empirical evidence remains inconclusive. Several studies report that superior ESG performance reduces stock volatility and corporate risk by strengthening risk management, improving transparency, and enhancing stakeholder trust. Conversely, other studies find insignificant or even positive relationships between ESG performance and investment risk, suggesting that ESG effectiveness depends on firm characteristics, industrial contexts, and market conditions (Tasnia et al., 2021). Moreover, most previous studies primarily emphasize aggregate ESG scores, while relatively limited attention has been given to examining the distinct effects of the Environmental, Social, and Governance dimensions on investment risk (Nurhayati, 2025; Yin et al., 2023). This limitation restricts a comprehensive understanding of which ESG dimension contributes most significantly to risk mitigation (Ainunnisa et al., 2024).

Building upon these research gaps, this study offers several contributions to the ESG and investment risk literature. First, it separately examines the effects of aggregate ESG performance and each individual ESG dimension, allowing a more comprehensive understanding of the heterogeneous influence of Environmental, Social, and Governance practices on stock investment risk. Second, this study incorporates market capitalization as a moderating variable to investigate whether firm size, as reflected by market value, strengthens or weakens the relationship between ESG performance and investment risk (Luo et

al., 2023; Nirino et al., 2022). This perspective extends previous studies that primarily focused on the direct effect of ESG while paying limited attention to contextual factors influencing this relationship (Drempetic et al., 2020). Therefore, this study is expected to provide more comprehensive empirical evidence regarding the effectiveness of ESG as a corporate risk management mechanism and enrich the development of sustainable investment literature (Shakil, 2022).

Based on the theoretical perspectives and the inconsistencies identified in previous studies, an important question remains regarding whether ESG performance effectively reduces stock investment risk and whether each ESG dimension contributes equally to risk mitigation. This issue is particularly relevant because investors may respond differently to environmental, social, and governance information depending on its perceived materiality and the characteristics of each industry. In addition, the relationship between ESG performance and investment risk may vary according to firm-specific characteristics that influence market perception. Among these characteristics, market capitalization represents an important contextual factor because it reflects firm size, market visibility, liquidity, and investor attention. Companies with greater market capitalization may transmit stronger ESG signals to investors, potentially altering the relationship between ESG performance and stock investment risk. Therefore, further investigation is necessary to clarify these relationships and provide more robust empirical evidence.

Drawing on Stakeholder Theory, Signaling Theory, and Portfolio Theory, this study argues that effective ESG implementation can reduce stock investment risk by strengthening stakeholder relationships, improving transparency, and enhancing corporate resilience. Nevertheless, the influence of ESG is unlikely to be uniform across its environmental, social, and governance dimensions because each dimension addresses different sources of corporate risk and may receive different responses from investors. Furthermore, the effectiveness of ESG information may depend on market capitalization, as larger firms generally receive greater investor attention and possess stronger market credibility. Accordingly, this study examines the effects of aggregate ESG performance and each ESG dimension on stock investment risk while also investigating whether market capitalization strengthens or weakens these relationships. The findings are expected to provide a more comprehensive understanding of ESG as a mechanism for investment risk management.

RESEARCH METHODS

This study employed a quantitative causal research design to examine the relationships between Environmental, Social, and Governance (ESG) performance, market capitalization, and stock investment risk (Feng et al., 2022). A causal design was selected because the study aimed to test hypothesized cause-

and-effect relationships among the independent, moderating, and dependent variables using panel data regression. The study focused on publicly listed mining companies during the 2021–2024 observation period because the industry is characterized by high environmental exposure, regulatory pressure, and commodity price volatility, making it an appropriate setting for investigating the role of ESG in investment risk (Tian et al., 2025). The population consisted of all mining companies listed during the observation period. Purposive sampling was employed to ensure data completeness and consistency based on the availability of annual reports, sustainability reports, ESG disclosures, and stock price data. This procedure resulted in 34 companies, generating 132 firm-year observations from 136 potential observations because several firms had incomplete monthly stock price data, resulting in an unbalanced panel dataset (Baltagi, 2021).

Table 1. Sample Selection Process

Criteria	Number of Companies
Mining companies listed during the observation period	63
Excluded due to industry classification	(9)
Excluded due to incomplete and inconsistent sustainability reports	(20)
Final sample	34
Potential observations (34 companies × 4 years)	136
Less: observations with incomplete monthly stock price data	(4)
Final observations	132

Table 1 presents the sample selection process using purposive sampling. The final sample comprised 34 companies that consistently met the predetermined criteria throughout the observation period, producing 132 firm-year observations. The difference between potential and final observations resulted from incomplete monthly stock price data for several companies, leading to an unbalanced panel. Nevertheless, unbalanced panel data remain appropriate for panel regression because they preserve available information while providing efficient and unbiased parameter estimates when the estimation assumptions are satisfied (Baltagi, 2021).

Secondary quantitative data were collected through documentation techniques from annual reports, sustainability reports, historical monthly stock prices, and publicly available financial information. ESG performance was measured through content analysis based on the Global Reporting Initiative (GRI) standards, including GRI 300 for Environmental, GRI 400 for Social, and GRI 102 for Governance disclosures. Each disclosed indicator received a score of one, while undisclosed indicators received zero, and the disclosure indices were aggregated using the arithmetic mean of the three ESG dimensions. Stock investment risk was measured using the natural logarithm of the standard

deviation of monthly stock returns, whereas market capitalization was calculated by multiplying the closing stock price by the number of outstanding shares. Profitability (ROA) and leverage (LEV) were included as control variables to minimize omitted-variable bias in the regression models (Janicka & Sajnóg, 2022).

The data were analyzed using panel data regression because this approach combines cross-sectional and time-series observations while controlling for unobserved firm-specific heterogeneity and improving estimation efficiency. Three estimation models, namely the Common Effect Model (CEM), Fixed Effect Model (FEM), and Random Effect Model (REM), were evaluated through the Chow, Hausman, and Lagrange Multiplier tests to determine the most appropriate specification. The Random Effect Model was selected as the final estimation model. The study estimated two regression models, including the direct effect model and the moderated regression model, to evaluate whether market capitalization strengthened or weakened the relationship between ESG performance and stock investment risk. Prior to estimation, multicollinearity was assessed using the Variance Inflation Factor (VIF), while heteroskedasticity tests were conducted to verify residual variance assumptions. All analyses were performed using EViews 13 with the Generalized Least Squares (GLS) estimation procedure (Baltagi, 2021).

RESULTS AND DISCUSSION

Results

Descriptive Statistics

This section presents the empirical findings obtained from the data analysis conducted to address the research objectives. The analysis begins with descriptive statistics to provide an overview of the characteristics and distribution of the research variables during the observation period. Subsequently, panel data model selection was performed to determine the most appropriate estimation approach among the Common Effect Model (CEM), Fixed Effect Model (FEM), and Random Effect Model (REM). The selected panel regression model was then employed to estimate the research models and test the proposed hypotheses. The descriptive statistics of all research variables are presented in Table 1.

Table 1. Descriptive Statistics								
Statistics	RISK	ESG	E	S	G	MCAP	LEV	ROA
Mean	2.00401	0.70380	0.64512	0.64053	0.82575	29.2456	0.42746	0.11121
	3	4	3	0	8	2	2	4

Median	- 2.00771 8	0.71223 0	0.68750 0	0.67500 0	0.83333 3	29.2592 3	0.39252 0	0.07441 9
Maximum	- 0.30288 9	0.88348 8	1.00000 0	1.00000 0	1.00000 0	34.1821 0	2.38031 9	0.61634 6
Minimum	- 3.45655 8	0.34907 4	0.06250 0	0.12500 0	0.22222 2	24.9876 5	0.02788 8	- 0.25993 9
Standard Deviation	0.53928 0	0.10137 9	0.20577 8	0.17407 1	0.12036 1	1.98007 3	0.28239 1	0.15943 8
Skewness	0.23528 0	- 0.61821 1	- 1.10196 7	- 0.40904 0	- 1.25849 5	- 0.05539 0	2.57622 8	1.11975 2
Kurtosis	3.74264 2	3.25870 4	3.96282 4	2.95605 2	6.63878 8	2.61608 6	18.4314 6	4.59574 9
Jarque-Bera	4.25119 4	8.77616 2	31.8139 6	3.69151 9	107.668 1	0.87814 1	1455.72 7	41.5898 5
Probability	0.11936 2	0.01242 5	0.00000 0	0.15790 5	0.00000 0	0.64463 5	0.00000 0	0.00000 0
Sum	- 264.529 8	92.9020 8	85.1562 5	84.5500 0	109.000 0	3860.42 2	56.4250 0	14.6803 1
Sum of Squared Deviations	38.0977 4	1.34636 7	5.54713 4	3.96941 3	1.89777 4	513.610 1	10.4465 2	3.33007 0
Observations	132	132	132	132	132	132	132	132

Table 1 presents the descriptive statistics of the research variables based on 132 firm-year observations during the 2021–2024 period. The stock investment risk variable (RISK), measured as the natural logarithm of stock return volatility, has a mean value of –2.004, with values ranging from –3.457 to –0.303. This distribution indicates considerable variation in investment risk across the sampled firms. The standard deviation of 0.539 suggests a moderate level of variability in stock investment risk. In addition, the skewness value of 0.235 indicates a relatively symmetric distribution, while the kurtosis value of 3.743 suggests a slightly leptokurtic distribution. Overall, these statistics indicate sufficient heterogeneity among the observations, supporting the application of panel data regression analysis.

The aggregate ESG performance exhibits a mean value of 0.704 with a standard deviation of 0.101, indicating that the sampled firms generally demonstrate moderate to high ESG disclosure with relatively limited variation across companies. Among the ESG dimensions, the Governance (G) score records

the highest average (0.826), followed by Environmental (E) (0.645) and Social (S) (0.641). These results suggest that governance-related disclosures are more extensively reported than environmental and social disclosures. Regarding the control variables, Market Capitalization (MCAP) has an average value of 29.246, reflecting differences in firm size across the sample. The average leverage (LEV) is 0.427, indicating a moderate reliance on debt financing, whereas profitability (ROA) averages 0.111, with both positive and negative values observed during the study period. Overall, the descriptive statistics reflect the heterogeneous characteristics of the mining industry, which is generally associated with high investment risk and substantial capital requirements, thereby providing an appropriate empirical basis for the subsequent regression analysis.

Panel Model Selection and Diagnostic Tests

Panel data model selection was conducted to identify the most appropriate estimation approach for the regression analysis. Three alternative panel data models were evaluated, namely the Common Effect Model (CEM), Fixed Effect Model (FEM), and Random Effect Model (REM). Model selection was performed sequentially using the Chow test, Hausman test, and Lagrange Multiplier (LM) test. The results consistently indicated that the Random Effect Model (REM) was the most appropriate estimation method for all research models. The Hausman test produced probability values exceeding the 5% significance level, indicating that the null hypothesis could not be rejected and that the REM was preferred over the FEM. Furthermore, the Lagrange Multiplier test based on the Breusch–Pagan statistic yielded significant probability values, confirming that the REM provided a better specification than the CEM. Accordingly, all subsequent regression analyses and hypothesis testing were estimated using the Random Effect Model.

Prior to estimating the regression models, several diagnostic tests were conducted to evaluate whether the data satisfied the fundamental assumptions of panel regression analysis. The diagnostic procedures included normality, multicollinearity, and heteroskedasticity tests involving the dependent, independent, moderating, and control variables. These tests were performed to ensure the reliability of the estimation results and the robustness of the statistical inferences. Although the diagnostic outputs were generated separately by EViews according to each test specification, they collectively served as the basis for assessing the adequacy of the regression model before hypothesis testing.

The normality test indicated that the residuals were not perfectly normally distributed due to the presence of several extreme observations, particularly in the RISK and LEV variables. Such characteristics are commonly observed in financial data, especially within industries characterized by high volatility.

Nevertheless, the violation of residual normality does not constitute a critical issue in panel data regression when the number of observations is sufficiently large. Therefore, the regression estimation remained appropriate because the primary assumptions required for panel data analysis were satisfied.

The multicollinearity test demonstrated that the independent variables exhibited acceptable levels of correlation, indicating the absence of serious multicollinearity problems. Consequently, each explanatory variable contributed distinct information in explaining variations in stock investment risk, allowing the estimated regression coefficients to be interpreted reliably. Overall, the diagnostic test results indicate that the selected panel regression model satisfies the required statistical assumptions and is appropriate for subsequent regression estimation and hypothesis testing.

Regression Results

The regression analysis was performed using the Random Effect Model (REM), which was identified as the most appropriate estimation approach through the panel model selection procedure. Four regression models were estimated to examine the direct effects of ESG performance and its individual dimensions on stock investment risk, as well as the moderating role of market capitalization. The estimation results are presented in Table 2.

Table 2. Regression Results

No.	Variables	Model 1	Model 2	Model 3	Model 4
		Coefficient	Coefficient	Coefficient	Coefficient
1	C	-1.282943 (0.953420)	2.397627 (4.665132)	-1.893638 (1.033266)*	-1.609788 (5.720356)
2	ESG	-0.390754 (0.488818)	-5.549212 (6.464425)	–	–
3	E	–	–	-0.559281 (0.284756)*	-2.099544 (3.985139)
4	S	–	–	0.289819 (0.346645)	-0.388462 (5.741407)
5	G	–	–	-0.247887 (0.473200)	1.166865 (7.633858)
6	MCAP	-0.027511 (0.032492)	-0.155118 (0.161827)	-0.002693 (0.034562)	-0.013948 (0.199401)
7	ROA	0.838570 (0.368893)**	0.810982 (0.361201)**	0.718038 (0.365338)*	0.737557 (0.382007)*
8	LEV	0.622715 (0.185707)***	0.617890 (0.181582)***	0.629772 (0.184543)***	0.629338 (0.188676)**
9	ESG × MCAP	–	0.178709 (0.223080)	–	–
10	E × MCAP	–	–	–	0.054515 (0.140746)

11	S × MCAP	–	–	–	0.022914 (0.196167)
12	G × MCAP	–	–	–	-0.048348 (0.264529)
13	R-squared	0.111784	0.114518	0.138247	0.139557
14	Adjusted R-squared	0.083809	0.079380	0.096883	0.076081
15	F-statistic	3.995816	3.259089	3.342205	2.198599
16	Prob. (F-statistic)	0.004358	0.008411	0.004352	0.026471

Notes: Values in parentheses represent the standard errors. *** Significant at the 1% level; ** significant at the 5% level; * significant at the 10% level.

Source: Processed by the author using EViews 13 (2026).

Table 2 reports the regression results for the four estimated models. Model 1 examines the direct effect of aggregate ESG performance on stock investment risk while controlling for market capitalization (MCAP), leverage (LEV), and profitability (ROA). Model 2 extends the analysis by incorporating the interaction term between ESG performance and market capitalization to evaluate the moderating effect of firm size. Model 3 investigates the individual effects of the Environmental (E), Social (S), and Governance (G) dimensions on stock investment risk, together with the control variables. Finally, Model 4 evaluates whether market capitalization moderates the relationships between each ESG dimension and stock investment risk through the interaction terms E×MCAP, S×MCAP, and G×MCAP.

Overall, the regression results indicate that not all proposed relationships receive empirical support. Aggregate ESG performance does not significantly affect stock investment risk in either Model 1 or Model 2. Similarly, the interaction between ESG performance and market capitalization is statistically insignificant, indicating that market capitalization does not moderate the relationship between aggregate ESG performance and stock investment risk. In contrast, the Environmental dimension exhibits a negative and statistically significant coefficient in Model 3 at the 10% significance level, suggesting that better environmental performance is associated with lower stock investment risk. However, the Social and Governance dimensions do not demonstrate statistically significant effects. Furthermore, none of the interaction terms between the ESG dimensions and market capitalization in Model 4 are statistically significant, indicating the absence of a moderating effect.

Model 1 shows that the coefficient of aggregate ESG performance is -0.391, but the relationship is statistically insignificant. This result indicates that aggregate ESG performance does not have a significant direct effect on stock investment risk. The findings suggest that the market has not fully incorporated

aggregate ESG information into investment risk assessments. Among the control variables, leverage has a positive and statistically significant effect, while profitability is positively significant at the 5% significance level. These results indicate that stock investment risk is more strongly associated with firms' financial conditions than with their aggregate ESG performance.

Model 2 incorporates the interaction between ESG performance and market capitalization. The estimated coefficient of the interaction term is positive but statistically insignificant, indicating that market capitalization does not strengthen or weaken the relationship between aggregate ESG performance and stock investment risk. Similar to Model 1, leverage remains positively significant, whereas profitability continues to exhibit a significant positive effect. These findings suggest that firm size, as measured by market capitalization, does not alter the influence of aggregate ESG performance on stock investment risk.

Model 3 examines the individual ESG dimensions. The Environmental dimension has a negative coefficient of -0.559 and is statistically significant at the 10% significance level, indicating that improvements in environmental performance are associated with lower stock investment risk. In contrast, the Social and Governance dimensions do not exhibit statistically significant effects. The control variables remain generally consistent with the previous models, where leverage has a positive and significant coefficient and profitability remains significant at the 10% significance level. These findings imply that environmental performance contributes more strongly to explaining stock investment risk than the aggregate ESG score or the other ESG dimensions.

Model 4 evaluates the moderating role of market capitalization on each ESG dimension. The interaction terms $E \times \text{MCAP}$, $S \times \text{MCAP}$, and $G \times \text{MCAP}$ are all statistically insignificant, indicating that market capitalization does not moderate the relationships between the Environmental, Social, and Governance dimensions and stock investment risk. The explanatory power of the estimated models remains relatively limited, with the highest adjusted R-squared value of 0.096 reported in Model 3. This finding indicates that although the included variables explain part of the variation in stock investment risk, a substantial proportion of the variation is attributable to other factors outside the scope of the present study.

Discussion

The findings indicate that aggregate ESG performance does not significantly influence stock investment risk, suggesting that investors have not fully incorporated ESG information into their investment decisions. According to Portfolio Theory, investors consider all available information that may affect the trade-off between expected return and investment risk. However, aggregate ESG

disclosure has not yet become a sufficiently strong signal to alter investors' perceptions of investment risk. Investors continue to rely more on conventional financial indicators because they provide more direct information about firms' financial performance and future prospects (Tasnia et al., 2021). This finding is consistent with studies showing that the impact of ESG on corporate risk depends on market maturity, institutional quality, and disclosure credibility. However, it differs from evidence in developed markets where ESG plays a more important role in reducing corporate risk and supporting investment decisions.

The insignificant effect of aggregate ESG performance may also reflect the characteristics of the mining industry, where investment risk is more strongly influenced by commodity price volatility, regulatory changes, and macroeconomic uncertainty than by sustainability information. Consequently, investors tend to prioritize firms' financial fundamentals when evaluating investment risk. This interpretation is supported by the significant effects of leverage and profitability, indicating that financial conditions remain the primary determinants of stock investment risk. These findings extend Portfolio Theory by suggesting that the relevance of ESG information depends on industrial characteristics and market conditions rather than serving as a universal indicator of investment risk. Practically, the findings imply that improving ESG disclosure alone is insufficient to reduce investment risk unless supported by strong financial performance and credible sustainability implementation that enhances investor confidence (Tasnia et al., 2021).

An important finding of this study is that only the Environmental dimension significantly reduces stock investment risk, whereas the Social and Governance dimensions have no significant effect (Ahmad et al., 2023; Pacelli et al., 2022). This result indicates that investors evaluate individual ESG dimensions differently rather than relying solely on aggregate ESG scores. Environmental performance is considered more relevant because it is directly associated with operational continuity, regulatory compliance, and environmental risk in the mining industry. Consequently, firms with stronger environmental performance are perceived as having lower operational uncertainty and investment risk. This finding supports previous studies showing that the materiality of ESG dimensions varies across industries. The novelty of this study lies in demonstrating that individual ESG dimensions provide greater explanatory power than aggregate ESG scores in explaining stock investment risk in environmentally sensitive industries.

Another important finding is that Market Capitalization does not moderate the relationship between ESG performance and stock investment risk. This result indicates that firm size does not strengthen or weaken the effectiveness of ESG practices in reducing investment risk. Regardless of whether

firms have large or small market capitalization, investors appear to evaluate ESG performance using similar criteria. This finding suggests that market value alone does not necessarily reflect the quality or credibility of ESG implementation. Instead, investors continue to focus on the economic consequences of ESG practices rather than the scale of the company. These results are consistent with previous studies reporting that firm value does not always correspond to the effectiveness of ESG disclosure, particularly in emerging markets where sustainability reporting is still developing (Janicka & Sajnóg, 2022). However, the findings differ from studies arguing that larger firms generally obtain greater benefits from ESG implementation because they possess stronger resources and higher stakeholder visibility.

The insignificant moderating effects of the Social and Governance dimensions further indicate that investors do not perceive these aspects as immediate determinants of investment risk. Social and governance disclosures are more likely viewed as standard corporate practices that ensure regulatory compliance rather than as strategic factors capable of reducing uncertainty. Consequently, variations in these disclosures are insufficient to create different risk perceptions among investors. This finding implies that investors in the mining industry remain more responsive to financial performance and operational risks than to sustainability information with indirect economic impacts. From a practical perspective, firms should prioritize improving the quality and credibility of ESG implementation instead of merely increasing the quantity of sustainability disclosures. This interpretation supports the view that ESG information is frequently treated as complementary rather than as the primary basis for investment risk assessment in emerging capital markets (Parfitt, 2020).

Overall, this study contributes to the ESG and investment literature by demonstrating that the relationship between ESG performance and stock investment risk is multidimensional and industry-specific. The findings show that aggregate ESG scores may conceal the influence of individual dimensions, particularly the Environmental dimension, which is more relevant for environmentally sensitive industries. Accordingly, this study extends Portfolio Theory by emphasizing that investors respond selectively to sustainability information according to its perceived relevance to operational and financial risk. The practical implication is that managers should strengthen environmental performance as part of corporate risk management, while policymakers should encourage more transparent and decision-useful ESG reporting to improve the informational value of sustainability disclosures. The novelty of this study lies in simultaneously examining aggregate ESG performance, individual ESG dimensions, and the moderating role of Market Capitalization in explaining stock

investment risk within a single empirical framework, thereby providing a more comprehensive understanding of ESG-based investment risk assessment (Li et al., 2022).

CONCLUSION

This study demonstrates that aggregate ESG performance does not significantly influence stock investment risk, and Market Capitalization does not moderate this relationship. However, the Environmental dimension significantly reduces stock investment risk, whereas the Social and Governance dimensions have no significant effect. These findings suggest that investors respond more strongly to sustainability information directly associated with operational and regulatory risks than to aggregate ESG disclosures. The study contributes to the ESG and investment literature by demonstrating that disaggregating ESG into individual dimensions provides a more comprehensive explanation of investment risk than relying solely on aggregate ESG scores, thereby extending the application of Portfolio Theory in the context of environmentally sensitive industries. Nevertheless, this study is limited to mining companies, a relatively short observation period, and disclosure-based ESG measurement, which may not fully capture actual ESG performance. Future research is encouraged to examine other industries, employ longer observation periods, incorporate alternative ESG measures and investment risk proxies, and apply more advanced estimation techniques to address potential endogeneity and unobserved heterogeneity.

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