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ESG and Firm Risk: Evidence in Korea

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Abstract: This study examines the intricate relationship between ESG considerations and risk profiles of firms by presenting a comprehensive analysis of total, systematic, and idiosyncratic risks. Using 7834 firm-year observations from 2011 to 2022 in the Korean market, the findings reveal that ESG engagement effectively reduces total, systematic, and idiosyncratic risks. Especially noteworthy is the fact that the reduction in systematic risk, a discovery associated with ESG engagement in medium-sized firms, remains concealed when examining only the total risk. During the COVID-19 crisis, ESG remained valuable in lowering total and idiosyncratic risks but paradoxically increased systematic risk in certain circumstances. These findings emphasize the risk-mitigating potential of ESG, advocating customized strategies based on firm size. They also underscore the resilience of firms that are dedicated to ESG practices during a crisis. Investors may enhance risk-adjusted returns and mitigate overall portfolio risk by integrating ESG factors into their investment strategies, with the importance of tailoring such strategies emphasized, while governments should develop policies incentivizing ESG engagement and allocating resources for ESG-related initiatives.

Keywords: ESG; firm total risk; systematic risk; idiosyncratic risk; firm size

1. Introduction

This study focuses primarily on examining the correlation between environmental, social, and governance (ESG) practices and the extent of risk within firms. While previous studies predominantly focused on assessing how corporate social responsibility (CSR) impacted a company's total risk [1–6], our study goes one step further by also segregating and investigating systematic and idiosyncratic risks. We believe that exclusive reliance on total risk to assess the impact of ESG practices may not yield a comprehensive understanding of the phenomenon, especially when total risk is found to be statistically insignificant. This is because total risk encompasses both systematic and idiosyncratic components. Investigating the individual components of risk, such as systematic and idiosyncratic risk, is expected to yield a more nuanced and informative picture. Systematic risk refers to a company's market-associated risk. Idiosyncratic risk pertains to the specific risk associated with an individual asset or a small group of assets as opposed to the entire market. This type of risk, also called unsystematic, diversifiable, or firm-specific risk, can be mitigated by diversifying investments across various assets or asset classes.

Additionally, we examine the individual influence of each ESG component on a firm's risk, with a specific focus on the Korean stock market. ESG components encompass the environmental, social, and governance factors used to assess a company's ethical and sustainability practices. Environmental criteria evaluate the environmental impact; social criteria gauge social responsibility, and governance criteria scrutinize corporate governance and ethical leadership.

Furthermore, the importance of firm risk becomes more evident during crises, highlighting the necessity for measures that can reduce risk and minimize losses for companies. Our research aims to identify the aspects of firm risk that could potentially be alleviated by implementing ESG activities, especially in the context of the COVID-19 crisis.

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We recognize that a company's size affects its capacity to handle ESG practices [7,8]. For instance, owing to limited resources, smaller firms may struggle to effectively address ESG practices, leading to weaker sustainable practices and higher total risk. Conversely, larger firms with greater resources can adopt comprehensive ESG strategies and dedicated teams, enabling them to manage ESG challenges. Therefore, this study considers various company sizes to gain a deeper understanding of the impact of ESG practices on risk.

The existing literature presents varied perspectives on the relationship between ESG and risk. Some literature found a positive relationship between high ESG ratings and lower financial risk, suggesting that strong ESG practices could reduce risk [1,3,9]. However, it is also noted that ESG integration might introduce new risks, especially in environmentally sensitive sectors [10]. Additionally, other studies emphasized the importance of robust ESG data and assessment methodologies for effective risk management [11,12]. In summary, while some studies indicate a risk-reducing effect of ESG integration, others highlight complexities and challenges, warranting further investigation into this relationship.

This study is unique in that it uncovers a special finding on the impact of ESG practices on diverse types of risk. It shows the importance of examining each risk separately, as considering only the total risk might not have revealed this discovery. This study demonstrates that adopting ESG practices can effectively lower a company's risk across multiple dimensions, including total, systemic, and idiosyncratic risks. Notably, the influence of ESG practices on total risk stems primarily from their impact on idiosyncratic risks. Furthermore, our investigation, which encompasses firms of various sizes, reveals disparities in how ESG practices influence risk. ESG practices significantly affect systematic risk, particularly in medium-sized firms. Throughout the COVID-19 pandemic, the efficacy of ESG practices in mitigating both total and idiosyncratic risks declined slightly. However, we find compelling evidence that ESG practices positively impact systematic risk amid the challenges posed by the pandemic.

2. The Literature Review and Hypothesis Development

The relationship between ESG factors and firm total risk is the focus of our study. Environmental factors like climate change affect operations, while social factors impact reputation. Governance, including board structure, mitigates risks. Integrating ESG into business strategies enhances risk management and resilience. As the economy places increasing importance on social responsibility, a growing body of the literature has been dedicated to examining this topic. Numerous studies provide evidence supporting the idea that CSR initiatives can reduce the total risk faced by firms. However, some studies have also reported positive or neutral effects of CSR on firm risk.

The relationship between ESG factors and firm risk has attracted considerable interest in financial research. Key studies have explored different aspects of this connection, providing valuable perspectives on its potential impact on risk management and corporate social responsibility. The impact of corporate environmental responsibility on firm risk was explored by [1], revealing a potential association between environmental performance and risk management strategies. The influence of social performance dimensions on firm risk was examined by [2], with an emphasis placed on the role of social metrics in assessing and managing financial risks. A longitudinal analysis of the long-term impact of corporate social performance on financial risk and utility was conducted by [3], with their findings shedding light on the enduring implications of social performance for firms' risk profiles and utilities over time. In a study focusing on the German capital market, u-shaped relationships between disaggregated ESG rating scores and risk were explored [4]. This study highlighted the complexity of the relationship between corporate sustainability and risk management, underscoring the need for nuanced approaches to ESG integration. Another study examined the relationship between corporate social responsibility (CSR) and financial risk, suggesting potential risk-reducing benefits associated with CSR initiatives [5]. In addition, one of the previous literature provided insights into the interplay between

corporate governance, firm risk, and CSR practices within Korean firms, emphasizing the influence of governance structures on risk profiles and CSR activities [6].

CSR has proven to be an essential instrument for reducing systematic risks [9,13–16]. Systematic risk, also known as market risk, refers to the inherent risk that affects the entire market or a segment of the market and cannot be mitigated through diversification. It is influenced by factors such as economic changes, political events, and natural disasters. The relationship between environmental, social, and governance (ESG) factors and systematic risk has been examined in several studies. The link between corporate social responsibility (CSR) and systematic risk was explored by [9], where theoretical frameworks and empirical evidence were presented to support the findings that reduced systematic risk may be experienced by companies with robust CSR practices. The bidirectional effects between organizational sustainability disclosure and systematic risk were investigated by [13]. The dynamic nature of this relationship was highlighted in their research, suggesting that risk levels can be influenced by sustainability disclosure and vice versa. An examination of whether systematic risk could be reduced by optimizing a company's environmental performance was conducted by another study [14]. Their findings indicated a potential risk-reducing effect associated with improved environmental performance among European listed companies. International evidence on the relationship between CSR and systematic risk was provided by [15]. Their study suggested that a role may be played by CSR initiatives in mitigating systematic risk across different markets. The systemic impact of lower-rated ESG companies in Europe and the United States was investigated by [16]. Their empirical evidence indicated that a higher systemic impact might be exerted by companies with lower ESG ratings, highlighting the importance of ESG considerations in assessing systemic risk. One of the previous studies discovered an adverse impact of CSR linked to lowering systematic risk [17]. This study utilized control for environmental pollution (CEP) reports as a metric to assess CSR. Additionally, in the context of controversial industries, CSR was found to be even more effective in lowering risk [8]. The research concentrates on contentious sectors, such as tobacco, gambling, and alcohol, within the US market. It explores the influence of CSR on risk and concludes that CSR is more successful in mitigating risk in controversial rather than non-controversial sectors. While most studies indicate that ESG practices decrease systematic risk, contrasting findings in the literature indicate a positive or neutral influence of CSR on systematic risk [18]. Based on the literature review, environmental initiatives prepare companies for climate-related changes, reducing the systematic risks associated with environmental crises. Companies that prioritize strong social practices can enhance their reputation, foster customer loyalty, and build robust relationships with stakeholders, all of which contribute to greater overall stability. This stability helps companies better withstand market-wide shocks and uncertainties, thereby reducing their systematic risk. Good governance reduces information asymmetry and agency conflicts, thereby lowering the likelihood of fraud and mismanagement. This increased transparency and accountability build investor confidence and contribute to more stable financial performance. Furthermore, firms with strong governance practices are better equipped to comply with regulations and adapt to changing market conditions, thereby reducing their overall exposure to systematic risk.

Likewise, many earlier research studies have established that CSR could effectively lower a company's idiosyncratic risk [19–24]. Idiosyncratic risk, also known as unsystematic risk or specific risk, is a risk that is unique to a particular company or industry and can be mitigated through diversification. Notably, one study investigated the association between social governance and firm-specific risk, finding a negative relationship between them [19]. Another study adopted a marketing approach, revealing a negative relationship between CSR and idiosyncratic risk [25]. Examining the relationship between the two across the Asia–Pacific region, Europe, Japan, and the U.S. markets reveals a negative association [22]. This study determined the optimal CSR levels specific to each region to minimize the idiosyncratic risk. However, a limited number of studies present contradictory evidence for this effect [26,27]. While some scholars focused on the social responsibility of leading

and lagging firms and found that CSR practices decreased idiosyncratic risk [20], others examined the effects of negative and positive CSR ratings on idiosyncratic risk and found an association in both cases [21]. Based on the literature review, ESG practices mitigate risks unique to individual companies by improving operational efficiency, lowering costs, enhancing reputation, and boosting customer loyalty through strong environmental and social initiatives. Effective governance ensures regulatory compliance, minimizes legal risks, increases transparency, and reduces the potential for fraud and mismanagement. Additionally, ESG practices attract and retain top talent, support innovation, and promote long-term strategic planning, making companies more resilient to industry challenges. Therefore, we hypothesize that companies with strong ESG practices experience lower idiosyncratic risk due to their enhanced ability to mitigate operational, reputational, regulatory, and strategic risks inherent in their operations.

According to the previous literature, we explore how enhancing ESG practices can mitigate the risks linked to each ESG component (environmental, social, and governance). Risks related to environmental components are mainly due to the firm's non-compliance with environmental regulations. Environmental risks encompass the potential financial losses arising from several factors, including stricter environmental regulations enacted by governments, legal actions seeking restitution for environmental harm, and substantial non-compliance penalties imposed by authorities on polluting companies [5]. Regarding social component-related risks, they are mainly related to stakeholder theory. Neglecting stakeholder interests can lead to repercussions such as boycotts for the company [5]. Establishing positive relationships with stakeholders fosters loyalty, enhances corporate reputation, and may manifest in increased market share, profits, and long-term financial stability [28]. As for governance-related risks, they mainly stem from issues surrounding information asymmetry and agency conflicts. The outcomes of management practices may exacerbate information asymmetry and diminish the company's value, reputation, and corporate image [29]. Companies engaging in socially responsible activities tend to offer greater financial disclosure [30]. Higher earnings quality is associated with reduced information asymmetries and lower cost of capital [31,32].

Previous studies examined the relationship between ESG factors and firm risk levels similarly to our study. However, there are notable differences between these studies and our research. One study investigates this relationship within the European market, where corporate social responsibility (CSR) is obligatory [33]. In contrast, our study focuses on the Korean market, where CSR is voluntary. Additionally, another study concentrated solely on the gas and oil industry when examining the relationship between ESG and risk [34]. In our research, we cover all categories of industry.

This study is motivated by the need to conduct a more comprehensive exploration of the relationship between ESG factors and firm risk, encompassing the entire sample period and focusing on the COVID-19 crisis context. Most studies suggest that ESG practices mitigate risks, although conflicting results have been reported in the literature. Considering the above, the following hypothesis is formulated:

Hypothesis 1. *An engagement in ESG activities reduces firm risk, including systematic and idiosyncratic risk.*

Figure 1 displays the relationship between ESG and its components (environmental, social, and governance) and firm risk. Total risk is divided into systematic and idiosyncratic risks.

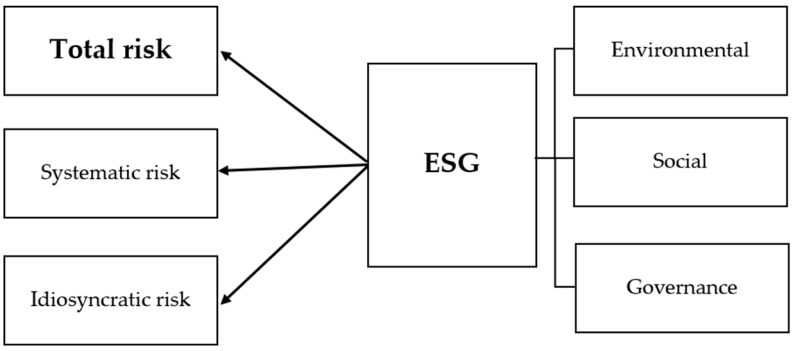

Figure 1. ESG–risk relationship.

3. Data and Methodology

3.1. Data

As our focus is on examining the Korean stock market, we sourced ESG data from the Korea Institute of Corporate (KCGS). The ESG data cover the period from 2011 to 2021. This dataset includes comprehensive ESG scores and grades, including detailed assessments of each of its three components. The ESG rating system is based on 18 primary categories and evaluated against 265 specific criteria.

Financial data pertaining to stocks, markets, and portfolio returns, alongside all control variables, were sourced from the FnGuide database. Our analysis is structured around key factors, such as firm size, value, and momentum, and encompasses various financial metrics, including firm market capitalization, book-to-market ratio, debt-to-equity ratio, and return on assets (ROA) ratio.

The dataset comprises 7834 firm-year observations from 2011 to 2022. Daily data were employed to track stock and market returns, while annual data were utilized for financial metrics, such as firm size, book-to-market ratio, debt-to-equity ratio, and ROA ratios. The risk-free rate was determined based on the monthly 90-day yield of Certificates of Deposit of the Republic of Korea (CD91).

Our study sample specifically targets firms listed on both KOSPI and KOSDAQ. The dataset comprises 7834 firm-year observations. Moreover, we used a substantial sample size to examine the relationship between ESG and risk during the COVID-19 crisis. It comprised 6163 and 1671 observations, respectively, before and during the crisis period, allowing for a robust analysis of these distinct timeframes. The pandemic crisis period has been indicated in previous studies as 2020–2021 [35]. In this study, considering that the impact of the crisis continued into 2022 [36], the duration of the crisis was considered from 2020 to 2022.

3.2. Variables

As described in Section 3.3 below, we regressed the ESG score on the risk variables with controls. This section describes how we obtained and computed the ESG score, risk variables, and control variables.

3.2.1. Scores on Environmental, Social, and Governance

The KCGS database offers scores for each ESG dimension, namely, environmental, social, and governance, for Korean firms. Evaluation of environmental factors comprises three major categories: environmental management; environmental performance; and stakeholder relationships. Moreover, the KCGS uses four major categories for the social component: employees; suppliers and competitors; consumers; and the local community. Governance components were represented by the following four categories: shareholder rights protection; board of directors; auditing bodies; and disclosure.

To comprehensively examine the ESG data, we provided descriptive statistics for both the total ESG score and each individual ESG component. Table 1 presents the mean score for total ESG and its individual components for each year from 2011 to 2021. The number of firms varied across the years. The primary purpose of calculating the change in the mean

value of the total ESG score and its components over the years was to verify that there was no significant change in these indicators during the study period. Additionally, in the Appendix A, Table A1 shows an overall trend of increasing average ESG scores and the widening range of scores over time.

Table 1. Mean value of ESG total score and its components by year.

Year	Firms	ESG	Environmental	Social	Governance
2011	317	2.23	21.99	26.36	37.14
2012	703	2.01	34.95	30.02	35.34
2013	784	2.84	40.85	34.35	34.86
2014	812	2.86	40.62	34.88	35.35
2015	768	2.76	29.02	26.29	23.12
2016	808	2.84	28.65	30.17	24.47
2017	810	2.65	26.19	22.41	27.98
2018	796	2.45	25.9	23.02	25.43
2019	796	2.61	22.9	25.44	27.51
2020	830	2.8	23.99	28.27	29.92
2021	871	3.11	27.4	30.36	34.97

3.2.2. Systematic Risk

The calculation of systematic risk in the existing literature is often based on the capital asset pricing model (CAPM). However, some studies have employed more comprehensive models, such as the Fama–French–Carhart 4-factor model or even the 5-factor model, for more precise results. Additionally, certain research endeavors have utilized more efficient methods to compute beta, such as the quintile-located conditional value-at-risk (QL-CoVar) approach, for identifying systematic risk [16].

In this study, we employed the Fama–French–Carhart four-factor model to calculate systematic risk. Fama and French's influential work highlighted a limitation of the CAPM, where market beta alone failed to fully explain excess returns [37]. To address this, they introduced size and value factors that significantly enhanced the performance of the model. Subsequently, the four-factor model was further expanded to include the momentum factor, ultimately displaying a lower pricing error than the three-factor model [38]. This improvement was also reported in other studies [39,40].

Fama and French later introduced the profitability factor (Robust Minus Weak (RMW)) and investment factor (Conservative Minus Aggressive (CMA)) as supplementary factors [41]. However, they also acknowledged certain shortcomings of the five-factor model in their research [42]. For instance, they conclude that incorporating profitability (RMW) and investment (CMA) factors into the Fama–French three-factor model provides valuable insights into various anomalies in average stock returns. Positive exposure to RMW and CMA factors helps explain the higher average returns observed in stocks with low market beta, share repurchases, and lower stock return volatility. Conversely, the negative slopes for the RMW and CMA factors account for the lower average stock returns associated with high beta, large share issuances, and highly volatile returns [43]. Considering these factors, we tested market beta using a four-factor model as a measure of systematic risk.

$$R_{i,t} - R_{f,t} = \alpha + \beta_{i,Mkt} Mkt_t + \beta_{i,HML} HML_t + \beta_{i,SMB} SMB_t + \beta_{i,UMD} UMD_t + \epsilon_{i,t} \quad (1)$$

where $R_{i,t} - R_f$ is the stock return in excess of the risk-free rate for firm i in year t; Mkt_t is the market risk premium in year t; HML_t is a risk premium factor, based on book-to-market value; SMB is a risk premium factor, based on firm size; UMD_t is a momentum-based risk premium factor.

This study used daily excess returns and independent variables (market return, book-to-market factor (High Minus Low (HML)), size factor (Small Minus Big (SMB)), and momentum factor) for the regression analysis. The daily risk-free rate was derived by converting the monthly return of CD91 to daily returns. To calculate the daily excess

returns of the companies listed on the KOSPI, the risk-free rate was subtracted from their daily returns. Excess market returns were calculated using the same method. The data for HML, SMB, and momentum were downloaded daily from DataGuide 5.0. Python 3.10.11 was used to estimate the standard deviation of the residuals resulting from the regression. The regression was performed separately for each firm and year to estimate a separate residual result for each firm and year following the approach described by [21].

3.2.3. Idiosyncratic Risk

Idiosyncratic risk is discerned from the residuals obtained by regressing asset returns on systematic factors. Once the relationship between asset returns and systematic factors (such as market returns, size, value, etc.) is estimated, the residual variability in returns reflects idiosyncratic risk. The variance or standard deviation of these residuals quantifies the level of idiosyncratic risk associated with the asset. Prior research has employed various approaches to quantify idiosyncratic risk. For instance, certain studies have computed the standard deviation of regression residuals using the Fama–French three-factor model [44], while others have utilized extended market model regressions [45] or the Fama–French–Carhart four-factor model [21]. In this study, the Fama–French–Carhart four-factor model (1) was used as detailed in previous section.

3.2.4. Total Risk

A company's total risk can be computed by summing its systematic and idiosyncratic risks. However, if we measure systematic risk using beta, which is a relative rather than an absolute metric, we cannot sum systematic risk (by relative measure) and idiosyncratic risk (by absolute measure).

Alternatively, it is commonly calculated as the standard deviation of stock returns. In this study, the standard deviation of daily stock returns was computed to estimate the total risk.

$$Risk_{i,t} = \sqrt{\frac{\sum(r_{i,t} - \overline{r_i})}{n-1}} \quad (2)$$

where $Risk_{i,t}$ is the daily total risk of firm i; $r_{i,t}$ is the daily stock return of firm i; $\overline{r_i}$ is the average stock return of firm i, and n is the number of observations.

3.2.5. Control Variables

Drawing from prior research [22,27,45–49], the following indicators serve as control variables: market capitalization of firms (Size); book-to-market ratio; debt-to-equity ratio; return-on-asset (ROA) ratio; and the age of the firm in years (Firm age).

- Size is measured as the logarithm of a firm's market capitalization at the end of each year. Annual market capitalization data were employed to create the size variable. Because of the challenge posed by large values for market capitalization, their logarithms were calculated, as in previous studies. Previous research validates the significance of firm size in influencing returns. Specifically, larger firms tend to earn lower profits. The impact of firm size on risk was included as a control variable. Moreover, firm size is a key determinant of idiosyncratic risk in the prior literature [22,27,45,46]. Moreover, a previous study demonstrates a strong inverse relationship between idiosyncratic risk and firm size [47];
- The book-to-market ratio is calculated by dividing a firm's book value of equity by its market value, which, in turn, is determined by its market capitalization. To compute book value, we subtracted total liabilities from total assets, both measured at the end of the year. This ratio signifies the market value of a company's share price. Previous studies have found that the book-to-market ratio had a significant influence on returns [50,51]. Because the book-to-market ratio reflects firm value and growth opportunities, it encapsulates firm-specific information, as indicated in the prior literature [22,45];

- The debt-to-equity ratio is the ratio of total debt to total equity measured at the end of each year. To address the outlier values, this variable was winsorized at the 5% level. Prior research emphasizes the significance of the debt-to-equity ratio in influencing a firm's risk and expected return [52]. Prior studies have employed this variable to assess companies' specific risks [22,45];
- ROA is calculated by dividing net income by total assets measured at the end of each year. The ROA variable was winsorized at 1% to handle outliers. Previous research [22,45] has acknowledged ROA as a crucial factor influencing idiosyncratic risk.

For simplicity, the firm's age variable indicates the number of months since its establishment converted to years. Previous research demonstrates that younger firms exhibit greater return volatility [49].

Table 2 presents the descriptive statistics of the variables used as dependent and independent factors, along with the control variables. For all variables, the statistical measures included the mean, standard deviation (SD), minimum (Min), median, and maximum (Max). The dataset includes 7834 observations of South Korean firms from the 2011–2022 period.

Table 2. Descriptive statistics.

	Mean	SD	Min	Median	Max
Total risk (%)	2.63	1.08	0.01	2.43	9.19
Systematic risk (β)	0.89	0.42	−1.27	0.87	2.84
Idiosyncratic risk (%)	2.49	1.09	0.02	2.28	9.48
ESG	2.64	0.96	0.25	2.55	6
Environmental	30.38	21.91	0	31.52	93.27
Social	28.4	17.19	0	24	93.33
Governance	29.54	10.03	0	28.67	77.33
Size (log)	26.44	1.57	22.44	26.18	33.93
Book-to-market ratio	1.39	1.14	0.01	1.12	15.37
Debt-to-equity ratio	0.63	0.66	0	0.41	2.42
ROA ratio	0.02	0.1	−1.45	0.02	2.52
Firm age (years)	3.65	1.6	0.33	3.83	10.41

3.3. Methodology

This study utilized the Least Square Dummy Variable (LSDV) regression model to investigate the relationship between the score for total ESG, including that for its components, and total, systematic, and idiosyncratic risks. Employing this method in panel data analysis is aimed at managing time-invariant heterogeneity, individual-specific trends, and unobservable factors, consequently enhancing the reliability and validity of the estimated coefficients. Moreover, it accounts for the impact of unobserved industry- and year-specific characteristics and helps mitigate concerns related to omitted variables [53–55]. We also included several control variables, namely, firm size, return-on-asset (ROA) ratio, debt-to-equity ratio, firm age, and book-to-market ratio, all of which may influence risk [28,33,55–58]. This study addresses the potential influence of company size as a confounding variable in analyzing the connection between ESG practices and risk reduction by categorizing companies into three size categories. By including size as a confounding factor, the analysis controls for this potential bias, ensuring that any observed relationship between ESG practices and risk reduction is not solely driven by variations in company size [56]. The regression model was designed to predict future risk, indicating its capability for assessing risk levels in the upcoming year. The regression model was structured as follows:

$$Risk_{i,t+1} = \alpha + \beta_{ESG} ESG_{i,t} + \sum CV_{i,t} + \beta_{YEAR} YEAR_{i,t} + \beta_{ind} IND_{i,t} + \epsilon_{i,t+1} \quad (3)$$

where $Risk_{i,t+1}$ refers to the total, systematic, and idiosyncratic risks for year $t+1$ and firm i; $ESG_{i,t}$ is the ESG integrated score for firm i in year t; $ENV_{i,t}$ is the environment score for firm

i in year *t*. $SOC_{i,t}$ is the social score for firm *i* in year *t*; $GOV_{i,t}$ is governance score for firm *i* in year *t*; $\sum CV_{i,t}$ is control variables. It includes the following variables: $Size_{i,t}$ is the logarithm of the market value of equity at the end of year *t* for firm *i*; $BM_{i,t}$ is the book-to-market ratio at the end of year *t* for firm *i*; $LEV_{i,t}$ is the debt-to-equity ratio at the end of year *t* for firm *i*; $ROA_{i,t}$ is the return on assets at the end of year *t* for firm *i*; and $Age_{i,t}$ is firm age in years for year *t* and firm *i*. $IND_{i,t}$ is an industry dummy variable that incorporates industry-specific categories defined by FICS Korea (FnGuide Industry Classification Standard Korea). $YEAR_{i,t}$ (year-fixed effects) is employed to account for fluctuations in economic conditions over time and specific industry effects. We consider the temporal lag to evaluate the relationship between ESG and firm risk because an organization's CSR performance does not directly affect firm risk. Therefore, we estimate the risk level at time $t + 1$ using the CSR performance recorded at the end of time t.

4. Results

This section presents the main results of this study; it analyzes the results reflecting the effects of ESG on total, systematic, and idiosyncratic risks. Table 3 summarizes the regression results, examining the relationships between the total ESG score, various financial variables as control variables, and three different types of risk measures: total; systematic; and idiosyncratic risks.

Table 3. Regression results between total ESG score and risk.

	Total Risk	Systematic Risk	Idiosyncratic Risk
ESG	−0.117 ***	−0.011 *	−0.123 ***
	−0.015	−0.006	−0.015
Size	−0.130 ***	0.027 ***	−0.153 ***
	−0.009	−0.004	−0.009
B/M ratio	−0.173 ***	−0.023 ***	−0.182 ***
	−0.011	−0.005	−0.011
ROA ratio	−1.577 ***	−0.156 ***	−1.717 ***
	−0.117	−0.049	−0.121
Firm age	−0.005	−0.007 **	−0.006
	−0.007	−0.003	−0.007
D/E ratio	0.224 ***	0.111 ***	0.226 ***
	−0.018	−0.008	−0.018
Year dummies	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes
Observations	7834	7834	7834
R^2	0.305	0.124	0.276
Adjusted R^2	0.303	0.121	0.273

Note: The figures enclosed in parentheses indicate the standard error. B/M ratio indicates book-to-market ratio. D/E ratio indicates debt-to-equity ratio. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

4.1. ESG and Total Risk Relationship

The results show a significant and negative relationship between the total ESG score and total risk (Table 3). Following a prior study [57], our findings reveal that a one standard deviation increase in the ESG score leads to a 0.112 reduction in total risk, calculated as the product of −0.117 (ESG coefficient) and 0.96 (ESG standard deviation). Economically, this reduction amounts to a 4.27% (−0.112/0.026) decrease in the total risk. These results support the hypothesis that a company's ESG performance is negatively associated with total risk. Overall, the results suggest that a higher ESG total score is associated with lower total risk in firms.

4.2. ESG and Systematic Risk

Table 3 displays the outcomes of the regression analysis that explored the connection between the total ESG score and systematic risk. This study revealed that each standard

deviation increase in the ESG score translated into a 0.011 reduction in systematic risk. Economically, this reduction corresponds to a 1.18% decrease in the average systematic risk level. From an economic perspective, this negative coefficient suggests that companies actively committed to environmental, social, and governance practices may experience reduced exposure to market fluctuations. Such companies may be better equipped to navigate economic uncertainties, adapt to regulatory changes, and withstand external shocks because of their sustainability efforts, potentially leading to more consistent financial performance. These findings confirm the hypothesis that higher Corporate Social Responsibility (CSR) performance, as indicated by ESG scores, correlates with lower systematic risk.

4.3. ESG and Idiosyncratic Risk

The estimation results show that the total ESG scores of firms in the Korean market were inversely related to their idiosyncratic risk. With all other factors being constant, an increase in one standard deviation in the ESG score results in a reduction of 0.118 (−0.123 (ESG coefficient) × 0.96 (ESG standard deviation)) in idiosyncratic risk. This reduction economically represents a 4.72% (−0.118/0.025) decrease in the average idiosyncratic risk. These findings support the hypothesis that a company's CSR performance, as measured by its ESG score, is inversely associated with idiosyncratic risk.

4.4. Robustness Analysis

To explore the relationship between ESG and total risk, systematic risk, and idiosyncratic risk from various perspectives and under different conditions, regression analysis is conducted using different models. Each model represents a different approach to controlling the potential confounding factors and addressing specific sources of variation in the data.

Tables 4 and 5 show that the relationship between ESG practices and systematic risk seems inconclusive, showing a weak and varied pattern, with the significance of the effect becoming slightly clearer only in the most detailed model. However, firm-specific factors like size, book-to-market ratio, ROA, age, and debt-to-equity ratio consistently impact systematic risk, underscoring their significance in grasping company-level risk dynamics.

Table 4. Regression results of ESG–total risk relationship.

	(1)	(2)	(3)	(4)	(5)	(6)
ESG	−0.228 ***	−0.247 ***	−0.107 ***	−0.131 ***	−0.090 ***	−0.117 ***
	(0.013)	(0.013)	(0.015)	(0.015)	(0.015)	(0.015)
Size			−0.130 ***	−0.134 ***	−0.124 ***	−0.130 ***
			(0.010)	(0.009)	(0.010)	(0.009)
Book-to-market			−0.200 ***	−0.213 ***	−0.155 ***	−0.173 ***
			(0.011)	(0.010)	(0.011)	(0.011)
ROA			−1.873 ***	−1.619 ***	−1.820 ***	−1.577 ***
			(0.128)	(0.118)	(0.127)	(0.117)
AGE			−0.015 **	−0.004	−0.017 **	−0.005
			(0.008)	(0.007)	(0.008)	(0.007)
Debt-to-equity			0.153 ***	0.186 ***	0.204 ***	0.224 ***
			(0.019)	(0.018)	(0.019)	(0.018)
Control variables	No	No	Yes	Yes	Yes	Yes
Year dummies	No	Yes	No	Yes	No	Yes
Industry dummies	No	Yes	No	No	Yes	Yes
Observations	7834	7834	7834	7834	7834	7834
R^2	0.041	0.209	0.146	0.283	0.174	0.305
Adjusted R^2	0.041	0.207	0.146	0.281	0.173	0.303

Note: Total risk is measured as standard deviation of daily stock returns of firms. The figures enclosed in parentheses indicate the standard error. B/M ratio indicates book-to-market ratio. D/E ratio indicates debt-to-equity ratio. ** $p < 0.05$; *** $p < 0.01$.

Tables 5 and 6 show that strong ESG practices consistently correlate with reduced firm-specific risk across all model variations. Adding control variables along with year and industry dummies improves model accuracy, offering a more thorough grasp of the factors affecting firm-specific risk.

Table 6 displays the regression analysis investigating the relationship between ESG total score and different levels of firm risk across six distinct models, each computed using 7834 observations. The results are presented as percentages. In the initial model, both the dependent and independent variables are regressed using a random effects model, without controlling for control variables, year, or industry fixed effects. This initial model establishes a baseline assessment of the relationship. Subsequently, the second model regresses the independent variable using fixed effects, without accounting for control variables, offering insights into the relationship while controlling for unobserved heterogeneity across entities. Moving forward, the third model incorporates random effects regression while including all control variables, yet without controlling for year and industry fixed effects, providing a nuanced examination of the relationship while considering additional factors that may influence it. In the fourth model, all variables are controlled, and fixed effects for the year are included. This controls for time-specific effects that may impact the relationship between ESG total score and total risk, allowing for a more accurate estimation of the relationship over time. Similarly, the fifth model controls all variables and includes fixed effects for the industry. Finally, the sixth model conducts regression analysis while controlling for all variables, along with fixed effects for both year and industry, offering a comprehensive analysis that accounts for various factors simultaneously.

Table 5. Regression results of ESG–systematic risk relationship.

	(1)	(2)	(3)	(4)	(5)	(6)
ESG	0.024 ***	0.017 ***	0.001	−0.009	0.000	−0.011 *
	(0.005)	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)
Size			0.019 ***	0.021 ***	0.025 ***	0.027 ***
			(0.004)	(0.004)	(0.004)	(0.004)
Book-to-market			−0.032 ***	−0.029 ***	−0.025 ***	−0.023 ***
			(0.004)	(0.004)	(0.004)	(0.005)
ROA			−0.149 ***	−0.127 **	−0.179 ***	−0.156 ***
			(0.051)	(0.051)	(0.049)	(0.049)
AGE			−0.007 **	−0.007 **	−0.008 ***	−0.007 **
			(0.003)	(0.003)	(0.003)	(0.003)
Debt-to-equity			0.110 ***	0.113 ***	0.108 ***	0.111 ***
			(0.008)	(0.008)	(0.008)	(0.008)
Control variables	No	No	Yes	Yes	Yes	Yes
Year dummies	No	Yes	No	Yes	No	Yes
Industry dummies	No	Yes	No	No	Yes	Yes
Observations	7834	7834	7834	7834	7834	7834
R^2	0.003	0.081	0.049	0.060	0.112	0.124
Adjusted R^2	0.003	0.078	0.048	0.058	0.110	0.121

Note: Systematic risk is measured as market beta of Fama–French–Carhart four-factor model for each firm. The figures enclosed in parentheses indicate the standard error. B/M ratio indicates book-to-market ratio. D/E ratio indicates debt-to-equity ratio. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Table 4 shows that ESG practices have a clear, consistent, and significant impact on reducing total risk for firms. The inclusion of control variables and year/industry dummies progressively improves the models, highlighting the importance of these factors in explaining the variation in total risk. Model (6) provides the best fit, suggesting the most comprehensive understanding of the factors influencing total risk.

Table 5 shows that the relationship between ESG practices and systematic risk seems inconclusive, showing a weak and varied pattern, with the significance of the effect becoming slightly clearer only in the most detailed model. However, firm-specific factors like size, book-to-market ratio, ROA, age, and debt-to-equity ratio consistently impact systematic risk, underscoring their significance in grasping company-level risk dynamics.

Table 6 shows that strong ESG practices consistently correlate with reduced firm-specific risk across all model variations. Adding control variables along with year and industry dummies improves model accuracy, offering a more thorough grasp of the factors affecting firm-specific risk.

Table 6. Regression results of ESG–idiosyncratic risk relationship.

	(1)	(2)	(3)	(4)	(5)	(6)
ESG	−0.251 ***	−0.276 ***	−0.106 ***	−0.138 ***	−0.088 ***	−0.123 ***
	(0.013)	(0.013)	(0.015)	(0.015)	(0.015)	(0.015)
Size			−0.157 ***	−0.155 ***	−0.154 ***	−0.153 ***
			(0.010)	(0.009)	(0.010)	(0.009)
Book-to-market			−0.219 ***	−0.225 ***	−0.174 ***	−0.182 ***
			(0.011)	(0.011)	(0.011)	(0.011)
ROA			−1.951 ***	−1.769 ***	−1.889 ***	−1.717 ***
			(0.128)	(0.122)	(0.126)	(0.121)
Age			−0.013 *	−0.005	−0.014 *	−0.006
			(0.008)	(0.007)	(0.008)	(0.007)
Debt-to-equity			0.159 ***	0.186 ***	0.209 ***	0.226 ***
			(0.019)	(0.018)	(0.019)	(0.018)
Control variables	No	No	Yes	Yes	Yes	Yes
Year dummies	No	Yes	No	Yes	No	Yes
Industry dummies	No	Yes	No	No	Yes	Yes
Observations	7834	7834	7834	7834	7834	7834
R^2	0.049	0.166	0.172	0.254	0.198	0.276
Adjusted R^2	0.049	0.164	0.171	0.252	0.196	0.273

Note: Idiosyncratic risk is measured as standardized residual of Fama–French–Carhart four-factor model for each firm. The figures enclosed in parentheses indicate the standard error. B/M ratio indicates book-to-market ratio. D/E ratio indicates debt-to-equity ratio. * $p < 0.1$; *** $p < 0.01$.

4.5. ESG Components and Firm–Risk Relationship

Table 7 displays the results of a regression analysis examining how the individual components (environmental, social, and governance) of ESG are related to various risk measures (total, systematic, and idiosyncratic risks). These findings reveal the diverse influences of different ESG components on a company's risk profile. Notably, while the environmental component exhibits a relatively modest level of significance in increasing systematic risk, environmental considerations may introduce market-related risks to some extent. However, it is important to note that with the entire focus on the total risk, this finding may not have come to light. By contrast, the social component shows no significant impact on any form of risk, while the governance component demonstrates a robust negative effect on all types of risk.

Our evidence highlights the need to divide ESG practices into individual components to understand their unique roles in influencing the various facets of risk. It also underscores the critical role of robust governance practices in effectively managing total risk.

Table 7. Regression results for individual components of ESG and risk.

		Total Risk	Systematic Risk	Idiosyncratic Risk
Environment	Coef.	−0.001	0.001 ***	−0.001
	Std. err.	(−0.001)	(0.000)	(−0.001)
	Adj. R-squared	0.297	0.121	0.276
Social	Coef.	−0.002 *	0.000	−0.001
	Std. err.	(−0.001)	(0.000)	(−0.001)
	Adj. R-squared	0.297	0.121	0.276
Governance	Coef.	−0.014 ***	−0.003 ***	−0.015 ***
	Std. err.	(−0.002)	(−0.001)	(−0.002)
	Adj. R-squared	0.305	0.123	0.276
	Control variables	Yes	Yes	Yes
	Year dummies	Yes	Yes	Yes
	Industry dummies	Yes	Yes	Yes
	Observations	7834	7834	7834

Note: * $p < 0.1$; *** $p < 0.01$. The figures enclosed in parentheses indicate the standard error.

4.6. ESG and Firm Risk Relationship in Different Sized Firms

We examined the relationships between the total ESG score and three types of risk measures (total, systematic, and idiosyncratic risks) based on three different firm sizes. Our approach relies solely on market capitalization as the basis for firm categorization. This decision is based on the belief that market capitalization is a fundamental indicator of a company's size and financial significance, making it universally recognized and applicable in financial analysis. Moreover, a prior study has found that among various firm size measures, market capitalization emerges as the most relevant proxy for enhancing the goodness of fit, particularly in areas such as firm risk, capital structure, investment, and mergers and acquisitions (M&A) [58]. By exclusively utilizing this criterion, we aimed to create a categorization system that not only aligns closely with our research objectives but also remains adaptable to changing market dynamics while remaining independent of any pre-established categorizations by the KOSPI or KOSDAQ. This customization allows us to address the specific questions and requirements of our analysis more effectively, ensuring that firm sizes are evaluated on a consistent and data-driven basis.

As observed from Table 8, when examining total risk and its components (systematic and idiosyncratic risks), it is evident that medium-sized firms exhibit the most substantial coefficients. This suggests that the role of ESG practices in mitigating firm risk is more prominent in medium-sized companies. Additionally, our analysis reveals interesting evidence: while ESG activities among large and small firms do not significantly reduce systematic risk, medium-sized firms contribute more meaningfully to decreasing this risk.

Medium-sized Korean firms have demonstrated an effective reduction in systematic risks, showcasing their capacity to seize substantial growth opportunities while maintaining systematic risk at manageable levels. This compelling narrative of medium-sized firms playing a more prominent role in mitigating systematic risk also finds support in the U.S. market, where historical performance data, exemplified by the outperformance of the S&P MidCap 400 Index, underscore their ability to manage systematic risks [59]. Additionally, when studying the implementation of environmental management by small and medium-sized firms in the Japanese market, it was determined that the latter had a competitive advantage [8]. One possible explanation for this finding could be the relative flexibility and adaptability of medium-sized companies compared to large-sized ones [60]. Middle-sized companies may have more resources and capabilities than small-sized companies [61], allowing them to invest in and implement ESG practices more comprehensively. Additionally, they may be more agile than large companies, enabling them to respond and adapt more effectively to changing market demands and regulatory requirements related to ESG.

Table 8. Results of regression on ESG total score and firm risk in differently sized firms.

		Total Risk	Systematic Risk	Idiosyncratic Risk
ESG	Small size	−0.113 ***	−0.009	−0.147 ***
	Middle size	−0.170 ***	−0.037 ***	−0.168 ***
	Large size	−0.107 ***	0.001	−0.108 ***
	Control variables	Yes	Yes	Yes
	Year dummies	Yes	Yes	Yes
	Industry dummies	Yes	Yes	Yes

Note: *** $p < 0.01$.

4.7. ESG–Risk Relationship during COVID-19 Crisis

This section examines the impact of ESG practices on risk changes during the COVID-19 pandemic. The test period was divided into two parts. The first is the pre-crisis period, which includes the years 2011–2019. The second part is the crisis period, which includes the years 2020–2022 [35,36]. Table 9 provides the regression results showing the relationships between ESG and firms' risk levels (total, systematic, and idiosyncratic risk) before and during the crisis.

Table 9. ESG–firm risk relationship during COVID-19 crisis.

	Total Risk		Systematic Risk		Idiosyncratic Risk	
	Pre-Crisis	**Crisis**	**Pre-Crisis**	**Crisis**	**Pre-Crisis**	**Crisis**
ESG score	−0.140 ***	−0.117 ***	−0.012 *	0.038 **	−0.148 ***	−0.123 ***
	(−0.017)	(−0.026)	(−0.006)	(−0.019)	(−0.017)	(−0.027)
Size	−0.108 ***	−0.131 ***	0.046 ***	0.064 ***	−0.123 ***	−0.147 ***
	−0.01	−0.022	−0.004	(−0.016)	(−0.01)	(−0.024)
B/M ratio	−0.154 ***	−0.159 ***	−0.034 ***	−0.057 ***	−0.158 ***	−0.169 ***
	(−0.012)	(−0.024)	(−0.004)	(−0.018)	(−0.012)	(−0.026)
ROA ratio	−1.699 ***	−1.813 ***	−0.293 ***	−1.142 ***	−1.715 ***	−1.857 ***
	(−0.131)	(−0.27)	(−0.048)	(−0.196)	(−0.134)	(−0.282)
Firm age	−0.004	0.001	−0.004	−0.016	−0.003	0.002
	(−0.008)	(−0.016)	(−0.003)	(−0.011)	(−0.008)	(−0.017)
D/E ratio	0.184 ***	0.065 **	0.040 ***	0.070 ***	0.184 ***	0.067 **
	(−0.014)	(−0.032)	(−0.005)	(−0.024)	(−0.015)	(−0.034)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	6163	1671	6163	1671	6163	1671
R^2	0.323	0.154	0.68	0.704	0.275	0.159
Adjusted R^2	0.321	0.146	0.678	0.701	0.272	0.151

Note: Total risk is measured as standard deviation of daily stock returns of firms. Systematic and idiosyncratic risks are measured as market betas and standardized residuals of Fama–French–Carhart four-factor model for each firm. The figures enclosed in parentheses indicate the standard error. B/M ratio indicates book-to-market ratio. D/E ratio indicates debt-to-equity ratio. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Examining the regression results regarding the relationship between ESG scores and total risk during both pre-crisis and crisis periods reveals several important findings. ESG scores consistently demonstrate a significant influence on total risk, with higher scores associated with decreased total risk, indicating the potential of ESG practices to mitigate firm risks. This relationship holds true for both pre-crisis and crisis periods, although the impact is somewhat attenuated during crises. Essentially, ESG investments continue to have a positive effect on total risk during crises, albeit with some moderation in the magnitude of the effect.

Investigating the connection between ESG scores and systematic risk during the pre-crisis and crisis periods yielded notable results. Statistical analysis demonstrated a significant relationship between ESG scores and systematic risk in both timeframes. However, the nature of this relationship varies. In pre-crisis periods, higher ESG scores correspond to lower systematic risk, as is evident from the negative coefficient estimate. By contrast, during crises, higher ESG scores align with higher systematic risk, as indicated by the positive coefficient estimate. The same results were obtained in a previous study [62]. These divergent results highlight the importance of contextual considerations and market dynamics when assessing the association between CSR investment and systematic risk. Although CSR investments contribute to risk mitigation, their effectiveness may be constrained during crises.

Regarding the examination of the relationship between ESG scores and idiosyncratic risk across pre-crisis and crisis periods, the outcomes mirror those observed in the ESG–total risk relationship. The coefficient estimates emphasize the statistically significant association between ESG scores and idiosyncratic risk for both timeframes. The negative coefficient estimates indicate that higher ESG scores correspond to reduced idiosyncratic risk. This finding implies that investments in Corporate Social Responsibility (CSR), as measured by ESG scores, can potentially reduce idiosyncratic risk.

These divergent results highlight the importance of contextual considerations and market dynamics when assessing the interplay between CSR investment and systematic risk. Although CSR investments contribute to risk mitigation, their effectiveness in crises may be constrained. The positive association between ESG and systematic risk during the COVID-19 period may result from a shift in ESG focus, with investors and stakeholders prioritizing immediate financial stability over long-term sustainability; it could also be due to changes in market sentiment that may lead to fluctuations in the perceived effectiveness of ESG practices in managing systematic risk.

5. Conclusions, Limitations, and Implications

This study is motivated by the increasing importance of corporate social responsibility in global capital markets, particularly the Korean stock market. The establishment of non-mandatory procedures for companies by the government and international organizations, researchers' observations that firm risk has received limited attention, and the impact of the COVID-19 crisis have all contributed to this study. Consequently, this study investigates the influence of ESG factors on the total, systematic, and idiosyncratic risk in the Korean stock market.

The findings reveal a paradoxical trend in the impact of ESG practices. While these practices proved to be effective in reducing total, systematic, and idiosyncratic risks before the COVID-19 crisis, they surprisingly exhibit the potential to increase systematic risk during the crisis. It is crucial to emphasize that the decrease in total risk is largely attributable to a substantial reduction in idiosyncratic risk. By contrast, the observed rise in systematic risk during the crisis goes against the usual or expected trend of risk reduction during challenging times. This study makes a unique contribution to understanding the complex connection between ESG practices and risk patterns. It emphasizes the importance of scrutinizing individual risk components, as focusing solely on the total risk could have concealed this fascinating finding.

Our study's intention to provide a comprehensive grasp of the relationship between ESG practices and risk reduction inadvertently neglected the complexities existing within specific industries. The absence of extensively exploring sector-specific setting might have resulted in overlooking valuable insights into the varying interactions of ESG practices across different sectors. To improve the robustness of future research, conducting sector-specific analyses would allow for a deeper exploration of ESG's impact. By examining sector-specific ESG performances or conducting case studies within specific sectors, researchers can gain a better understanding of ESG initiatives' effects within each industry setting. Additionally, our reliance solely on market capitalization to categorize firm sizes might oversimplify diversity within each category. To address this, future research could

incorporate supplementary metrics or alternative methodologies. This might involve integrating additional financial metrics or employee numbers or exploring more sophisticated statistical techniques to capture the multidimensionality of firms' characteristics.

Our findings have several implications. ESG factors have emerged as critical considerations for investors, governments, and company management. For investors, integrating ESG into their decision-making processes is essential, given its proven risk-mitigating benefits. Diversifying portfolios with ESG-committed firms while being mindful of the varied impacts of ESG on systematic risk can significantly enhance risk-adjusted returns. Government authorities should foster a supportive ESG environment and encourage CSR activities that contribute to economic stability during periods of financial turbulence. However, regulatory measures must remain adaptable to account for the varied influences of ESG on systematic risk and industry-specific nuances. ESG practices are indispensable for effective risk management. Integrating ESG considerations into strategic planning can bolster stability and resilience, particularly during crises such as the COVID-19 pandemic. Tailoring ESG strategies based on firm size and industry specifics is a strategic imperative to ensure that the full risk-reduction and resilience potential of ESG practices are harnessed.

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Appendix A

Descriptive Statistics of ESG Total Score by Year

Table A1 displays the variations in mean, minimum, and maximum values of ESG total scores across different years, with fluctuations observed in the number of firms evaluated during this period.

Table A1. Descriptive statistics of ESG total score by year.

Year	Firms	ESG Total Score		
		Mean	Min	Max
2011	317	2.23	1.00	5.00
2012	703	2.01	1.00	5.00
2013	784	2.84	1.60	6.00
2014	812	2.86	1.30	5.70
2015	768	2.76	1.30	5.70
2016	808	2.84	1.00	6.00
2017	810	2.65	0.25	6.35
2018	796	2.45	0.25	5.85
2019	796	2.61	0.25	5.85
2020	830	2.80	0.25	5.85
2021	871	3.11	0.25	6.00

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