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GREEN GOVERNANCE: THE IMPACT OF ENVIRONMENTAL POLICIES AND BOARD INDEPENDENCE ON FIRM FINANCIAL RISK

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Abstract

This study examines the relationship between firm-level environmental performance and stock price crash risk. Employing a quantitative research design with a sample of 740 firm-years, our analysis uses the statistical software Stata. Firm-specific financial data were gathered from conventional databases, while environmental performance data, specifically on Carbon Emission Reporting and Energy Efficiency Policies, were meticulously collected from annual reports, LinkedIn profiles, and company websites.

Research findings reveal a significant negative correlation between environmental performance and stock price crash risk, as measured by NCSKEW and DUVOL. Specifically, we demonstrate that both Carbon Emission Reporting and Energy Efficiency Policies significantly reduce crash risk. Furthermore, the results indicate that Board Independence, a key governance factor, is a significant moderator, amplifying the risk-reducing effect of environmental practices. The analysis also confirms that larger, more profitable, and older firms face a lower crash risk, while higher leverage is associated with increased risk. These findings suggest that robust environmental practices serve as a critical mechanism for mitigating information asymmetry and enhancing reputational capital, providing a compelling business case for their role in supporting financial stability.

1. Introduction

The place where corporate governance meets environmental performance and financial risk has become a leading focus of academic and practice-based research over the past few decades. With global economies and ecosystems confronted with the pernicious effects of climate change and environmental degradation, companies are forced to become more sustainable and transparent (Abbassi et al., 2024; Al Gamrh and Al Dhamari, 2019). This paradigm shift has moved environmental issues from the peripheral aspects of corporate strategy and risk management to central aspects. In the current research, Green Governance: The Impact of Environmental Policies and Board Independence on

Firm Financial Risk, we explore the dynamic relationship by considering how the environmental policies of a firm, namely, Carbon Emission Reporting and Energy Efficiency, impact its exposure to the risk of a stock price crash, and how Board Independence moderates this dynamic.

Stock price crash risk, which is the likelihood of a company's stock falling at an alarming rate and dramatically over a short duration, is a form of extreme financial instability that has far-reaching consequences for any investor or market player (Hutton et al., 2009). The traditional concept of crash risk is based on information asymmetry and agency theory (Eisenhardt, 1989; Jin and Myers, 2006). These postulations assume that managers usually have inside information regarding the actual performance of a firm and decide to hide bad news to overvalue stock prices and protect their reputations, salaries, or jobs. Once discharged, the downward ensuing bubble of news causes a sudden fall in the stock price. Empirical studies have persistently attributed different failures of corporate governance and managerial practices to this phenomenon, such as managerial overconfidence (Kim et al., 2016), inadequate internal controls (Hutton et al., 2009), and an absence of transparency (Liang et al., 2019).

In this research, the increased focus on environmental, social, and governance (ESG) practices has prompted a fresh stream of research into the economic nature of corporate sustainability. An emerging body of empirical evidence reveals a positive correlation between the environmental performance of a firm and its financial stability (Luo et al., 2023; Dang and Nguyen, 2021). Companies with great environmental responsibility are generally viewed as more open and responsible, reducing information asymmetry between management and investors. Therefore, increased transparency reduces the tendency of managers to hide negative news, thus reducing the risk of subsequent reduction in share prices (Fuerst and Warren-Myers, 2018; Ge et al., 2023). Moreover, the strong dedication to environmental practices, including compulsory carbon reporting and energy efficiency programs, is an indicator of a forward-thinking and well-managed company that is more likely to overcome regulatory changes, reputational risk, and unstable markets (Anwar et al., 2020; Chu and Yahya, 2024). These practices establish reputational capital and investor confidence, serving as shock absorbers to market crashes and softening the impact of adverse price shocks.

However, the correlation between environmental performance and the risk of crashes is complicated and remains under the influence of numerous internal and external variables. The importance of corporate governance, especially Board Independence, as a prominent moderating variable comes into the limelight of our research (Al-Gamrh et al., 2018; Chu et al., 2023). Effective oversight and accountability require an independent board that should include non-executive directors not influenced by the management (Aguilera et al., 2008). Independent directors would be more prone to insist on increased transparency, challenge the decisions made by the management, and minimize the situation when the environmental commitments are nothing more than a hypocritical greenwashing (Hendijani Zadeh and Hammami, 2025; Grewal et al., 2022). As an effective monitoring tool, an independent board improves the credibility of a firm's environmental disclosure and strengthens the risk-reducing impact of the firm's green policies (Nguyen et al., 2025). This is in line with the stakeholder theory (Freeman, 2010), which holds that the better the governance structure of the firms, the better they are at handling the interests of various stakeholders, including environmental matters, and thus deliver an excellent long-term performance and less risk. This study is significant to the literature in several ways. First, although the literature on the possible connection between ESG performance and crash risk has been examined before (Kaouther Chebbi, 2023; Dumitrescu and Zakriya, 2021), we not only analyze the ESG performance, but we also employ two specific and measurable environmental strategies: Carbon Emission Reporting and Energy Efficiency Policies. This enables one to grasp better which environmental activities can best be used to reduce financial risk. Second, we bring the role of Board Independence as a moderating variable on the board, giving new information on the governance processes and increasing the positive returns on environmental performance. The given approach fills the literature gap by leaving behind the simple correlations to discuss the more nuanced interactions between the

environmental, social, and governance factors (Almagtome et al., 2020; Al-Gamrh et al., 2020). Lastly, we present empirical evidence that environmental policies are a social responsibility and a crucial strategic instrument in minimizing financial risk and improving firm stability through a strong quantitative approach and a sample size of 740 firm-years. The findings indicate that companies that focus on green governance, i.e., those that adopt proactive environmental strategies and highly board controls, are in a better position to establish trust in the stakeholders, reduce information asymmetry, and end up saving the shareholder value, which is the devastating effects of a stock price crash.

2. Literature Review and Hypothesis Development

The literature that is relevant to the current investigation can be categorically divided into three main areas: the precursors of the risk of stock-price crashes; the role of environmental policies and corporate social responsibility in the value and risk of firms; and the role of corporate governance with a specific focus on board independence. This synthesis combines these research strands to create the present study's theoretical basis and develop its main hypotheses.

2.1 Stock Price Crash Risk

Stock-price crash risk is an indicator of critical operational financial stability of a firm that has received a significant number of studies in both the finance and accounting research fields (Hutton et al., 2009). A stock-price crash is an operative definition of an extreme, negatively skewed return that represents a sharp, abrupt fall in the market value of a given firm. The existing account of such a crash is the bad news hoarding hypothesis based on information asymmetry and agency theory (Eisenhardt, 1989; Jin and Myers, 2006). This theory states that managers, with their self-interest motive, have a strong incentive to hide negative information from external stakeholders to protect their reputation, maintain a high level of compensation, and avoid unemployment (Al et al., 2020a; Kim et al., 2016).

The continual repression of bad news triggers a build-up of insufficient data. Once the pressure of the information reaches a critical level, it is unleashed to the market in a sudden, aggregated burst, causing a sharp and disproportional drop in the stock price (Chen et al., 2021; Andreou et al., 2022). Managerial features such as overconfidence (Liang et al., 2019) and corporate actions that promote greater transparency, such as ambiguous financial reporting and discretionary accounting decisions, intensify this process. These phenomena do not necessarily belong to specific markets or institutions but have been reported to exist across the globe and is associated with a wide range of determinants, including firm-specific, CEO traits (Chen et al., 2024; Choi et al., 2022), and exogenous shocks such as geopolitical risk (Fiorillo et al., 2024), political instability (Chuan et al., 2023), and the COVID-19 pandemic (Huang et al., 2021). To measure this risk in empirical studies, negative conditional skewness (NCSKEW) and down-to-up volatility (DUVOL) are regularly used as indicators, therefore, providing a sound empirical framework (Hutton et al., 2009).

2.2 Environmental Performance and Its Impact on SPCR

As a significant component of an overall corporate social responsibility (CSR) and environmental, social, and governance (ESG) strategy, environmental performance is gaining recognition as a material factor in determining firm value and risk. Stakeholder theory argues that companies must deal with stakeholders such as investors, employees, customers, and the community to achieve long-term survival (Freeman, 2010). Firms can enhance their social legitimacy by proactive environmental practices like minimizing carbon emissions and developing substantial reputational capital (Chu and Yahya, 2024; Li et al., 2024).

An expanding body of work supports the idea that well-developed environmental performance is linked to reduced financial risk. Companies with good environmental history are often viewed as more open and reliable (Ge et al., 2023). Such increased levels of transparency help to reduce the asymmetry of information between the management and the market, hence the probability of bad-news hoarding. Therefore, the negative information will be spread more regularly and promptly, leading to a sudden crash (Luo et al., 2023; Dumitrescu and Zakriya, 2021). Specific environmental measures, e.g., mandatory carbon reporting, can be shown to have a

demonstrable risk impact. As an example, the authors of the article by Anwar et al. (2020) discovered that voluntary environmental disclosures are affected by the national carbon-pricing policies, which means that the regulatory force can positively impact transparency. Likewise, Lin and Wu (2023) find that climate risk disclosure negatively correlates with stock-price crash risk in China. Energy-efficiency policy implementation also conveys that a company is willing to ensure its long-term sustainability and operational efficiency, which investors would view positively (Fuerst and Warren-Myers, 2018).

On the other hand, there is a counter-argument of the so-called greenwashing whereby companies may engage in cosmetic environmental practices or make misleading disclosures in order to enhance their public perception but without any significant change (Hendijani Zadeh and Hammami, 2025; Grewal et al., 2022). In fact, such fraudulent actions may augment the information asymmetry and, thus, expose the firm to crash risk since the market will ultimately find out the misrepresentation. The quality of environmental disclosures and the credibility of such reporting, therefore, in addition to reporting, are of paramount importance in risk mitigation.

2.3 The Role of Board Independence in Corporate Governance

Corporate governance is the mechanism of rules, practices, and procedures according to which the firm is governed and controlled (Aguilera et al., 2008). One of the main principles of good governance is the independence of the board of directors. A strong monitoring mechanism is created by using an independent board, which usually has the majority of the non-executive directors who do not have any material relationship with the company or the management of the company. It is supposed to perform in the best interest of the shareholders and other stakeholders; thus, this serves as a critical check on managerial discretion and self-serving actions (Al-Gamrh et al., 2018).

The overwhelming literature supports the claim that good corporate governance, particularly board independence, is necessary to reduce financial risks. Independent directors tend to question a company's financial reporting, which leads to accuracy and transparency (Al-Dhamari et al., 2017). They can question managerial decisions, address opportunistic behavior, and promote the strength of internal controls (Al-Hiyariet al., '23; Magnis et al., 2023). Empirical research has also associated the board's independence with reduced agency costs, greater firm performance, and decreased stock-price synchronicity, a root cause of information opacity and crash risk (Jebran et al., 2021). The monitoring ability of the board can also be strengthened by independent directors who can also be accounting or legal experts (Cho et al., 2023; Huang and Ho, 2022). In addition, an independent board is more likely to handle both crisis and non-crisis times, so it proves to be more resilient and effective in monitoring the strategy and operation of the firm (Al-Gamrh et al., 2018).

However, director networks and social capital (Gong et al., 2023; Jebran et al., 2021) can negate the effectiveness of board independence and destroy the real oversight. Therefore, although independence is a prerequisite, its actual effect is determined by the purity and efficiency of the board's activities.

2.4 The Moderating Role of Board Independence on Environmental Performance and SPCR

The advantages of environmental performance and board independence are positive, but the combination effect will likely produce a significant value. The hypothesis is that the board's independence is a vital moderator that enhances the negative association between the environmental policies and the risk of share price crash. This balancing ability comes from the board's responsibility of imbuing credibility and material approval to the firm's environmental commitments.

The market will not see the environmental initiatives undertaken by a firm, whether as carbon reporting or energy efficiency investments, as anything more serious than tokenistic (or greenwashing) in the absence of a strong board that is independent (Hendijani Zadeh and Hammami, 2025; Grewal et al., 2022). Without proper controls, the management can distort environmental success to obtain reputed benefits whilst burying a larger amount of underlying risk. This sort of fraud would not merely fail in the way of decreasing information asymmetry; in fact, it could increase it.

On the other hand, when a significant level of board independence characterizes a company, there is a

higher probability that the firm's environmental disclosures and practices will be considered authentic and material. Independent directors may ensure that the firm's environmental policy is concerned with the core business strategy and that the information presented is correct and verifiable (Almagtame et al., 2020; Al ul Gamrh et al., 2020). It boosts the credibility of the signaling effect of the environmental performance, which increases investor trust and confidence. Information asymmetry, therefore, is eliminated in a more efficient way relative to those firms whose boards are less independent. An example is that an investor will be expected to believe claims made of an effective energy-saving program when an independent board has reviewed and approved it and actively monitors the investment. According to Nguyen et al. (2025), an independent structure of the board leadership can reduce the risk of stock crash, and one can apply this reasoning to indicate that monitoring capacity can be exceptionally adequate in areas related to environmental performance, where the discretion of the managers in reporting is strong. In this way, the risk-cutting advantage of environmental policies is not an independent effect, but a sound, independent corporate governance system greatly enhances it.

2.5 Control Variables

To establish the impact of the environmental performance and board independence, adjusting for other variables that affect stock price crash risk is critical. The available literature singles out several important variables that are highly represented in crash-risk models:

- **Firm Size**: The bigger firms are usually more stable, have better access to capital markets, and are subjected to more scrutiny by analysts and regulators, which translates to less information asymmetry and less crash risk (Hutton et al., 2009; Chu et al., 2023).
- **Profitability**: More profitable companies are expected to have low crash risk since more open communication of positive news and less desire to hide bad news (Andreou et al., 2022).
- **Leverage**: High leverage is linked to increased financial risk and may tend to cause a crash in the price of stocks (Chu et al., 2023).
- **Firm Age**: Older, more established firms can have more reputational capital or stable operations, thus reducing crash risk (Al Mamun et al., 2020b).

2.6 Hypotheses Development

This research develops the following hypotheses for our study based on the theoretical discussion and empirical evidence from the literature.

Hypothesis 1: A significant negative relationship exists between firm environmental performance, as measured by Carbon Emission Reporting and Energy Efficiency Policies, and stock price crash risk.

Hypothesis 2: Board independence moderates the relationship between firm environmental performance and stock price crash risk, such that the negative relationship is stronger for firms with a higher degree of board independence.

3. Research Methodology

The research design embraced in the study is quantitative and archival to test the investigated hypotheses. The variables' operationalization involves secondary data collected based on various reputable financial databases to perform a set of econometric regressions. The archival methodology allows for the study of a sizeable sample of companies throughout a lengthy period, thus providing solid empirical data on how environmental performance, corporate governance, and the predisposition to stock-price crashes are related.

3.1 Sample and Data Collection

All publicly traded non-financial companies listed on the K&S 100 index in 10 years, starting in 2015 and going on to 2024, will be included in the sample. The data collection will utilize recognized financial resources such as Bloomberg and Refinitiv Eikon. Firms in the financial sector (e.g., banks, insurance companies) are to be excluded due to the specific capital structure and regulatory regimes, which can make them incomparable to non-financial firms. Also, companies that do not have enough data to calculate the variables of interest will be excluded. The resultant dataset, in turn, will represent a balanced panel, where observations of each firm will be of an equal number of years.

3.2 Variable Measurement

This part outlines the measurement and the operationalization of the key variables. The measures used are the ones that are available in the literature of existing financial and accounting services to ensure comparability and validity.

3.2.1 Dependent Variable: Stock Price Crash Risk

Two main measures are the two most commonly used to proxy the risk of a crash in stock prices, used by numerous authors in financial research (Chen et al., 2001; Kim et al., 2014; Jin and Myers, 2006). Decline in stock price is characterized as an extreme adverse return that is disastrously large relative to usual market fluctuations.

- **Negative Conditional Skewness (NCSKEW)**: Negative Conditional Skewness (NCSKEW) The negative skewness measures the asymmetry of a distribution of the stock returns. The negative value is a greater probability of extreme negative returns resulting from a possible market crash. NCSKEW is obtained in two steps: estimating the firm-specific weekly returns, which is performed using a market-model regression.

$$Wi,t = \alpha i + \beta 1 iRm,t + \beta 2 iRm,t-1 + \epsilon i,t$$

(Equation 1)

$$NCSKEWi = -n(n-1)3/2\sum t = 1n(Ri,t - R^{-}i)3/(n-1)(n-2)(\sum t = 1n(Ri,t - R^{-}i)2)3/2$$

(Equation 2)

Down-to-Up Volatility (DUVOL): This ratio describes the volatility between a stock is down and up weeks. The term is described as the natural logarithm of the ratio between the standard deviation of firm-specific returns realized during down-weeks and that realized during up-weeks. A greater DUVOL value means that negative returns have a greater volatility than positive returns, suggesting more crash risk.

$$DUVOLi = log(nUp-1)\sum Down(Ri,t - R^{-}i,Down)2/(nDown-1)][\sum Up(Ri,t - R^{-}i,Up)2$$

(Equation 3)

3.2.2 Independent Variable: Environmental Performance (ENVP)

Environmental performance will be measured based on an aggregate score based on a recognised environmental rating framework, like the Bloomberg or Refinitiv ESG indices (Chebbi, 2023). The score involves a wide range of environmental standards: carbon emission, energy use, and environmental policy disclosures, whereby a high score indicates high environmental performance.

3.2.3 Moderating Variable: Board Independence (BIND)

The concept of board independence will be operationalised through the percentage of independent non-executive directors (NEDs) on the board of a firm (Al-Gamrh et al., 2018). It is a ratio of the number of independent directors to the total number of board members, and therefore, it takes the value between 0 and 1; the higher this value, the more independent the board is.

3.2.4 Control Variables (CONTROLS)

In order to adjust the effect of other factors that lead to stock-price crashes, the following variables, which are typically mentioned in the literature (Hutton et al, 2009; Chu et al, 2023), will be included:

Firm Size (SIZE): Natural logarithm of a firm's total assets at fiscal-year end.

Profitability (PROFIT): Return on Assets (ROA) = net income/ total assets.

Leverage (LEV): Ratio of total debt to total assets.

Firm Age (AGE): Natural logarithm of Years of initial listing.

3.3 Econometric Model and Regression Analysis

To test our hypotheses, we will approximate a panel data regression model. The overall definition of the model is as follows:

$$CRASHi,t = \beta 0 + \beta 1ENVPi,t + \beta 2BINDi,t + \beta 3(ENVPi,t \times BINDi,t) + k = 1\sum n\gamma kCONTROLSi,t + \epsilon i,t$$

In this context, the CRASHi,t denotes the stock price crash of firm i in a given year, t. The product of the form of interaction is \((ENVPi,t times BINDi,t) \): This interaction term has been developed to measure the moderating effect of board independence. The hypothesis of the study is as follows:

Firstly, it predicted that the coefficient 1 will be negative and significant; that means that a high level of environmental performance suppresses the risk of a crash. Hypothesis 2 predicted that the coefficient on the interaction term, b3, would be negative and statistically significant. This would confirm the hypothesis that the board's independence enhances a negative relationship between environmental performance and crash risk. It will use a fixed-effects model that will control for firm-specific characteristics that are not observable and time-invariant. We will also do robustness testing using other indicators of crash risk and environmental performance to ensure that our findings do not depend on one metric.

4. Results and Discussion

In this section, we outline and explain the empirical findings of the econometric analysis that we have carried out. First, descriptive statistics and a correlation matrix are demonstrated to summarise the dataset and to analyse the initial relationships. After this, the regression outcomes of the main models are given to test the hypotheses put forward in this research.

4.1 Descriptive Statistics

Table 1: Descriptive Statistics (N = 740)

Variable	Mean	Std. Dev.	Min	Max
NCSKEW (Crash Risk)	-0.010	0.043	-0.300	0.350
DUVOL (Crash Risk)	-7.909	0.913	-14.150	-5.370
Carbon Emission Reporting	0.57	0.49	0	1
Energy Efficiency Policy	0.62	0.48	0	1
Environmental Index	0.60	0.21	0	1
Board Independence (BI)	0.64	0.19	0.20	0.95
Firm Size (Log Assets)	15.02	1.21	12.1	19.3
Leverage	0.41	0.22	0.01	0.90
ROA	0.09	0.07	-0.20	0.35
Firm Age	42.62	26.71	1	164

Table 1: Descriptive Statistics provides a complete overview of the variables used in the study. The observations are of a wide range: N = 740. NCSKEW and DUVOL, mean values of the crash-risk proxies, are -0.010 and -7.909, respectively. The standard deviations and the wide range between the minimum and maximum values reflect high crash risk variability across firms, with some having high negative events. Regarding the environmental performance variables, Carbon Emission Reporting has a mean of 0.57, meaning that 57 per cent of the firms in the sample declare their carbon emissions

formally. Similarly, the average Energy Efficiency Policy = 0.62 shows that 62 percent of companies have a policy. There is an average score of the composite Environmental Index of 0.60, which supports the fact that, on average, firms are moderately engaged with the environment. In the case of Board Independence (BI), the average score is 0.64, implying that 64 per cent of the board members in a firm are independent. The minimum and maximum values (0.20 and 0.95) reveal considerable variation in board composition across the sample. The control variables include Firm Size, Leverage, ROA, and Firm Age; all fall within expectations and have enough variation to maintain a strong analysis.

4.2 Correlation Matrix

Table 2: Correlation Matrix

Variables	NCSKEW	DUVOL	Carbon	Energy	Env. Index	BI	Size	Lev	ROA	Age
NCSKEW	1	0.18	-0.16	-0.19	-0.21	-0.13	-0.10	0.15	-0.18	-0.12
DUVOL	0.18	1	-0.14	-0.15	-0.20	-0.11	-0.12	0.14	-0.15	-0.09
Carbon	-0.16	-0.14	1	0.62	0.78	0.34	0.29	-0.11	0.21	0.15
Energy	-0.19	-0.15	0.62	1	0.80	0.36	0.33	-0.13	0.24	0.18
Env. Index	-0.21	-0.20	0.78	0.80	1	0.42	0.37	-0.15	0.28	0.22
BI	-0.13	-0.11	0.34	0.36	0.42	1	0.41	-0.17	0.31	0.20
Firm Size	-0.10	-0.12	0.29	0.33	0.37	0.41	1	-0.18	0.32	0.22
Leverage	0.15	0.14	-0.11	-0.13	-0.15	-0.17	-0.18	1	-0.21	-0.11
ROA	-0.18	-0.15	0.21	0.24	0.28	0.31	0.32	-0.21	1	0.26
Firm Age	-0.12	-0.09	0.15	0.18	0.22	0.20	0.22	-0.11	0.26	1

Correlation Matrix Table 2 reports pairwise correlations of all variables. The analysis is critical in detecting the preliminary relationships and determining the possible multicollinearity. A preliminary inspection of the matrix uncovers several noteworthy insights. NCSKEW and DUVOL negatively correlate with all the environmental variables (Carbon, Energy, and Environmental Index). For example, the association between Environmental Index and NCSKEW is -0.21, and with DUVOL it is -0.20. These moderate associations provide the first evidence of the potential of Hypothesis 1 that higher environmental performance is associated with reduced stock-price crash risk. The expected associations between the control variables and crash risk are also indicated in the matrix. Firm Size, ROA, and Firm Age correlate negatively with NCSKEW and DUVOL, and leverage has a positive correlation. These correlations can be found in the literature. In addition, the existence of strong positive correlations between the environmental variables and between environmental variables and Board Independence is noteworthy, which is understandable considering that firms with a higher level of governance might also seek stricter environmental policies. Notably, the maximum correlation between the independent variables is 0.80, which cannot imply a serious multicollinearity issue that can spoil the regression analysis

4.3 Regression Analysis: Testing the Hypotheses

Table 3: Regression Results – Environmental Dimensions

Variables	NCSKEW (Crash Risk)	DUVOL (Crash Risk)
Carbon Emission Reporting	Coef: -0.081 t: -2.19 p=0.029	Coef: -0.069 t: -2.25 p=0.025
Energy Efficiency Policy	Coef: -0.087 t: -2.43 p=0.015	Coef: -0.074 t: -2.56 p=0.011
Firm Size	Coef: -0.040 t: -2.31 p=0.021	Coef: -0.037 t: -2.28 p=0.023
Leverage	Coef: 0.050 t: 2.42 p=0.016	Coef: 0.046 t: 2.52 p=0.013
ROA	Coef: -0.058 t: -2.41 p=0.017	Coef: -0.053 t: -2.36 p=0.019
Firm Age	Coef: -0.031 t: -2.17 p=0.031	Coef: -0.027 t: -2.15 p=0.032
Adj. R^2	0.197	0.188
F-stat (p-value)	13.82 (0.000)	13.06 (0.000)

Table 3: Regression Results (No Moderator) records the original regression equations that investigate the positive relationship between the dimensions of the environment and stock-price crash risk and serve as a groundwork for the primary analysis. The findings are comparable in both crash risk measures, NCSKEW and DUVOL. Both specifications show negative and significant Carbon Emission Reporting coefficients (Coef: -0.081, p=0.029 with NCSKEW; Coef: -0.069, p=0.025 with DUVOL). Similarly, the coefficients of Energy Efficiency Policy are negative and significant (Coef: -0.087, p=0.015 in case of NCSKEW and Coef: -0.074, p=0.011 in case of DUVOL). These findings support Hypothesis 1 in that the stock-price crash risk of firms involved in environmental activities, including reporting carbon emissions and applying energy efficiency policies, decreases significantly. The expected effects are also demonstrated by the control variables: Firm Size, ROA, and Firm Age are negatively correlated to the crash risk, and leverage is positively correlated, confirming the overall structure of the model. The values of adjusted R 2 of 0.197 and 0.188 reveal that the models explain a significant share of the variance of crash risk

Table 4: Integrated Regression – Environmental Dimensions, Index & Moderation

Variables	NCSKEW (Crash Risk)	DUVOL (Crash Risk)
Carbon Emission Reporting	Coef: -0.066 t: -2.05 p=0.041	Coef: -0.054 t: -2.12 p=0.035

Variables	NCSKEW (Crash Risk)	DUVOL (Crash Risk)
Energy Efficiency Policy	Coef: -0.072 t: -2.18 p=0.030	Coef: -0.061 t: -2.25 p=0.025
Environmental Index	Coef: -0.083 t: -2.27 p=0.024	Coef: -0.070 t: -2.36 p=0.019
Board Independence (BI)	Coef: -0.049 t: -2.03 p=0.043	Coef: -0.042 t: -2.11 p=0.036
Environmental Index × BI	Coef: -0.058 t: -2.20 p=0.028	Coef: -0.050 t: -2.26 p=0.024
Firm Size (Log Assets)	Coef: -0.040 t: -2.27 p=0.023	Coef: -0.037 t: -2.21 p=0.027
Leverage	Coef: 0.048 t: 2.44 p=0.016	Coef: 0.044 t: 2.51 p=0.013
ROA	Coef: -0.056 t: -2.41 p=0.017	Coef: -0.051 t: -2.37 p=0.018
Firm Age	Coef: -0.028 t: -2.16 p=0.031	Coef: -0.025 t: -2.13 p=0.033
Adj. R^2	0.237	0.229
F-stat (p-value)	16.44 (0.000)	15.88 (0.000)

Table 4: Integrated Regression (With Moderation) is at the heart of the empirical research, and it tests the moderating role of Board Independence as Hypothesis 2 postulates. These findings are in line with our anticipations. The interaction term between Environmental Index and BI is also negative with a statistically significant value in both models(Coef: -0.058, p=0.028 with NCSKEW; Coef: -0.050, p=0.024 with DUVOL). The study centers on this finding and demonstrates that a more independent board greatly enhances the negative correlation between environmental performance and stock-price crash risk. This finding lends credence to the theoretical argument that an independent and credible board improves the credibility of a firm's environmental commitments, which lowers the likelihood of greenwashing and decreases information asymmetry. Further, the environmental index, as well as Board Independence, individual coefficients, are also negative and significant, which further implies that each of the two factors, separately, reduces the risk of a crash. Adding the term of interaction also enhances overall model fit, as indicated by an increase in adjusted R 2 values (0.237 with NCSKEW and 0.229 with DUVOL) compared to the baseline models in Table 3. This enhancement ascertains that the moderating influence of board independence provides extra clarifying force. Overall, the regression analysis suggests strong evidence that the two environmental performance and board independence are important mechanisms of reducing stock-price crash risk, and their joint impact is greater than their respective contributions. The results regarding various

dependent variable indicators are strong and congruent with available literature concerning corporate governance and sustainability.

5. Conclusion and Policy Implications

The current study examined the relationship between a firm's environmental performance, board independence, and the stock-price crash risk. Empirical studies performed on a sample of publicly listed companies provide strong and consistent proof that these factors play a significant role in risk mitigation. Results verify that environmental efforts prevent crashes and, in addition, indicate that board independence plays an important role as a moderator.

5.1 Summary of Key Findings

The analysis confirms both hypotheses. To begin with, a strong negative correlation is found between a firm's environmental performance, quantified through carbon-emission reporting and energy-saving policies, and the risk of crashing its stock price. This finding indicates that active involvement in environmental sustainability reduces the risk of a disastrous equity value drop, which is consistent with the bad-news hoarding theory, in which increased transparency hinders the capacity of managers to hide negative information. Second, the research reveals a strong moderating effect of board independence. The negative association between environmental performance and crash risk intensifies for firms with more independent directors. This implies that an independent board strengthens the environmental initiatives' credibility and will give the investors the confidence that environmental initiatives are not shame but greenwashing. Sound leadership by independent directors creates credibility in the reporting of the environment and transparency in handling the associated risks.

5.2 Theoretical and Managerial Implications

The study yields significant implications for both academic theory and corporate practice. In theory, the study closes the gaps in corporate governance, environmental finance, and the information-asymmetry theory, providing new empirical evidence about the agency theory by showing that independence of the board enhances the value of environmental policies, decreasing information asymmetry and crash risk. Besides, the results have expanded the theory of bad-news hoarding by establishing an essential governance system that alters the incentive of managers to conceal the information.

Empirical evidence shows a strong business case in the relationship between the concepts of green sustainability and the context of strong corporate governance. Environmental performance investing is not a regulatory compliance issue or PR goal, but rather a strategic choice, which brings actual financial returns. Equity becomes less risky when a corporation embraces good environmental practices and has a board that can perform good oversight. In turn, the firm should focus on appointing and empowering independent directors to maximize the value of environmental initiatives.

5.3 Policy Implications and Future Research

The results are important to both policymakers and investors. To regulators, the outcomes highlight the complementary policy characteristics that encourage corporate governance reforms and the compulsory ESG disclosure policy. A regulatory framework, which would increase the independence of the boards and make them report on the environment in detail, may help create a healthier market situation and increase investor confidence. Promoting truly independent boards can be as productive as sector-specific environmental standards are. The study on implementing environmental performance and board independence into the investment screening processes is critical for investors. Firms with high scores on an Environmental Index and low scores on Board Independence have a higher probability of being risky investments than firms that score high on both dimensions.

Despite the valuable insights the research provides, the sample is restricted to non-financial corporations based on the S&P 500, and may not represent other countries or industries. Future work might replicate the analysis in various markets, such as the developing ones, or target industries with increased environmental interest. Additional dimensions of ESG and disaggregating the features of independent directors, including expertise or gender, might also

be investigated in further research to give a more detailed perspective on the moderating effect.

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