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Corporate Sustainability and Stock Price Crash Risk

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Abstract: Contemporary society requires enterprises to improve the ability of sustainable development, ESG as a major indicator of corporate sustainability, and the study of its impact on stock price crash risk has attracted the attention of academia and society. This paper takes Chinese A-share listed companies as the research object to empirically test the impact of corporate sustainability on stock price crash risk. It is found that good ESG performance implying satisfactory firm sustainable development can alleviate information asymmetry and principal-agent problem, thus reducing stock price crash risk. Further heterogeneity test reveals that ESG has a stronger curbing effect on stock price crash risk for firms with low CFO. The final conclusion also passed the robustness test. The findings not only provide empirical evidence for the construction of ESG system and the suppression of stock price crash risk in emerging market countries, but also have some practical significance in promoting both corporate and so-cial sustainable development.

Keywords: Corporate Sustainability, ESG, Stock Pirce Crash Risk

1. Introduction

As the core and lifeline of modern economy, the stabilization of financial market is indispensable to the operation and development of countries and even the world economy. The sharp fluctuations in the stock market especially the crash, as a major branch of the financial market, not only affect the benefits of investors and cause the financial market downturn and disorders, but also affect the business operation, which is unfavorable to the development of the real economy [1]. Therefore, the study of the influencing factors that lead to the occurrence of stock price crash of firms and the development of preventive measures has become a major concern of the scholars and the society.

Modern society requires that enterprises should not only pursue short-term rapid financial growth, but also harmonize the environment and society, improve sustainable development capability, and achieve self-survival and sustainable development. ESG, as a major indicator of corporate sustainability, has begun to attract public attention. ESG discloses corporate non-financial information about three aspects: environment, social responsibility, and corporate governance. Existing literature shows that ESG performance affects analyst forecast accuracy, corporate financial performance, information transparency and corporate risk-taking [2-4].

In the context of the above, this paper will explore whether there is an inhibitory relationship between corporate sustainability on stock price crash risk and its mechanisms. In the empirical part, this paper will select the data of Chinese A-share listed companies from 2010 to 2020 to test the role and mechanism of corporate sustainability to stock price crash risk. It further analyses whether there

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is a difference in the influence degree of corporate sustainability on stock price crash risk when firms have different CFO. Finally, the robustness of the conclusions is tested by robustness test.

In addition, at this stage, most of the studies on the causes of stock price crash risk are analyzed in terms of opaque financial statements, managerial characteristics, corporate governance mechanisms, religion, politics and social trust [5-8]. There are fewer studies dealing with the impact of corporate sustainability gauged by ESG performance on stock price crash risk and its mechanisms, so this paper may complement the findings on corporate sustainability related economic consequences and may also enrich the research related to the causes of stock price crash risk. Since this paper analyses the mechanism of stock price crash risk occurrence through firm sustainable development, the research is also of some practical meaning since when firms improve their financial performance as well as reduce their own stock price crash risk and thus try to strengthen their ability to integrate environmental and social factors, they bring positive externalities to the society, which in turn provides a virtuous cycle for social development.

2. Literature Review and Hypothesis Development

2.1. Literature Review

As a general practice, it is inevitable to focus the ESG ratings of a company in order to study its corporate sustainability. ESG is the acronym for Environmental, Social and Governance, and as the name implies, ESG measures the efficiency and effectiveness of a company's environmental protection, social responsibility, and governance mechanisms, which is non-financial information. The ESG system includes ESG ratings, ESG disclosure, and ESG investment [9], which are interrelated, especially between ESG disclosure and ESG ratings, more comprehensive and effective ESG disclosure means better ESG ratings.

ESG factors have a positive impact on corporate performance, and sound environmental ratings do not only serve as a means for companies to promote their environmental contributions thereby improving their corporate social reputation. The “E” in ESG factors also includes the market trading environment, and according to [10], if the environment becomes more unpredictable, market supply and demand, policies, and the timeliness of production & transactions will be affected, which will have uncontrollable consequences on corporate value. According to Kim and Li, (2021), the improvement of social responsibility (S) and governance mechanism (G) has a beneficial effect on corporate financial performance, as well as a dampening effect on corporate credit[11]. ESG ratings, with their concern for social welfare and long-term sustainability, can motivate companies to adopt a more conservative attitude at the risk-taking level [4] and reduce their financial risk.

Regarding the relationship between corporate sustainability and information asymmetry, according to Disclosure Theory, firm with virtuous sustainable development would motivate its non-financial information disclosure and ESG establishment, then alleviate information asymmetry to a certain extent and facilitate investors to adopt more proper investment decisions, therefore enhance analyst forecast accuracy [3][12].

As a hotspot concerned by both financial market participants and academics, there is a lot of dissection and analysis on stock price crash risk conducted by burgeoning literature. With regard to the drivers of stock price crash, the vast majority of literature follows the bad news concealment hypothesis proposed by Jin and Myers, (2006), which states that managers conceal bad news unfavorable to the company's stock price in pursuit of their own interests, and information asymmetry leads investors in the market to have an inflated estimate of the firm's value, and the company's stock price faces a crash after the bad news accumulates to a certain threshold where it can no longer be concealed[5]. Therefore, according to the bad news hoarding theory, the causes of stock price crash risk are mainly clustered into ---- agency problem and information asymmetry. Most of the literature

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on the analysis of agency problems has focused on internal control or on the governance mechanism of the company. Kim et al. (2016) found that CEO overconfidence is positively associated with the stock price crash risk, as they hold an overrating of their chosen projects, which leads them to possibly still have better expectations at the beginning of the loss[13]. They may overestimate future cash flows and fail to stop losses in time, thus making the stock price crash risk more likely. Moreover, a good corporate managerial organization plays a vital role in a company's ability to effectively disclose financial or non-financial information, and good internal controls can also better regulate and supervise company operations and improve company performance, thus reducing the stock price crash risk [14-15].

As for how to moderate information asymmetry, the research focuses more on Corporate Social Responsibility (CSR). There is a negative correlation between CSR performance and stock price crash risk because companies that are willing to take up social responsibility will spontaneously disclose more detailed and high-quality financial information [16], thus lessening information opacity and further avoiding stock price crash risk; The more information disclosure by company can also improve the accuracy of analysts' forecast, and bring diminution of forecast error for analysts based on additional information, reducing information asymmetry within the company and the majority of investors, compressing the likelihood of stock price crash in the future. At the same time, the ESG rating is an important indicator of CSR [9], and further inference can be made: superior corporate sustainability and ESG performance can also relieve information asymmetry.

As a summary, firm sustainable development requires improving both ESG system and ranking, based on the existing literature, this paper summarizes that corporate sustainability affect the stock price crash risk through ESG rating from the following perspectives.

First, ESG rating is a kind of external supervision, as it is a third-party organization that gives ratings, in order to get higher scores, firms will improve their corporate management mechanisms and internal controls, further restraining the management personnel and preventing them from withholding financial and non-financial bad news, alleviating principal-agent problem, so as to reduce the occurrence of stock price crash from the root.

Second, the level of ESG rating corresponds to the degree of effectiveness and meticulousness of ESG information disclosure; the more transparent the non-financial information disclosure to external investors, the more comprehensive the corporate information reflected in the stock price, thus narrowing the internal and external information gap, mitigating the information asymmetry, and reducing stock price crash risk to a certain extent.

2.2. Hypothesis Development

Stock price crash is defined as a stock that is left skewed in the return distribution, with a thick-tailed distribution on the right side and a greater probability of extreme losses than a normal distribution [7]. According to Hutton et al. (2009) and Kothari et al. (2009) "If managers succeed in isolating bad news from the market and the public perception, the distribution of stock returns will no longer be symmetrical", further supports that the agent problem and information asymmetry are two major contributing factors to the formation of a thick tail on the left side ---- the increased risk of stock price crash [6][17]. This paper will examine how firms can narrow the occurrence likelihood of stock price crash event by pursuing better corporate sustainability qualified by ESG ratings.

2.2.1. Principal-Agent Problem

By definition, the principal-agent problem, whereby management withholds a certain amount of bad news, is the primary trigger for the occurrence of stock price crashes. The following section will address this problem from two perspectives:

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For one thing, reduce the generation and pileup of bad news. Firstly, ESG ratings rank corporate sustainability on environmental, social and governance dimensions, serves as complementary on financial performance, transparent disclosure of non-financial information reduces the likelihood that management will keep bad news related to green, social responsibility and governance mechanisms, and mitigates principal-agent problems.

Secondly, in a society that values environmental protection and social responsibility, better corporate sustainability embodied by ESG rating means that the company has a better reputation and attracts more attention from investors, therefore, to a certain extent, the financing cost of company will get reduced in the capital market, at the same time, company's litigation risk will be shrunk as well [12].

Corporate sustainability is not only assessed in terms of financial performance, but also evaluates non-financial performance from ESG aspect. From perspective on stability of trading environment, unstable trading environment may lead to a mismatch between market supply and demand, or poor trading timeliness, both of which could result in losses [10]. For social and governance, companies that are willing to take on social responsibility and have better internal controls face fewer credit and operational risks.

Managers of companies with high ESG ratings may profit from external reputation and social influence, not just from the company's value, consequently, they are more willing to focus on long-term sustainable development, rather than increasing corporate risk-taking in the short term, which lowers the company's risk-taking level and to a certain extent curb the management's inappropriate or excessive investment [13].

In addition, China's policy support for green credit [1] has also enabled firms with high ESG ratings to broaden their financing channels, according to the social context in which this paper's research subjects are located.

In this regard, vigorous corporate sustainability can bring firms more stable operations, better internal mechanisms, and better financial risk control through ESG construction, thereby increasing firm performance and smoothing stock price volatility, lowering the financing cost while broadening financing channels, further reducing the generation and underreporting of bad news associated with broken capital chains, as well as curbing principal-agent conflicts.

For another, third-party regulation. Since the ratings are conducted by the third-party agency, to a certain extent, it regulates the disclosure of corporate sustainability related information as well as the construction of internal control of the company, and the possibility and maneuverability of the management to hide the unfavorable financial and non-financial news is reduced, thus alleviating the principal-agent problem, and further inhibiting stock price crush risk.

2.2.2. Information Asymmetry

Another major source of stock price crashes is information asymmetry. Superior corporate sustainability can help reduce information gap between internal and external by disclosing more non-financial information based on ESG construction. The underlying logic behind mitigating information asymmetry lies in the disclosure of internal information, which can help mitigate the information asymmetry of internal and external. Increasing the intensity of disclosure is also a major strategy to solving information asymmetry. When making investment decisions, investors are primarily concerned with a company's financial information, which is a decisive factor that can directly reflect a company's stock price. However, there is relatively little discussion on how ESG information provided by corporate sustainable development affects investors' investment forecasting accuracy and the mechanism of mitigating information asymmetry. In the financial market, investors can be classified into institutions and retail investors, respectively refers to large investors and small investors. Following the settings of Glebkin and Kuong (2022) and Edmans et al. (2022), large

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investors have more systematic theories of finance and investment, as well as more sources of information. In addition, non-financial information conveyed by ESG performance can supplement their valuation accuracy as additional information input [18-19]. They can and are willing to focus on both financial and ESG payoff. In contrast, small investors tend to focus more on financial information such as the financial reports. The empirical results of Moss et al. (2022) also indicate that small investors' investment decisions are insensitive to ESG disclosures, which means that they focus more on the company's financial payoff [20]. In markets with asymmetric information and imperfect competition, large investors tend to focus on and incorporate more comprehensive and accurate information than small investors in their valuation, such as a company's sustainable development information. For small investors who only care about financial payoff, ESG disclosure is more like noise compared to financial information provided by the company's financial reports. The higher the precision of non-financial information disclosure and the validity of ESG ratings, the more effective financial information small investors can obtain from prices, which increases price efficiency and reduces the uncertainty faced by small investors [21]. This, in turn, enhances the effectiveness of asset allocation and investment decisions, and clarifies companies' operating and financial performance. Therefore, vigorous corporate sustainability not only reduce the information asymmetry between the internal (company) and external (market), but also reduce the information asymmetry between large investors (e.g., institution) and small investors (e.g., retail investors).

Moreover, ESG ratings are generally issued by third-party organizations that serve as regulators to some extent. To pursue higher ESG score from these third-party organizations, companies will strive to meet their various sustainability requirements and achieve more comprehensive and effective ESG information disclosure, thereby reducing information asymmetry. However, companies may excessively pursue high corporate sustainability appraisal from third-party organizations, resulting in unreasonable increases in implementation costs and compliance costs, which may affect the company's profit-ability (lead to a mismatch between the actual profitability and ESG score), thereby exacerbating information asymmetry and increasing the stock price crash risk. To sum up, virtuous corporate sustainability can reduce the stock price crash risk by reducing internal and external information asymmetry.

In summary, to examine whether corporate sustainability can moderate stock price crash risk by mitigating principal-agent problems and information asymmetry through ESG system, the following hypothesis is proposed in this paper:

Hypothesis: Corporate sustainability ratings have a positive impact on the reduction of stock price crash risk.

3. Sample and Research Design

3.1. Sample an Data

This paper conducted research on China's A-share listed companies from 2010 to 2020, in which ESG data was obtained from the Wind database, and the rest of the data was obtained from the China Stock Market and Account Research (CSMAR) database. For the consideration of accuracy and scientificity of the study, this paper will eliminate: (1) companies in the financial industry; (2) companies that will be delisted (ST, PT firms). This paper winsorized the data at the top and bottom 1% levels to eliminate the effects of outlier extremes. The sample interval is chosen from 2010 because the ESG ratings of listed companies in the database are generated since 2010, and the latest data ends in 2020.

3.2. Dependent Variable

Summarizing the existing literature, following Jin and Myers (2006), Hutton et al. (2009), Kim et al. (2011), Jin and Wu (2022), and Sheng et al. (2023), this paper uses two indicators to measure stock

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price crash risk, Negative coefficient of skewness of firm-specific weekly returns (NCSKEW) and down-to-up volatility of firm-specific weekly returns (DUVOL) [5-6][22-24]. First regress the weekly return on stock i:

$$R_{i,t} = \alpha_0 + \alpha_1 R_{m,t-2} + \alpha_2 R_{m,t-1} + \alpha_3 R_{m,t} + \alpha_4 R_{m,t+1} + \alpha_5 R_{m,t+2} + \varepsilon_{i,t} \quad (1)$$

The section text must be set to 12-point, justified and linespace single. Where $R_{i,t}$ refers to the return of stock i in week t, and $R_{m,t}$ refers to the average return of market m (all stocks) weighted by the traded market value in week t. $\varepsilon_{i,t}$, on the other hand, is the residual term of the regression (1), which represents the portion of return on stock i that cannot be explained by the market return, and which can be interpreted as a manifestation of the idiosyncratic nature of stock i.

A market-adjusted weekly idiosyncratic return is then obtained by taking the natural logarithm on the residual term $\varepsilon_{i,t}$, denoted as WRET.

$$WRET_{i,t} = ln\left(1 + \varepsilon_{i,t}\right) \quad (2)$$

The proxies of stock price crash risk are then constructed on the basis of WRET:

$$NCSKEW_{i,t} = -\frac{n(n-1)^{\frac{3}{2}} \sum WRET_{i,t}^3}{(n-1)(n-2)(\sum WRET_{i,t}^2)^{\frac{3}{2}}} \quad (3)$$

Where n represents the number of trading weeks of firm stock i, the cubic of $WRET_{i,t}$ divided by the cubic of the variance of $WRET_{i,t}$ represents the degree of deviation, and the minus sign denotes the coefficient of negative return skewness. The larger the indicator, the higher the stock price crash risk.

$$DUVOL_{i,t} = ln\frac{(n_u-1)\sum_{down} WRET_{i,t}^2}{(n_d-1)\sum_{up} WRET_{i,t}^2} \quad (4)$$

Where n_u and n_d denote the number of weeks in a year when the weekly idiosyncratic return of stock i is higher and lower than the annual average return, respectively. Define the weeks in which $WRET_{i,t}$ is greater than the average annual return as up weeks and vice versa as down weeks, and calculate the standard deviation of the WRET of the down weeks and the up weeks to obtain the down volatility and the up volatility, respectively. Finally, the downside volatility is divided by the upside volatility and the natural logarithm is taken. The larger the indicator, the more volatile the stock price and the greater the stock price crash risk.

3.3. Independent Variable

The heading of a section title must be 12-point bold, aligned to the left with a linespace single and an additional spacing of 10-point before and 10-point after. The initial letters should be capitalized. ESG rating ($ESG_{i,t}$), as a measure of firm sustainable development ability, is used as the main independent variable in this paper to study stock price crash risk. However, since the CSI ESG ratings are categorized by letter grades, this paper will refer to the methodology of Feng et al. (2022) and Sheng et al. (2023) to assign values to them [24-25]. The CSI ESG ratings are divided into nine grades, namely C, CC, CCC, B, BB, BBB, A, AA, AAA, and the assignment rules are from 1 to 9 from the lowest to the highest ratings (e.g., when the ESG rating is C, it is assigned as 1, and CC is 2, and so on, and so forth, and up to AAA, it is 9).

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3.4. Control Variable

Referring to the existing literature [1][12][23], the control variables selected in this paper are as follows: Firm size (Size), the natural logarithm of the total assets, usually the larger the firm size, the more stable the internal structure is, the more financing channels are available, and the stock price crash risk should be lower; Cash flow operating (CFO), this paper uses the ratio of operating activities cash flow to total assets as a measure of cash flow, which indicates the cash flow that can be obtained from each unit of assets, the more cash flow that can be generated by the enterprise assets, the stronger the ability to resist liquidity risk, thus reducing the stock price crash risk; Leverage (Lev), the ratio of the total liabilities to the total assets, usually the higher the leverage is, indicating that the creditors or investors are optimistic about the future development of the firm and the stock price crash risk is lower; The independent directors proportion (Indep), which is the ratio of the number of independent directors to the total number of directors; Board size (Board), which is the natural logarithm of directors number.

In addition, we introduce the year fixed effect to control for macroeconomic and other influences that do not vary with individuals at the time level, and incorporate the industry fixed effect to control for the unique characteristics of each industry or differences between industries in order to more accurately measure the impact of corporate sustainable development on stock price crash risk.

3.5. Sample Empirical Model

Displayed equations are centered and set on a separate line. Based on the above analysis, this paper develops the following model to test the impact of corporate sustainable development on stock price crash risk:

$$Crash_{i,t+1} = \beta_0 + \beta_1 ESG_{i,t} + \beta_2 Size_{i,t} + \beta_3 Lev_{i,t} + \beta_4 CFO_{i,t} + \beta_5 B_{Size\,i,t}$$

$$+\beta_6 B\_Independence_{i,t} + industry\ fixed\ effect + year\ fixed\ effect + \varepsilon_{i,t} \quad (5)$$

Table 1: Variable definitions.

Variable	Descriptions
NCSKEW	Indicator of stock price crash risk, as calculated in equation 3
DUVOL	Indicator of stock price crash risk, as calculated in equation 3
ESG	Indicator measuring the corporate sustainability, which is assigned values of '1-9' according to the CSI ESG system from low to high respectively
Size	Natural logarithm of total assets
CFO	Operating activities cash flow / Total assets
Lev	Total liabilities / Total assets
Indep	The number of independent directors / the total number of directors
Borad	Natural logarithm of the number of directors

4. Empirical Results

4.1. Descriptive Statistics

The overall situation of the sample was first analyzed, and Table 2 shows the descriptive statistics for the main variables of this paper.

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Table 2: Descriptibe statistics.

Variable	N	Mean	SD	P25	P50	P75
NCSKEW	31162	-0.417	0.742	-0.817	-0.377	0.026
DUVOL	31162	-0.294	0.485	-0.615	-0.297	0.019
ESG	31162	6.473	1.129	6	6	7
Size	31162	22.196	1.436	21.195	21.975	22.932
CFO	31162	0.044	0.074	0.005	0.044	0.087
Lev	31162	0.445	0.22	0.27	0.435	0.605
Indep	31162	0.38	0.071	0.333	0.364	0.429
Board	31162	2.292	0.257	2.197	2.303	2.485

As the table shows, the total sample size is 31,162 Chinese A-share listed companies. In terms of stock price crash risk indicators, the mean value of NCSKEW is -0.417 and the standard deviation is 0.742, with -0.817, -0.377 and 0.026 at the 25%, 50% and 70% quantiles, respectively, which implies that there is a large difference among the sample when the stock price crash risk is measured by the NCSKEW indicator; DUVOL has a mean and standard deviation of -0.294 and 0.485, and -0.615, -0.297, and 0.019 at the 25%, 50%, and 70% quantile, respectively, which reduces the variation among the sample firms when compared to NCSKEW. From the perspective of main explanatory variable ESG, its mean is 6.473, standard deviation is 1.129, and it is 6, 6, and 7 at the 25%, 50%, and 70% quantile points, respectively, and based on the mean and quantile point data, most of the sample firms are located in the 'BBB' - 'A ', and the standard deviation illustrates the large differences in ratings between firms. Among the control variables, there is one variable with a large inter-sample difference (standard deviation >1) is Size, whose mean is 22.196; the rest of the variables with standard deviations of under 0.3 are CFO, Lev, Indep, and Board, whose means are 0.044, 0.445, 0.38, and 2.292, respectively.

4.2. Baseline Regression

In this paper, the NCSKEW indicator is used as an explained variable in the baseline model, and Table 3 shows the regression results of the impact of corporate sustainability on stock price crash risk (measured by the NCSKEW indicator).

Table 3: Baseline regression.

	(1)	(2)
	NCSKEW	NCSKEW
ESG	-0.020***	-0.025***
	(-5.21)	(-6.12)
Size		0.011***
		(2.65)
Lev		-0.047**
		(-1.99)
CFO		0.143**
		(2.41)
Indep		0.051
		(0.86)
Board		0.008
		(0.48)

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Table 3: (continued).

Constant	-0.287***	-0.512***
	(-11.39)	(-6.03)
Industry FE	YES	YES
Year FE	YES	YES
N	31162	31162
R2	0.034	0.035

Column (1) in Table 3 shows the regression results without adding control variables, the coefficient of ESG is -0.020, which is significant at the 1%, indicating that ESG is negatively correlated with stock price crash risk, further meaning that good ESG performance suppresses stock price crash risk. Column (2) shows the regression results after adding the control variables, the coefficient of ESG is -0.025, still significant and negative at 1%, and the negative correlation between ESG ratings and stock price crash is still valid, meaning that if a company's ESG rating is increased by every 1 level, the resulting NCSKEW decreases by 0.025; and since its coefficient is increased by 0.005 in absolute value, albeit subtly, the addition of the control variables increases the strength of ESG's explanation of stock price crash risk. Therefore, as far as the regression results are concerned, the effect of corporate sustainability on stock price crash risk is significantly negative, thus supporting the hypothesis of this paper.

The regression results for some of the control variables in Table 3 are different from those presented in section 3, which are attempted to be explained here: first, the regression coefficient of firm size (Size) on the NCSKEW indicator is 0.011 and significant at the 1%. This suggests that firm size is significantly and positively related to stock price crash risk, probably because larger firms are themselves at a higher stock price and, according to the literature of Chen et al. (2001) and Murata and Hamori (2021), smaller firms have more scope to manipulate the timing of disclosure, while larger firms, due to more sophisticated mechanisms and market interest higher, are more likely to reach the threshold for bad news [26-27]. Secondly, cash flow (CFO) is positively correlated with stock price crash risk, which may be related to the imperfect development of China's capital market at this stage, as well as the serious phenomenon of retail investors' blind obedience [1], and firms with high CFO will be favored by more investors, which will lead to a bubble in the stock price, which is prone to crash when rationality returns.

4.3. Heterogeneity Analysis

The CFO indicator of firms represents the ability of the unit assets to generate cash flow, which is a reflection of the level of asset management of listed companies. Firstly, the sample is divided into high CFO enterprises and low CFO enterprises according to the median of CFO in the whole sample data, and regress the sub-samples separately to verify whether there is any discrepancy in the impact of Corporate Sustainability on stock price crash risk of listed companies with different cash CFO. The specific regression results are shown in Table 4: the ESG coefficient of the low CFO group is -0.037 and significant at 1%, while the ESG coefficient of the high CFO group is -0.012 and significant at 5%; the coefficient of the low group is over 3 times as large as that of the high group and at a stronger significance level, so there is a significant difference between the two subsamples.

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Table 4: The heterogeneous effects of CFO.

	(1)	(2)
	NCSKEW	NCSKEW
	Low CFO	High CFO
ESG	-0.037***	-0.012**
	(-6.17)	(-2.16)
Size	0.004	0.020***
	-0.77	-3.59
Lev	-0.016	-0.088**
	(-0.49)	(-2.55)
CFO	-0.304**	0.494***
	(-2.45)	-3.99
Indep	0.074	0.033
	-0.86	-0.4
Board	0.058**	-0.043*
	-2.33	(-1.79)
Constant	-0.440***	-0.699***
	(-3.54)	(-5.84)
Industry FE	YES	YES
Year FE	YES	YES
N	15535	15626
R^2	0.033	0.041

From the statistical results, it can be seen that the sustainability of listed companies has a more significant negative effect on low CFO firms compared to high CFO firms. This may be due to the fact that low cash flow firms receive less cash flow per unit of assets compared to high cash flow firms, so when the company has operational difficulties or debt crisis, its asset liquidity and debt servicing ability are low, and the company is more likely to incur unfavorable news, and at the same time, in order to avoid credit and default risk, the management will be more inclined to hide the bad news from the external market. While favorable ESG performance can restrain the concealment and pileup of bad news through better internal control and management mechanisms, it prevents the stock price of low CFO firms from being inflated and thus leading to stock price crash, thus validating the hypothesis presented in this paper.

4.4. Robustness Test

Based on Lin and Li, (2021) and Bae et al, (2021), this paper substitutes variable to test the robustness of the baseline model [28-29]. The indicator of the explained variable, NCSKEW, in the baseline model is replaced with DUVOL, which is another indicator measured stock price crash risk. Table 5 shows the regression results of the robustness test. As shown in Table 5, after replacing the measure of the dependent variable, the coefficient of ESG remains significantly negative at the 1% level, which verifies that the hypothesis is valid and indicates the robustness of the result.

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Table 5: Robustness test.

	(1)	(2)
	DUVOL	DUVOL
ESG	-0.012***	-0.014***
	(-4.60)	(-5.07)
Size		0.004
		(1.39)
Lev		-0.034**
		(-2.23)
CFO		0.085**
		(2.19)
Indep		0.033
		(0.86)
Board		0.010
		(0.92)
Constant	-0.220***	-0.311***
	(-13.39)	(-5.62)
Industry FE	YES	YES
Year FE	YES	YES
N	31162	31162
R2	0.039	0.040

5. Conclusion

This paper conducts an empirical study on how corporate sustainability affects stock price crash risk using a sample of Chinese A-share listed companies from 2010 to 2020. It is found that sound corporate sustainability implying good ESG performance enhance information disclosure and improve corporate management and internal control mechanisms, thus mitigating principal-agent problem and information asymmetry, and thus suppressing stock price crash risk. Secondly, further research finds that there is a heterogeneous effect of corporate sustainability on stock price crash risk when the CFO level of firms is inconsistent, which is manifested in the fact that the lower the CFO is, the more pronounced is the inhibiting effect of corporate sustainability on stock price crash risk. Finally, after the robustness test of replacing the explained variable, the result of this paper remains robust.

A major measure of corporate sustainability is ESG rating. This paper sheds light on how to reduce stock price crash risk by improving ability of corporate sustainable development: (1) From the perspective of external regulation and investors, third-party rating agencies should continuously update and improve the quantitative model of the ESG system so as to make ESG ratings more comprehensive and effective in disclosing information, and at the same time, more impartially score each enterprise; investors should also pay more attention to and make use of ESG information, especially small investors such as retail investors, and learn to find and evaluate non-financial information disclosed by enterprises and incorporate it into their investment decisions; improving the quality and ability of obtaining information in the external market is essential for narrowing the information gap and reducing stock price crash risk. (2) From the internal perspective, firms should establish and improve their own management and internal control mechanisms, restrain management from concealing bad news, improve their own sustainable development capability, and disclose green financial information such as ESG, which can simultaneously alleviate the principal-agent problem

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and information asymmetry, and thus stabilize the stock price. Since this paper only adopts the data of Chinese A-share listed companies, which can only be used as the basis for practicing ESG system in emerging market countries, this paper has certain limitations, and cross-country data can be used to conduct further in-depth research on developed markets or the differences between mature markets and emerging markets in future studies.

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