A Trigger for Institutional Herding and Investor Sentiment

The Effect of ESG Disclosure on the Stock Price Crash Risk in the Chinese A-Share Market

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ABSTRACT

We excerpted the stock prices of listed companies on the Shanghai and Shenzhen SE from 2012 to 2022 as the sample, designing a quasi-natural experiment based on the ESG rating announcement event of listed companies by Syntao Green Finance. Employing a multi-period difference-in-differences (DID) model, this paper investigates the impact of the ESG rating disclosure, as an exogenous event, on the stock price crash risk which is measured by NC-skewness, further revealing the underlying mechanism and causal relationship between ESG rating disclosure and stock price crash risk. Unexpectedly indicated by the study results, the announcement of ESG ratings by third-party agency significantly heightens the risk of stock price crashes. This increase is primarily due to the amplification of the herding effect among institutional investors and the heightened sentiments instability among retail investors. Following these findings, we performed a heterogeneity analysis focusing on market conditions and the quality of information disclosures by target companies. It was observed that the influence of ESG on the risk of stock price crashes is especially pronounced for targets with high standards of information transparency and for all entities under bull market conditions.

Keywords: *Investor behaviour; ESG rating, Stock price crash risk; Event study; DID model*

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I Introduction

1.1 Research Background

In recent years, the Chinese A-share market has frequently witnessed instances of dramatic drops in individual stock prices. Notably, around 2015, the A-share main board market encountered an unparalleled crisis, colloquially termed as the "Stock Market Turndown," where an extensive number of stocks reached their lower trading limits, profoundly undermining financial market stability. The global economic downturn triggered by the COVID-19 pandemic in 2019 led to volatile stock market conditions, characterized by sharp rises and falls, which in turn exacerbated the financial system's fragility. Against this backdrop, investors have increasingly prioritized the sustainable development of target companies. The concept of ESG (Environmental, Social, and Governance) investing has thus attracted considerable attention in China. Concurrently, the China Securities Regulatory Commission (CSRC) and the Shenzhen Stock Exchange (Shenzhen SE) have spearheaded initiatives to enhance the disclosure of ESG information, urging listed companies to embrace social responsibilities and attach importance on sustainable developments.

To achieve the sustainable development and high-quality economic growth requires an orderly stock price. Encouraging corporations to reveal accurate value information, enhancing the efficiency with which investors access information, minimizing the influence of retail investor sentiment, and fostering a synergistic feedback loop between market entities and the real economy are pivotal to maintain the stability of stock markets. Besides, these measures are essential for injecting new, robust, and stable vitality into the real economy.

Considering the lack of consensus in existing research and the specifics of institutional investors in China's securities market, this study investigates whether the ESG performance of listed companies can account for the risk of stock price crashes. To better measure the sustainable performance of different companies, we employed the ESG ratings published by Syntao Green Finance, which is one of the local third-party ESG & Credit rating agencies.

	ESG Issues	Examples of core ESG indicators	Examples of sector-specific ESG indicators	
			Mining	Agriculture, Forestry and Fishery
Environmental	E1 Environmental policy	Environmental management systems, objectives, energy and water savings policies, green procurement policies, etc.	Mining area recovery, etc.	Sustainable agriculture (fisheries), etc.
	E2 Energy & Resource Consumption	Energy consumption, energy saving, water saving, energy use monitoring, etc.	-	-
	E3 Pollutant Discharge	Sewage discharge, exhaust gas discharge, solid waste discharge, etc.	Integrated waste utilisation rate, etc.	Pollutant Emission Monitoring, etc.
	E4 Climate Actions	Greenhouse gas emissions, carbon intensity, climate change management system, etc.	-	-
	E5 Biodiversity	Biodiversity conservation targets and measures, etc.	Ecological restoration measures, etc.	Use of Threatened and Endangered Animals, etc.
Social	S1 Human Capital Development	Employee development, health and safety, employee rights, etc.	Occupational health and safety management systems, etc.	Occupational health and safety management systems etc.
	S2 Supply Chain Management	Supply chain responsibility management, supply chain monitoring system, etc.	-	-
	S3 Customer Rights	Customer relationship, customer information confidentiality, etc.	-	Sustainable consumption, etc.
	S4 Product Management	Quality management system certification, product/service quality management, etc.	-	-
	S5 Data Security	Data security management policies, etc.	-	-
	S6 Community	Community communication, community health and safety, donations, etc.	Community communication, etc.	Community communication, etc.
Governance	G1 Business Ethics	Information disclosure, board independence, executive compensation, audit independence, etc.	-	-
	G2 Governance Structure	Anti-corruption and bribery, whistleblowing systems, tax transparency	-	-
	G3 Compliance	Compliance management, risk management, etc.	-	-

Fig. 1. Example of SynTao Green Finance ESG Indicator System

1.2 Methodology Overview

Through employing a multi-period DID model, this paper concludes that ESG rating disclosures will lead to possible increase of stock price crash risks, a surprising finding given the generally positive view of transparency's impact on market stability. We excerpted data of listed companies on the Shanghai and Shenzhen stock exchanges over ten years, demonstrates that this increased risk is particularly pronounced in underliers with high-quality information disclosures and ESG practices. The mechanisms driving this relationship include exacerbated herding behavior among institutional investors and heightened negative sentiment among retail investors. Institutional investors tend to co-move based on ESG ratings, creating potential for significant market corrections. Simultaneously, individual investors may react emotionally to ESG disclosures, especially if the news is unexpectedly negative, further destabilizing stock prices. Simultaneously, high-quality disclosures are scrutinized more closely by both institutional and retail investors, and any negative revelations can prompt swift and volatile market reactions, leading to increased price crash risks.

This analysis incorporates the prevalent herding behavior in the Chinese security market and individual investor sentiments as mediating variables. By exploring the influence of ESG rating disclosure both on the institutional shareholding clustering and the individual investing sentiment instability, this study further examines their correlation with stock price crash risks based on the heterogeneous information disclosure qualities and across varying market natures.

1.3 Purpose and Contributions

This paper contributes in several unique ways: First, it diverges from most research by assessing the impact of ESG on stock price crash risks from the perspective of non-financial performance, offering a novel approach to mitigate such risks and providing insights for enhancing corporate ESG disclosure practices. Second, it introduces the holding preferences of institutional investors and the herding behavior in the securities market as mediating variables. This approach examines their responses to corporate ESG disclosures and their effects on stock price volatility, thereby elucidating the transmission

mechanisms between ESG factors and stock price movements. This provides direct evidence for investors aiming to reduce stock price crash risks, encourages a focus on ESG factors, and emphasizes the importance of institutional investor behaviors while seeking to minimize the clustering of retail investors and eradicate behavioral financial biases, thus improving the scientific rigor and rationality of investment decisions. Third, after robustness tests and addressing endogeneity concerns, the results remain significant. Considering industry-specific variations, this study further incorporates a heterogeneous analysis to probe the diverse emotional responses of investors under different ESG performances and market conditions of bull and bear phases, aiming to precisely decode the causal relationships and mechanisms linking ESG and stock price crash risks.

1.4 Scope and Delimitations

This study primarily focuses on the negative skewness of stock prices to assess crash risk. Future research could expand to include other dimensions of crash risk such as the probability and magnitude of potential losses. Our analysis of the mechanisms behind ESG disclosure effects is constrained by the availability of data to only two mediating variables: institutional investors' herd behavior and individual investors' sentiment. Further investigation into additional factors, such as analyst expectations and information asymmetry, is warranted. Additionally, as the ESG investment philosophy matures and market conditions evolve, the influence of ESG disclosures on crash risk might change, presenting a crucial area for future research. Besides, further studies could integrate the spectrum of ESG ratings of target companies into the model, enabling subsequent heterogeneity analyses or investigating whether various ESG ratings have different impacts on the stock price crash risk of individual stock.

1.5 Thesis Structure

The following parts are organized as follows: Chapter Two provides an outline of theoretical analysis and formulates research hypotheses. Chapter Three details the methodology design and explains the variables used. Chapter Four conducts empirical tests and analyzes the results, including the further analysis of heterogeneity. Chapter Five

concludes with a discussion of the findings and offers policy recommendations.

II Theoretical Analysis and Research Hypotheses

2.1 Stock Price Crash Risk

Stocks serve as investment tools within the capital market. Fluctuations in stock prices represent a critical indicator of risk and efficiency in this market (Li and Wang, 2023). Such fluctuations are influenced by changes in the macroeconomic environment, political risks, corporate performance, and interest rates. When manageable, moderate fluctuations can create opportunities within the market. Conversely, the occurrence of abrupt and significant drops in market indices or individual stock prices without prior indicators—known as "stock price crashes" (Pei et al., 2021)—pose significant challenges. The capital market plays a vital role in enabling corporations and investors to manage resources and risks effectively. It also acts as a platform for asset appreciation. The transparent, equitable, and secure functioning of this market is crucial for boosting the real economy's prosperity and safeguarding national economic security. Iterative crises in stock prices, which lead to systemic financial risks, impede the development of a stable and effective capital market infrastructure, thus diminishing its overall efficacy.

The Chinese stock market predominantly features retail investors who are speculative and lack rationality (Xu and Zhu, 2023). There exists a pronounced trend of simultaneous price movements among listed companies' stocks, commonly referred to as "Co-movement" (Morck et al., 2023). This trend, coupled with high-quality economic growth, leads to the gradual accumulation of risks and financial vulnerabilities. Given the confluence of multiple factors, the unsustainable nature of the bubbles generated by erratic stock price fluctuations heightens the likelihood of market crashes. Against this backdrop, exploring strategies to prevent and alleviate the risk of stock price crashes is of critical practical relevance. In contrast to the predominantly irrational retail investors, institutional investors are significantly more adept at refining and augmenting the mechanisms and efficiency with which traditional savings are converted into direct financial instruments. Their deepened understanding of market trajectories makes their investment behaviors crucial benchmarks in the securities market. The shareholding by institutional investors not only signifies their assessments of enterprise value but also influences the trends in stock

prices as well as encourages market participants towards value and long-term investments.

By the close of 2023, the average number of institutional shareholders in companies listed on China's A-share market was approximately 145, with the market value of these holdings reaching about 22.8 trillion yuan. Institutional investors have emerged as pivotal contributors to the advancement of the domestic capital market. The role of institutional holdings—whether they act as a stabilizing force providing positive feedback, or as a destabilizing one offering negative feedback—remains a subject of ongoing debate within the scholarly community.

2.2 ESG

The ESG (Environmental, Social, and Governance) rating system evaluates companies' capabilities for sustainable operations through three aspects: environmental, social, and corporate governance, serving as a critical support in achieving goals of "carbon peak" and "carbon neutrality." Introduced by the United Nations Global Compact in 2004, the ESG investment philosophy has gained prominence, fueled by the organization's efforts. As regulatory scrutiny over the environmental and social responsibilities of China's listed companies intensifies, investor attention to their ESG ratings and management has similarly increased. This progression was marked by the incorporation of ESG disclosure guidelines in the "Listed Company Governance Guidelines" of 2018, followed by the "China ESG Development White Paper" in 2020, signifying ESG's robust growth within China. Moreover, numerous Chinese third-party rating agencies such as Syntao Green Finance, China Alliance of Social Value Investment (CASVI), and Sino-Securities Index Information Service are increasingly involved in ESG rating assessment and formulation.

Data from the Research Institute of Capital Market indicate that in 2023, approximately 42% of A-share listed companies issued ESG reports. Among these, 78.9% of the CSI 300 enterprises published independent ESG reports or CSR reports. Corporate ESG disclosures significantly affect stock prices. With the continuous refinement of China's ESG disclosure regulations, the quality of such disclosures is improving, thereby increasingly mitigating the risk of stock price crashes. Nevertheless, research in China's ESG domain began relatively late, with existing studies primarily focusing on the effects of corporate ESG performance on financing costs (Qiu and Yin, 2019), the correlation

between ESG and corporate performance (Gao, Chu, Lian and Zheng, 2021), and the influence of ESG performance on investment efficiency (Wang and Lian, 2022). Literature examining the connection between ESG disclosure, and the risk of stock price crashes is notably limited, with scant exploration into the underlying mechanisms affecting stock price crash risks.

Currently, the issue of global climate change has captured global attention, prompting an increasing number of investors to allocate funds to initiatives focused on environmental protection and sustainable development. There is a growing tendency in public opinion and consumer behavior to favor companies that demonstrate strong ESG performance. ESG represents an investment philosophy that not only considers traditional metrics such as financial performance and return on investment but also evaluates a company's capacity for future development through the lens of responsibility. ESG has now become a universally significant topic across various sectors of society.

2.3 ESG and Stock Price Crash Risk

The influence of stock price crashes stems from a complex interplay of factors. Assessments of listed companies' ESG performances are primarily based on ratings from mainstream institutions. Information asymmetry and the management's accumulation of negative news are identified as key drivers of drastic stock price declines, impacting relationships between companies and various stakeholders including institutional and individual investors, employees, and regulators. Possessing a ESG rating typically signifies a greater accounting integrity and transparency, suggesting that a board with high ethical standards is less likely to conceal negative information. Corporate social responsibility reports, which provide a holistic view of non-financial information, play a crucial role. The disclosure of environmental information, especially by heavily polluting firms, not only meets regulatory expectations but also enhances public scrutiny and investor interest, thereby mitigating information asymmetry and reducing the likelihood of stock price crashes. Furthermore, the transparency in reporting on corporate social responsibilities reflects the company's ethical standards and cultural sophistication, which reduces the propensity for management to withhold adverse information and enhances governance transparency (Gelband & Strawser, 2001). This transparency helps build a strong corporate

reputation, which can buffer the impact of negative events on stock prices by moderating investors' emotional responses (Song Xianzhong et al., 2017). Based on these insights, the paper formulates its first research hypotheses.

H1: ESG rating disclosure reduces the risk of stock price crashes.

2.4 Institutional Investors' Shareholdings and Stock Price Crash Risk

Companies with robust ESG ratings are viewed as lower-risk and sustainable investments, attracting more institutional investors and leading to shareholding clustering. This clustering results in concentrated ownership among investors who often react similarly to new information, increasing market volatility. Institutional investors, particularly those focused on ESG, tend to have homogeneous investment strategies and risk assessments, leading to synchronous trading behaviors, such as buying or selling shares based on similar triggers like ESG score changes or regulatory updates. This homogeneity can reduce the liquidity of a stock, as a larger portion of shares is held by fewer hands, exacerbating price movements and making the stock more sensitive to trades. Furthermore, institutional investors often rely on similar sets of information for decision-making, which in scenarios of negative news can trigger a collective sell-off, sharply declining stock prices and increasing crash risk. Additionally, if the market perceives that institutional investors are exiting a stock, it can lead to panic selling among smaller investors, further escalating the crash risk. These interconnected dynamics illustrate how effective ESG rating disclosures, while attracting institutional investment, can paradoxically heighten the potential for stock price crashes due to ownership clustering and uniform reactions to market shifts. Based on these insights, the paper formulates its second research hypotheses.

H2: Institutional shareholding clustering increases the risk of stock price crashes.

2.5 Retail Investors Sentiments and Stock Price Crash Risk

High ESG ratings typically attract a larger contingent of institutional investors, as these entities perceive such companies as sustainable and lower-risk investments. This concentration of ownership can amplify optimistic market sentiments during bull markets, driven by positive expectations about the performance and prospects of high-ESG

companies. Conversely, in bear markets or during unstable market conditions, this same concentration can induce excessive volatility in stock prices. When consumer and small investor sentiments suffer, panic selling may ensue, especially if there are signs of significant selling by institutional investors. Additionally, given their substantial holdings, institutional investors may resort to conservative strategies amidst market volatility, including reducing or divesting their stakes, a tendency that becomes pronounced under conditions of information asymmetry. Such actions can exacerbate market panic and lead to sharp fluctuations in stock prices, particularly during transitions from bull to bear markets.

Moreover, overall market sentiment, whether bullish or bearish, significantly influences individual consumer mood. In bull markets, upbeat consumer sentiment can drive stock prices upwards, heightening the risk of market overheating. In contrast, during bear markets, negative consumer sentiment can provoke excessive panic, precipitating rapid stock declines. Driven by consumer emotions, such market volatility, especially in a modern context where information dissemination is swift, may be quickly magnified, thus elevating the risk of stock price crashes. Based on these insights, the paper formulates its third research hypotheses.

H3: Individual investors sentiments increase the risk of stock price crashes.

2.6 Literature Review

Stock price crashes are a multifaceted phenomenon, analyzed through both macro and micro perspectives based on agency theory and information manipulation theory. Key micro-level factors include managerial traits (Wu Dejun, 2015), inefficient investments (Wu Shinong et al., 2023), and media coverage (Huang Xinjian, Zhao Wei, 2015), while macro-level factors encompass economic policies (Chu Jian, Fang Junxiong, 2016), environmental uncertainty (Luo Jinhui, Du Xingqiang, 2014), and investor sentiment (Zhao Ruwei et al., 2019). Other studies have addressed the merger of national and local taxes (Yun Feng et al., 2023) and the stock pledges by major shareholders (Wang Bo, Gao Xingwei, 2023).

Simultaneously, the volume of academic research into the economic effects of corporate social responsibility (CSR) is growing, offering a systematic examination of the

link between companies' ESG responsibilities and their financial outcomes (Wang Xiaowei and Chen Hui 2011; Chelawat and Trivedi 2016). Such studies also assess whether CSR performance can draw investor interest (Wang and Chen 2017). Institutional investors, unlike individual ones, possess the resources and motivation necessary to gather detailed information on corporate social performance and responsibilities. This enables them to devise sophisticated and comprehensive investment strategies that may enhance their potential for future gains. Early international research, using data from the United States and Canada, found a significant positive correlation between institutional holdings and corporate social responsibility performance (CSRP) (Graves et al. 1994; Mahoney et al. 2007). Yet, other studies have revealed a complex, and sometimes negative, correlation between institutional investors and the CSR performance of listed companies (Fryxell et al. 1991).

III Research Design and Methodology

3.1 Sample Selection and Data Sources

This study examines the effect of ESG rating announcements on stock prices, using listed companies in Shanghai and Shenzhen from 2012 to 2022 as samples. To ensure a representative sample, we excluded listed companies in the financial and insurance sectors, which differ significantly from other listed companies in terms of their main business operations, company size, and information disclosure. Second, we exclude listed companies with special treatment (denoted as (*) ST), as they differ significantly from other companies in terms of financial indicators and information disclosure. Third, companies listed within the current year are excluded since they have a shorter listing time and less historical information, which results in significant differences in information disclosure compared to other companies. Fourth, we eliminate samples with missing data for stock price control variables. A total of 31,771 company-year sample observations were obtained. To mitigate the impact of outliers on the empirical results, this study used winsor2 to shrink the continuous variables at the 0.01 and 0.99 levels. The ESG ratings were obtained from the WIND database, and all other data were obtained from the CSMAR database. The model design and variable definitions will be discussed.

3.2 Variable Definitions

Table 1 Definition of Key Variables

Variable Type	Variable Name	Symbol	Definition
Dependent Variable	Stock Price Crash Risk	NCSKEW	Measures the risk of stock price crashes. Calculated as outlined by Hutton et al. (2009).
Independent Variable	ESG Disclosure	ESG	Dummy variable that is set to 1 if the company announces its ESG rating in the current year or any year thereafter, otherwise 0.
Control Variables	Return on Assets	ROA	Net income divided by total assets.
	Leverage	Lev	Ratio of total debt to total assets at the end of the year.
	Growth Opportunity	Growth	Percentage change in annual sales.
	Board Size	Board	Number of members on the board of directors.
	Proportion of Independent Directors	Indep	Percentage of independent directors on the board.
	Financing Constraints	SA	An index of financing constraints faced by the firm.
	Firm Size	Size	The natural logarithm of total assets to represent company size.
	Year dummy variable	Year	Year dummy variable
	Firm dummy variable	Firm	Firm dummy variable

3.3 Model Construction

To test the impact of ESG rating announcements on stock price changes, this study proposes a difference-in-differences model 1.1. The academic community commonly uses the NCSKEW index, a negative return skew coefficient, to measure stock price crash risk. A higher NCSKEW value indicates a more left-skewed distribution of weekly characteristic returns （Hutton et al. 2009). In other words, a greater skewness towards negative weekly returns correlates with a higher crash risk.

$$NCSKEW_{i,t} = \alpha_0 + \beta_1 ESG_{i,t} + \beta_2 CONTR_{i,t} + \beta_3 YEAR_{i,t} + \beta_4 FIRM_{i,t} + \varepsilon_{i,t} \quad (1.1)$$

The dependent variable, NCSKEW, in this study, we adopt the methodology proposed by Hutton et al. (2009).to quantify the risk of stock price crashes. First, we utilize weekly return data for stock i to compute market-adjusted returns, as delineated in model 1.2.

$$r_{i,t} = \alpha + \beta_1, r_{m,t-2} + \beta_2, r_{m,t-1} + \beta_3, r_{m,t} + \beta_4, r_{m,t+1} + \beta_5, r_{m,t+2} + \varepsilon_{i,t} \quad (1.2)$$

Where $r_{i,t}$ denotes the return of stock i in week t, and $r_{m,t}$ represents the average return of all A-shares, weighted by market capitalization, within the same timeframe. This model incorporates both lagged and leading market returns to correct for asynchronous trading effects. The market-adjusted return for stock i in week t, $W_{i,t}$, is thus defined as: $W_{i,t} = \ln(1 + \varepsilon_{i,t})$

Consequently, we define NCSKEW as a metric for evaluating the propensity for stock price crash. It is computed by measuring the negative skewness of market-adjusted weekly returns for stock i, as follows, where n is the number of weekly observations in the year:

$$NCSKEW_{i,t} = -\left[\frac{n}{(n-1)(n-2)}\sum w_{i,t}^3\right] / \left[\sqrt{(\frac{n}{n-1}\sum w_{i,t}^2)^3}\right] \quad (1.3)$$

A negative sign is put in front of the third moment such that a higher value of NCSKEW indicates higher crash risk.

The main independent variable is ESG. The main regression uses the announcement time points of ESG ratings for listed companies to construct multi-period DID dummy variables. If a company announces its ESG rating in a certain period, the value is set to 1 for that period and subsequent period; otherwise, it is set to 0. In robustness checks, the dummy variables related to ESG ratings are redefined based on whether the ESG ratings of listed companies were disclosed in the current period by Shangdao Ronglv. CONTR represents all control variables in this study. The study controls for company size (SIZE), leverage (LEV), return on assets (ROA), cash flow (Cashflow), growth (Growth), board size (Board), the proportion of independent directors (Indep), and financing constraints (SA), as per existing research literature. Furthermore, fixed effects of the year (YEAR) and the company (FIRM) are also controlled for.

IV Analysis of Empirical Results

4.1 Descriptive Statistics

Table 2 presents the results of the descriptive statistical analysis of the dependent, independent, and control variables used in this study. The mean value of NCSKEW is -0.429, with a standard deviation of 0.752, and minimum and maximum values of -2.682 and 1.673, respectively. A larger NCSKEW indicates a greater downward deviation of the stock price and a higher risk of stock price crash. The wide distribution of NCSKEW among the obviations, as evident from the minimum and maximum values, suggests that different firms face significant variations in the risk of stock price crash.

The mean value of ESG is 0.081, with a standard deviation of 0.273, indicating considerable differences in the ESG ratings of the sample firms. Among the control variables, firm size has maximum and minimum values of 26.329 and 19.941, respectively, with a standard deviation of 1.3, signifying substantial differences in the size of the sample firms. The gearing ratio has maximum and minimum values of 0.904 and 0.057, with a standard deviation of 0.205, indicating significant differences in the gearing ratios of the sample companies. Return on assets has maximum and minimum values of 0.223 and -0.239, with a mean value of 0.066. The descriptive statistics of the other control variables exhibit reasonable distributions.

Table 2 Descriptive Statistics for Key Variables

Variable	Obs	Mean	Std. Dev.	Min	Max
NCSKEW	32289	-.429	.752	-2.682	1.673
ESG	32289	.081	.273	0	1
ROA	32289	.038	.066	-.239	.223

Size	32289	22.273	1.3	19.941	26.329
Lev	32289	.425	.205	.057	.904
Cashflow	32289	.047	.068	-.153	.245
Growth	32289	.155	.388	-.568	2.33
Board	32289	2.116	.196	1.609	2.639
Indep	32289	37.723	5.365	33.33	57.14
SA	32289	-3.84	.25	-4.453	-3.174

Note: Table 2 presents descriptive statistics of the variables used in analyzing the impact of ESG disclosures on stock price crash risks from 2012 to 2022, capturing data on an annual basis for various firms, with each unit of observation representing a firm-year. The main variables include NCSKEW, which measures the risk of stock price crashes, and ESG, indicating whether a firm has made an ESG disclosure each year. The mean of NCSKEW is -0.429, suggesting a general negative skewness, which indicates a prevalence of crash risk among the firms studied. A negative value in NCSKEW implies that higher values indicate greater risk of stock price crashes. Approximately 8.1% of observations have ESG disclosures, providing a basis for the treatment group in the study's analysis, while the remaining 91.9% serve as controls for comparative analysis.

4.2 Correlation Analysis

To prevent multicollinearity within the model, which could result in high correlations among independent variables making it challenging to distinguish each variable's individual contribution to the dependent variable, this study conducted a correlation analysis of the principal variables. As illustrated in the table, the absolute values of the Pearson correlation coefficients among the main variables do not exceed 0.496, well below the commonly used threshold of concern at 0.7. This indicates that the model does not

present significant issues of multicollinearity, suggesting that the accuracy of the estimated regression coefficients is reliable, and the results are stable."

Table 3 Collinearity Test for Key Variables

Variables	(1)	(2)	(3)	(4)	(5)
(1) Stock crash risk	1.000				
(2) ESG	0.055***	1.000			
	(0.000)				
(3) ROA	0.049***	0.109***	1.000		
	(0.000)	(0.000)			
(4) Size	0.014**	0.454***	0.021***	1.000	
	(0.013)	(0.000)	(0.000)		
(5) Lev	-0.038***	0.085***	-0.361***	0.496***	1.000
	(0.000)	(0.000)	(0.000)	(0.000)	
(6) Cashflow	0.037***	0.116***	0.425***	0.076***	-0.168***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
(7) Growth	0.022***	0.006	0.280***	0.045***	0.021***
	(0.000)	(0.246)	(0.000)	(0.000)	(0.000)
(8) Board	-0.013**	0.091***	0.013**	0.267***	0.142***
	(0.020)	(0.000)	(0.016)	(0.000)	(0.000)
(9) Indep	0.010*	0.052***	-0.016***	-0.007	-0.009*
	(0.069)	(0.000)	(0.004)	(0.230)	(0.097)
(10) SA	0.018***	0.062***	0.061***	-0.011*	-0.078***
	(0.001)	(0.000)	(0.000)	(0.054)	(0.000)

Variables	(6)	(7)	(8)	(9)	(10)
(1) Stock crash risk					
(2) ESG					
(3) ROA					
(4) Size					
(5) Lev					
(6) Cashflow	1.000				
(7) Growth	0.038***	1.000			
	(0.000)				
(8) Board	0.042***	-0.012**	1.000		
	(0.000)	(0.029)			
(9) Indep	-0.007	-0.003	-0.560***	1.000	
	(0.231)	(0.631)	(0.000)		
(10) SA	-0.005	0.046***	-0.015***	0.044***	1.000
	(0.405)	(0.000)	(0.009)	(0.000)	

Note： *** p<0.01, ** p<0.05, * p<0.1

4.3 Analysis of Baseline Regression Results

The study utilizes a panel model with two-way fixed effects for time and individuals in addition to the basic results of the multi-period DID regression based on Model (1.1).

Robust standard errors clustered at the company level are used to mitigate the impact of heteroscedasticity on the empirical results. Table shows the impact of control variables on the stock crash risk. The first column controls for time fixed effects and individual fixed effects, while the second column adds additional control variables. Notably there is a significant negative impact of Return on Assets, indicating that higher profitability tends to reduce stock price crash risk. In contrast, the size of the company, as measured by the natural logarithm of total assets, shows a positive correlation, suggesting larger companies face higher risks of stock price crashes. Both columns' results indicate a significant positive correlation between the announcement of ESG ratings and stock price crashes. The test passed at a 5% statistical significance level, suggesting that ESG rating announcements increase the risk of stock price crashes for enterprises.

Table 4 Baseline Regression Results of the ESG Rating Disclosure Impact on Stock Price Crash Risk

	(1)	(2)
VARIABLES	Stock crash risk	Stock crash risk
ESG	0.161***	0.133***
	(0.0221)	(0.0241)
ROA		-0.247**
		(0.106)
Size		0.0893***
		(0.0125)
Lev		-0.193***
		(0.0503)
Cashflow		0.0560
		(0.0820)

Growth		0.0102
		(0.0128)
Board		-0.0132
		(0.0502)
Indep		0.00159
		(0.00157)
SA		-0.0179
		(0.0856)
Constant	-0.443***	-2.445***
	(0.00182)	(0.444)
Observations	31,771	31,771
R-squared	0.182	0.184
Firm Fe	Yes	Yes
Year Fe	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note： To eliminate the heteroscedasticity bias of the panel data, we also controlled cluster standard errors.

4.4 Parallel Trends Test

A key assumption for the application of a multi-period Difference-in-Differences (DID) model is the parallel trends assumption. To rigorously verify the parallel trends in the DID model over multiple time points, this study conducts a dynamic heterogeneity analysis following the methodology of Beck et al. The model also evaluates the impact of the company's ESG ratings announcement on the risk of stock price crashes. The analysis employs the following model:

$$NCSKEW_{i,t} = \beta_0 + \beta_1 ESG_{i,t}^{-4} + \cdots + \beta_9 ESG_{i,t}^{5} + \beta_{10} ROA_{i,t} + \beta_{11} Size_{i,t} + \beta_{12} Levi_{i,t} + \beta_{13} Cashflow_{i,t} + \beta_{14} Growth_{i,t} + \beta_{15} Broad_{i,t} + \beta_{16} Indep_{i,t} + \beta_{17} SA_{i,t} + \beta_{18} YEAR_{i,t} + \beta_{1i} FIRM_{i,t} + \varepsilon_{i,t} \quad (2)$$

$ESG_{i,t}$ represents the ESG rating announcement's lead or lag term, for example $ESG_{i,t}^{-4}$ indicates that firm i takes the value of 1 in the four years leading up to the ESG rating announcement, and 0 in all other years; $ESG_{i,t}^{4}$ means that firm i takes the value of 1 in the fourth year following the ESG rating announcement, and 0 in all other years. To avoid the dummy variable trap, the dummy variable for the year of the ESG rating announcement, $ESG_{i,t}^{-1}$ is removed, The series from $ESG_{i,t}^{-4}$ to $\beta_9 ESG_{i,t}^{5}$ represents the relative results with $\beta_9 ESG_{i,t}^{0}$ as the baseline.

The prerequisite for employing the difference-in-differences (DID) method is the assumption of parallel trends between the treatment and control groups. This means that the stock price performances of both groups need to exhibit similar trends prior to the ESG rating disclosure. The tables 5 illustrate the parallel trends before and after the ESG rating disclosure. This study sets the year before policy implementation as the baseline period, hence data for pre_1 is not reflected in the parallel trend test results. Prior to the ESG rating disclosure, the estimated coefficients are insignificantly different from zero; however, these coefficients significantly deviate from zero in the period of disclosure and thereafter, positively significant at the 5% level, aligning with the benchmark regression results. Moreover, the figure 2 further visualize the results of the parallel trend test. Before policy implementation, the coefficients fluctuate around the zero axis, indicating no systematic differences between the two groups, and their stock price movements tend to align before the disclosure. Following policy implementation, the magnitude of deviation from the zero axis for these coefficients increases, marking the emergence and immediate effect of ESG disclosure on stock price crashes without lag. Therefore, this study passes the parallel trend test, rendering the DID method suitable for evaluating the impact of ESG rating disclosure on stock price crashes.

Table 5 Parallel Trends Tests

VARIABLES	Stock crash risk
pre_3	0.00769
	(0.0448)
pre_2	-0.0716
	(0.0444)
current	0.106**
	(0.0494)
post_1	0.227***
	(0.0357)
post_2	0.102***
	(0.0307)
post_3	0.157***
	(0.0373)
post_4	0.148***
	(0.0478)
post_5	0.143***
	(0.0492)
Constant	-0.441***
	(0.00299)
Observations	31,771
R-squared	0.183
Firm Fe	Yes
Year Fe	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

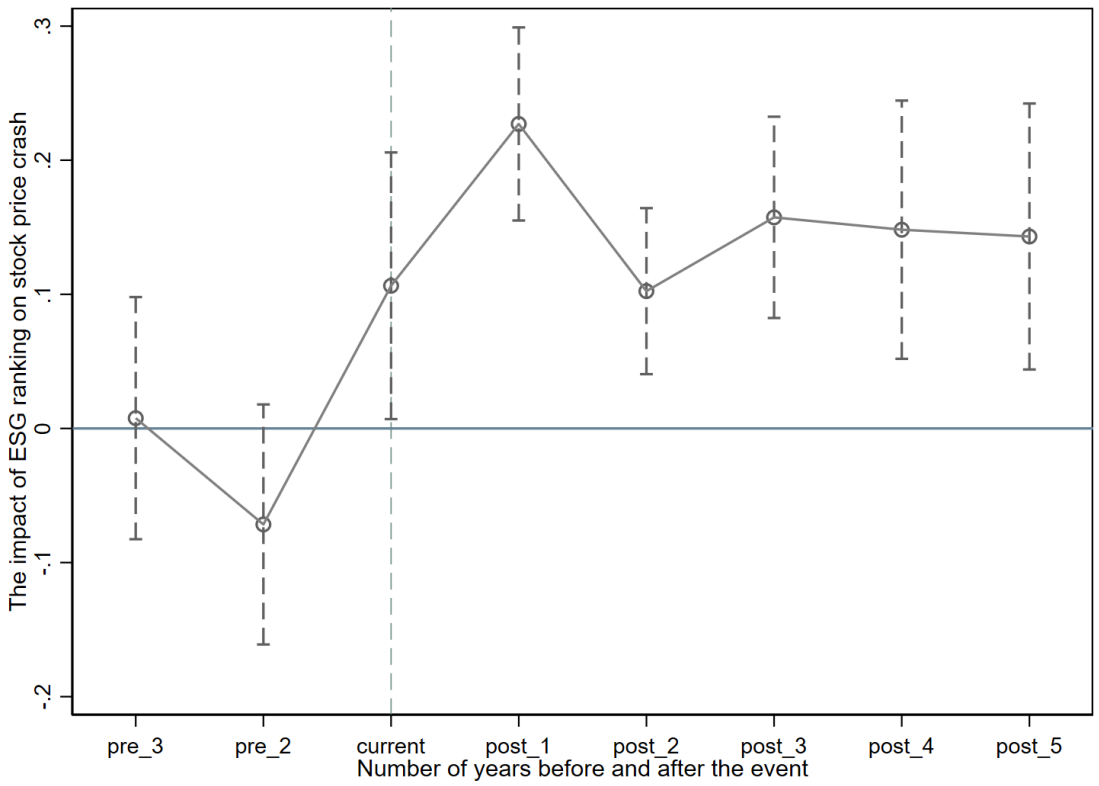


Fig. 2. Parallel Trends Tests

Note: The circles represent coefficients of interaction terms in the regression analysis. The vertical axis is the magnitude of the dynamic regression coefficient. If the interval of coefficient includes 0, there is no significant difference in stock price crash risk between the treated and control companies in that year.

4.5 Placebo Test

To further examine the robustness of the research conclusions, this study conducts a placebo test by randomly drawing samples to generate an artificially fabricated fake treatment group. Replicated the treatment 500 times, employing the difference-in-differences method for regression, to test the effect excluding the ESG rating disclosure. The results, as depicted in the Fig. 3., indicate that across the 500 treatments, the coefficients obtained fall within the interval of -0.05 to 0.05, distinctly different from the coefficient of 0.133 in the benchmark regression. Demonstrating that the coefficient obtained from the initial regression is reliable rather than statistically contingent, thus passing the placebo test.

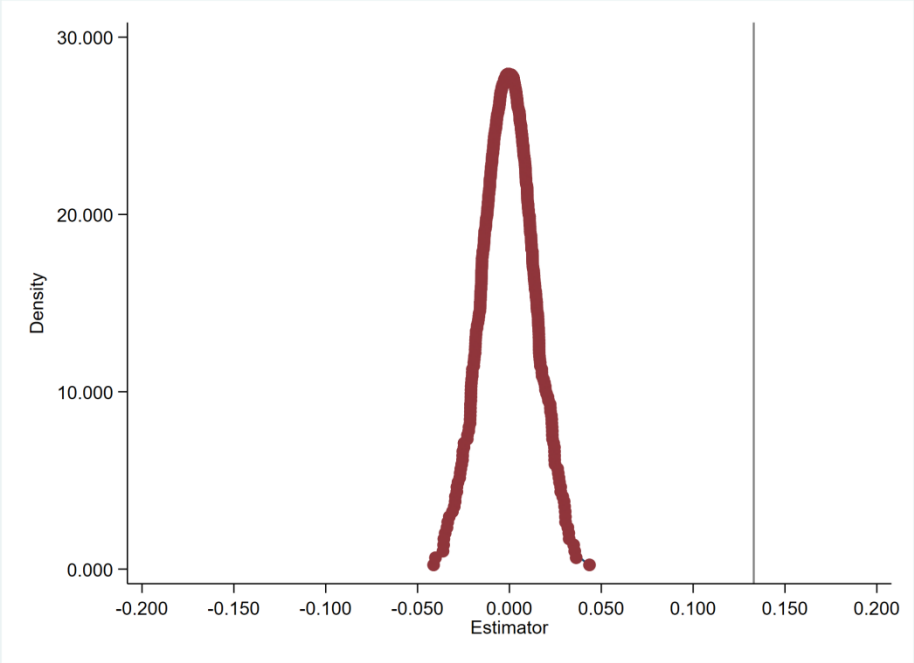


Fig. 3. Placebo Tests

Note：Control variables, fixed effects and cluster standard errors are the same as the baseline estimates.

4.6 Propensity Score Matching（PSM）

To address the potential sample selection bias arising from the manual screening by ESG rating agencies, this study employs propensity score matching (PSM) to construct a control group that exhibits greater comparability with the treatment group. Through this approach, we select listed companies that have not received ESG ratings but share similar characteristics with rated companies in terms of specific covariates, such as firm size, profitability, leverage, and growth factors. We then perform a 1:1 matching process, aiming to enhance the comparability between the treatment and control groups, thereby more effectively isolating the influence of confounding factors.

Regarding the selection of covariates, we establish a logit regression model to estimate propensity scores and adopt the nearest-neighbor matching method to ensure the similarity of propensity scores between the two groups. After matching, our study obtains a total of 32,194 observations, including4,660 observations in the treatment group and 27,534 observations in the control group. To validate the effectiveness of the matching process,

we compare the standardized differences of covariates before and after matching. The results demonstrate that the absolute values of standardized differences for all covariates decrease significantly and fall below the 10% threshold, indicating a satisfactory matching outcome and a well-balanced distribution of observable characteristics between the treatment and control groups.

Based on the matched sample, we conduct a difference-in-differences (DID) regression analysis. The results as depicted in table6 reveal that the coefficient of the interaction term capturing the difference between the treatment and control groups is 0.132, which is statistically significant at the 1% level. Compared to the pre-matching regression results, the absolute value of the interaction term coefficient remains relatively stable, suggesting that our conclusions hold and exhibit a certain degree of robustness after controlling for sample selection issues.

Table 6 Propensity Score Matching Test

	(1)
	psm
VARIABLES	Stock crash risk
newESG	0.132***
	(0.0241)
ROA	-0.223**
	(0.107)
Size	0.0909***
	(0.0126)
Lev	-0.195***
	(0.0506)

Cashflow	0.0568
	(0.0819)
Growth	0.00926
	(0.0129)
Board	-0.0132
	(0.0504)
Indep	0.00156
	(0.00157)
SA	-0.0311
	(0.0871)
Constant	-2.529***
	(0.451)
Observations	31,675
R-squared	0.184
Firm Fe	Yes
Year Fe	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: After Propensity Score Matching. The significant interaction term indicates that companies with ESG disclosures experience a higher risk of stock price crashes compared to those without such disclosures, without such disclosure but has similar characteristics in other aspects.

4.7 Heterogeneity Analysis

4.7.1 Heterogeneity analysis based on the quality of information disclosure by listed companies

In China's capital market, the quality of information disclosure among listed companies exhibits significant distributional characteristics due to the differences in regulatory systems and the diversity of investor needs. These characteristics not only mirror each listed company's degree of compliance with disclosure rules but also reflect the market's overall response to information transparency. This study contends that disparities in the quality of information disclosure among listed companies lead to varying degrees of stock price crash risk.

This hypothesis needs to be tested first. This study uses a quantitative assessment of disclosure quality. Based on the timeliness, accuracy, completeness, and comparability of information disclosure of listed companies, it is divided into a total of four gradients from low to high. The assessment utilizes the results of information disclosure quality assessment provided by the Shenzhen Stock Exchange Regulatory Information Disclosure System. The assessment grades correlate with the level of the company's information disclosure. Higher grades indicate better quality of information disclosure. As described in (1) to (4), this delineation method enables a detailed comparison of the risk of share price plunge for different disclosure quality levels. In this way, a significant stratification effect can be revealed.

From the regression analysis, the quality of disclosure is strongly associated with the risk of stock price plunge. When the quality is low, as shown in (1), this does not have a significant effect on the risk of stock price plunge. The opposite is true for (4). It shows a significant positive correlation between disclosure and stock price plunge risk. From this result, the market is more inclined to react to information disclosed by firms with higher quality of information. Most importantly, the market reacts quickly to any unfavorable information, which can cause substantial stock price fluctuations.

The impact is usually more pronounced for those firms with the highest quality of information. For such firms, the positive correlation between their ESG disclosure and the risk of a stock price crash ((4)) is significant at the 1% level. That is, the market can process

information related to ESG disclosure more efficiently when such firm's bulk information. Apart from (4), companies represented by (1) through (3) have poor information quality. In this case, the positive correlation is not significant. Alternatively, the relationship is significant to a lesser extent. The role and impact of information quality on the market can be seen from this comparison.

From the conclusions drawn above, the quality of disclosure has a significant impact on the market. It affects the risk of share price crash of listed companies. Moreover, there is a clear gradient difference in this impact. This certainly provides a useful course of action for regulators. If such an organization seeks to improve market efficiency, it can do so by improving the quality of information disclosure. Alternatively, the systemic risk of share price crashes can be reduced by mitigating information asymmetry. This is equally important for listed companies. For these companies, improving the quality of disclosure is, on the one hand, a mechanism to comply with regulatory requirements. On the other, it can help maintain investor confidence and optimize share price performance.

Table 7 Heterogeneity Test of Information Disclosure Quality

	(1)	(2)	(3)	(4)
	Low information quality	Lower medium information quality	Upper medium Information quality	High information quality
VARIABLES	Stock crash risk	Stock crash risk	Stock crash risk	Stock crash risk
ESG	-2.561	0.0278	0.0742	0.189***
	(1.900)	(0.304)	(0.0563)	(0.0636)
Constant	-3.940	-3.474*	-3.483***	-2.671*
	(9.441)	(1.958)	(0.826)	(1.618)
Controls	Yes	Yes	Yes	Yes
Observations	213	2,277	15,074	4,244
R-squared	0.484	0.355	0.250	0.331

Firm Fe	Yes	Yes	Yes	Yes
Year Fe	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note：We explores the heterogeneity analysis regarding the effects of information disclosure quality on stock price crash risk, differentiating between general company disclosures and third-party ESG ratings. Information disclosure quality refers to the thoroughness, accuracy, and timeliness of information that companies voluntarily release to the public, categorized into four distinct levels: High, Upper-Medium, Lower-Medium, and Low. On the other hand, ESG disclosures, sourced from third-party rating agencies, provide assessments based on environmental, social, and governance criteria. This table evaluates whether the quality of a company's general information disclosures influences the impact that third-party ESG ratings have on stock price crash risk.

4.7.2 Heterogeneity analysis based on bull and bear market conditions.

The impact of ESG rating disclosure on stock price crash risk is expected to vary significantly across different market states due to the volatile and cyclical nature of the stock market. Investor sentiment and market confidence differ considerably between bull and bear markets, potentially influencing how ESG rating disclosures affect stock price crash risk. As such, it is hypothesized that the impact of ESG rating disclosure on stock price crash risk will differ significantly between bull and bear markets. This study adopts the approach used by Chu Mu Xin (2023), who applied the Bollinger Bands model (BB model) to objectively classify the stock market into bull and bear markets for the period from 2012 to 2020.

This study uses the market situation as a point of reference to examine the heterogeneity by analyzing the ESG rating disclosures of listed corporations in both bull and bear markets. Under various market sentiment scenarios, the connection between ESG rating disclosure and stock price crash risk is investigated. In contrast to bear markets, which are generally linked to negative market sentiment and low investor confidence, bull markets are characterized by positive market sentiment and strong investor confidence. Based on the regression results, bull markets are defined in this study as times when stock prices are rising, and bear markets are defined as times when stock prices are falling.

Regression analysis results indicate that there is undeniable heterogeneity in the market states. The positive relationship between stock price fall risk and ESG rating

disclosure is more pronounced in a bull market. The large positive link between stock price fall risk and ESG rating disclosure is less pronounced during bad markets. This suggests that corporations' disclosure of their ESG ratings may increase market sensitivity to share price volatility in favorable market conditions, increasing the likelihood of a share price crash. However, because of the overall loss of market trust in a bear market, even better ESG rating disclosure is insufficient to appreciably lower the probability of share price collapses.

A rational explanation for this phenomenon can be attempted. First, a bull market will make the market more optimistic about companies. In this case, any disclosure of negative information may cause investors to overreact. This would increase the likelihood of a stock price crash. On the other hand, a bear market will make investors' attitudes calm. In this case, the reaction to ESG rating disclosures is relatively muted. This shadows the risk of a stock price crash less. As a result, investors get favorable feedback. Likewise, corporate leaders can gain some insight. After that, companies are likely to take changes in market sentiment into account. They can then adjust their disclosure strategies and effectively manage the risk of share price crashes under different market conditions.

Table 8 Heterogeneity Test in Bull and Bear Markets

	(1)	(2)
	Bull Market	Bear Market
VARIABLES	Stock crash risk	Stock crash risk
ESG	0.217***	0.137***
	(0.0347)	(0.0459)
Constant	-1.472*	-2.638***
	(0.873)	(0.884)
Controls	Yes	Yes
Observations	13,942	8,859

R-squared	0.302	0.326
Firm Fe	Yes	Yes
Year Fe	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: we explore heterogeneity analysis of the effects of ESG disclosures on stock price crash risks across defined bull and bear market periods from 2010 to 2022, as classified by Chu Mu Xin (2023). This analysis segments market conditions into distinct phases: from January 2010 to April 2014 as a bear market, from April 2014 to May 2015 as a bull market, from May 2015 to February 2016 again as a bear market, from February 2016 to January 2018 as a bull market, from January 2018 to December 2018 as a bear market, and from December 2018 to December 2020 as a bull market. Additional classifications include from December 2020 to December 2021 as a bull market, and from December 2021 to December 2022 as a bear market. This detailed periodization allows the study to assess how ESG disclosure impacts stock price crash risks differently depending on the prevailing market conditions, providing insight into whether the positive or negative sentiment of the market enhances or mitigates the effects of ESG disclosure.

4.8 Mechanisms Test

The impact of ESG rating disclosure on the market was discussed earlier. Based on this study, it is now intended to investigate the mechanism of its present impact on stock prices. This theoretical analysis is based on two hypotheses: ESG ratings disclosure affects stock price volatility primarily through institutional investor herding and individual investor sentiment. These hypotheses are tested in turn in the following section. The first step is to examine the impact of ESG ratings disclosure on institutional investor herding and individual investor sentiment. This will provide an initial test of the theoretically derived mechanisms. This is followed by a subsample regression using the institutional investor herd effect and individual investor sentiment indicators. In this way, the mechanism of the impact of ESG rating disclosure on stock prices can be further explored.

4.8.1 Testing the Mechanism Based on Institutional Investors' Herding Behavior

This study primarily draws on the methodologies of Lakonishok et al. (1992) and Wermers (1999), employing a method based on changes in institutional investors' shareholding proportions to quantify their herding behavior. The reseason for selecting this method is based these. Firstly, the public availability and accessibility of institutional investors' shareholding information are extremely high. This study uses the WIND database as the

data source, which comprehensively records the shareholding status of institutional investors in China's A-share market, ensuring the accuracy and reliability of the data used. Secondly, by observing the changes in the buying or selling proportions of institutional investors for specific stocks within a certain period and comparing these changes with those of other stocks in the same industry during the same period, the concentrated trading behavior of institutional investors, also known as herding behavior, can be intuitively identified. This comparison not only accurately quantifies the strength of institutional investors' herding behavior but also exposes their herding tendencies in both buying and selling directions, providing valuable insights into the nature of herding behavior and its impact on the market.

The calculation of institutional investors' herding behavior in this paper mainly refers to the methods of Lakonishok et al. (1992) and Wermers (1999). The specific model used is as follows:

$$HM_{i,t} = \left| p_{i,t} - E(p_{i,t}) \right| - E\left| p_{i,t} - E(p_{i,t}) \right| \tag{3}$$

Where $p_{i,t}$ is the proportion of institutional investors that increased their holdings in company i during quarter t, and $E(p_{i,t})$ is the expected value of this proportion, represented by the average proportion of institutional investors increasing holdings across all companies in the same industry during quarter t. The term $|p_{i,t} - E(p_{i,t})|$ measures the imbalance in buying and selling of company s stocks by institutional investors during quarter i's stocks by institutional investors during quarter t, *and* $E|p_{i,t} - E(p_{i,t})|$ is an adjustment term, indicating the presence of herding behavior only when the imbalance reaches a certain level.

Given the unique environment of China's capital market and the availability of data Xu et al.（2013）, we made appropriate adjustments to the existing research methods for measuring institutional investors' herding behavior, detailed as follows:

1. From the quarterly data on institutional investors' major stockholdings, calculate the change in the number of shares held by institutions for each company each quarter, denoted as $trade$. Set a dummy variable BUY to 1 if $trade$ and to 0 otherwise, excluding cases where $trade$.

2. Calculate the average value of BUY by grouping by quarter and company to derive $p_{i,t}$ as specified in model 3.

3. Calculate the average value of $p_{i,t}$ by grouping by quarter and industry to obtain $E(p_{i,t})$ for model 3.

4. Calculate $|p_{i,t} - E(p_{i,t})|$, the absolute value, as specified in model 3.

5. Since the institutional investors' shareholding data is quarterly and other data are annual, aggregate the quarterly herding behavior data into annual data by averaging the four $|p_{i,t} - E(p_{i,t})|$ values calculated for each company within a year to obtain the variable $HERD$.

6. Calculate the mean m and standard deviation t of $HERD$, and use（$m - 1.96t$）as an adjustment term, excluding data in the $HERD$ variable below ($m - 1.96t$) to derive the $Herding$ indicator of institutional investors' herding behavior.

The regression results presented in Table 8 indicate that ESG rating disclosures have a significant impact on the herding behavior of institutional investors. The dummy variable in the model, which represents the disclosure of ESG ratings, has a positive and significant effect on both overall herding behavior and buying herding behavior. This finding suggests that ESG rating disclosures encourage institutional investors to engage in more imitative behavior, resulting in increased herding on the buying side. In contrast, ESG rating disclosures have a negative and significant impact on selling herding behavior, implying that companies disclosing their ESG ratings experience relatively less herding on the selling side. This finding could indicate that ESG rating disclosures boost investors' confidence in the company's future performance. These findings provide empirical support for the theoretical hypotheses of this paper, confirming that ESG rating disclosures significantly influence stock price volatility by affecting institutional investors' herding behavior.

Table 9 Test of the Mechanism of Institutional Investors' Herd Behavior on Stock Price Crash Risk

	(1)	(2)	(3)
VARIABLES	Herding	Herd Buy	Herd Sell

ESG	0.00832***	0.0127***	-0.0233***
	(0.00216)	(0.00258)	(0.00828)
Constant	1.041***	0.703***	2.196***
	(0.0846)	(0.0703)	(0.250)
Controls	Yes	Yes	Yes
Observations	20,126	18,890	12,683
R-squared	0.467	0.368	0.349
Firm Fe	Yes	Yes	Yes
Year Fe	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: We used the Institutional Investors' Herd Behavior to denote the independent variable. Other control variables of companies are relaxed, while fixed effects and cluster standard errors are still controlled.

4.8.2 Testing the Mechanism Based on Individual Investor Sentiment

This study selects investor sentiment as the second mediating variable to explore the relationship between ESG rating disclosure and stock price movements. Measuring and analyzing investor sentiment has become increasingly important in financial market research. Following the research methodology of Yang et al. (2016), this study employs text mining techniques to categorize the sentiment of discussion posts within online communities and further analyzes the market impact of investor sentiment.

This research uses East Money Forum, China's largest online financial forum, as a case study. East Money Forum is a highly popular and influential platform among Chinese investors, with a large and diverse user base. The platform serves as a community for the exchange of stock information, subdivided into numerous sub-forums named after all listed stocks in China's Shanghai and Shenzhen stock markets. The posts in these forums reflect investors' opinions and emotions towards specific stocks, and the discussions on this

platform can potentially influence the stock market. Each post contains detailed information such as the posting time, providing a rich and representative source of data for sentiment analysis. The choice of East Money Forum as the research object is based on the platform's data representativeness and availability, making it an ideal platform for studying the impact of investor sentiment on the Chinese stock market.

To quantify investor sentiment, this research utilizes the open-source data mining tool Weka and applies the K-Nearest Neighbors (KNN) algorithm to analyze sentiment within a vast number of posts, both anonymous and non-anonymous, categorizing them into "positive," "neutral/noise," and "negative." A random sample of 2,000 posts was extracted from the overall dataset to serve as a training dataset. Three independent reviewers manually classified the sentiment of each post, with the mode of their assessments taken as the result. If there was disagreement among the reviewers, the post was categorized as "neutral/noise." Based on the manual classification results of the training dataset, a machine learning model was constructed using Weka, with the parameter K set to 5 to achieve the highest classification accuracy.

After training and validation, the classification model demonstrated a high accuracy rate, effectively automating the identification of investor sentiment in posts. In the analysis phase, posts classified as "neutral/noise" were excluded, focusing on the market impact of "positive" and "negative" sentiments. Through this approach, this study aims to gain a deeper understanding of how investor sentiment affects stock price volatility.

Table 9 presents the regression results that investigate the association between ESG disclosure and investor sentiment, employing various types of posts, including total posts (all post), positive posts (positive post), and negative posts (negative post), as dependent variables. The findings demonstrate that ESG disclosure exerts a statistically significant positive influence on the quantity of negative posts (negative post) at the 10% level, suggesting that the release of a company's ESG rating precipitates a notable increase in negative discussions pertaining to the company. This phenomenon may reflect the heightened sensitivity of investors, particularly among individual investors who are prone to irrationality or possess insufficient information, to negative news. Such sensitivity to negative information could potentially trigger greater emotional volatility, thereby amplifying market instability. However, for positive posts (positive post) and total posts

(all post), the impact of ESG disclosure is not statistically significant, further implying that individual investors may be more susceptible to the influence of negative information.

Table 10 Test of the Mechanism of Individual Investors' Sentiment on Stock Price Crash Risk

	(1)	(2)	(3)
VARIABLES	All post	Positive post	Negative post
ESG	0.0470	0.0264	0.0674*
	(0.0324)	(0.0302)	(0.0353)
Constant	5.570***	4.376***	3.530***
	(0.515)	(0.482)	(0.561)
Controls	Yes	Yes	Yes
Observations	31,771	31,771	31,771
R-squared	0.608	0.612	0.561
Firm Fe	Yes	Yes	Yes
Year Fe	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: We used the posts from East Money Forum to denote the independent variable. Other control variables of companies are relaxed, while fixed effects and cluster standard errors are still controlled.

V Conclusion and Suggestions

This study investigates the effects of ESG rating disclosures on stock price crash risk among listed companies on the Shanghai and Shenzhen stock exchanges from 2012 to 2022. Employing a multi-period difference-in-differences (DID) model, along with a series of key robustness tests—including correlation analyses to address multicollinearity, placebo tests to establish causality, and propensity score matching for ensuring comparability—we have found substantial evidence that ESG rating disclosures significantly elevate stock price crash risk. This finding is robust, persisting even after adjusting for firm-specific characteristics, industry variations, and annual fluctuations. Moreover, heterogeneity analysis indicates that the impact of ESG disclosures on crash risk is particularly pronounced in companies with high-quality disclosure practices and during bull market conditions. Our analysis also suggests that these disclosures indirectly heighten crash risk by exacerbating herd behavior among institutional investors and individual investors.

As an important supplement to capital market disclosure, ESG rating disclosure plays an important role in enhancing ESG performance of listed companies and guiding socially responsible investment. However, our study finds that ESG rating disclosure may trigger negative market reactions and increase the risk of stock price collapse. Therefore, regulators, listed companies and investors should be cautious about the impact of ESG disclosure and work together to address potential systemic financial risks.

Regulatory Improvement: Regulators could consider refining the ESG disclosure framework to improve the objectivity, comparability, and reliability of ESG ratings. Developing ESG disclosure guidelines that consider the unique characteristics of different industries and types of companies could help avoid a broad, one-size-fits-all approach. Additionally, enhancing oversight of third-party ESG rating agencies and standardizing rating practices would be beneficial in nurturing a more mature ESG investment ecosystem.

Companies should proactively manage their responses to third-party ESG evaluations and refine their internal ESG procedures, even when they have no direct influence over these ratings. It’s helpful for businesses to focus on truly enhancing their ESG performance, openly and regularly communicating about their sustainability initiatives, and fostering a positive public perception. Additionally, companies should actively engage with investors

by providing clear, consistent information that helps them understand the implications and details of ESG ratings. By doing this, companies can help reduce market volatility associated with changes in third-party ESG ratings and set appropriate expectations for the market.

Investor Education and Behavioral Guidance: Adjustments might be necessary when the market shows signs of irrational volatility, and this could be a good opportunity for some targeted investor education. Although institutional investors typically exhibit more rational behavior than individual investors, the prevalence of herd mentality can still lead to significant price drops. In such instances, it might be beneficial for regulators and industry self-regulatory organizations to offer investment rules and educational training to help investors grasp the long-term impacts of ESG ratings. Regulators play a crucial role in this process, striving to ensure that the rules of market behavior are just and reliable. This will enhance the transparency and accessibility of market information, enabling all market participants—especially individual investors—to access thorough information on the environmental, social, and corporate governance performance of companies, thus minimizing their investment risks.

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Appendices

Exhibit. 1. Test of the Mechanism of Individual Investors' Sentiment on Stock Price Crash Risk

	(1)	(2)	(3)
	post1	post2	post3
VARIABLES	allpost	pospost	negpost
EP	0.0470	0.0264	0.0674*
	(0.0324)	(0.0302)	(0.0353)
ROA	-0.107	0.140	-0.294***
	(0.0996)	(0.0931)	(0.107)
Size	0.181***	0.179***	0.189***
	(0.0155)	(0.0144)	(0.0168)
Lev	0.0528	0.0537	0.0653
	(0.0563)	(0.0520)	(0.0621)
Cashflow	0.451***	0.414***	0.479***
	(0.0749)	(0.0697)	(0.0815)
Growth	-0.0372***	-0.0223**	-0.0522***
	(0.0107)	(0.00997)	(0.0116)
Board	-0.0812	-0.0698	-0.0923
	(0.0580)	(0.0540)	(0.0635)
Indep	-0.000286	-0.000122	-0.000197
	(0.00165)	(0.00153)	(0.00180)
SA	0.168	0.188*	0.0809
	(0.117)	(0.110)	(0.127)
Constant	5.570***	4.376***	3.530***
	(0.515)	(0.482)	(0.561)
Observations	31,771	31,771	31,771
R-squared	0.608	0.612	0.561
Stkcd Fe	Yes	Yes	Yes
Year Fe	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Exhibit. 2. Test of the Mechanism of Institutional Investors' Herd Behavior on Stock Price Crash Risk

	(1)	(2)	(3)
	h1	h2	h3
VARIABLES	Herding	Herd_Buy	Herd_Sell
EP	0.00832***	0.0127***	-0.0233***
	(0.00216)	(0.00258)	(0.00828)
ROA	-0.0725***	-0.0101	-0.289***
	(0.0158)	(0.0142)	(0.0507)
Size	-0.0161***	-0.0129***	-0.0324***
	(0.00221)	(0.00203)	(0.00709)
Lev	-0.00618	-0.00434	0.0354
	(0.00949)	(0.00806)	(0.0257)
Cashflow	-0.0156	-0.0168	-0.0338
	(0.0109)	(0.0105)	(0.0374)
Growth	0.000951	0.00632***	-0.00679
	(0.00176)	(0.00176)	(0.00567)
Board	-0.00618	0.00121	-0.0312
	(0.00818)	(0.00776)	(0.0242)
Indep	-8.07e-05	-8.08e-05	-0.000652
	(0.000242)	(0.000231)	(0.000679)
SA	0.132***	0.0709***	0.260***
	(0.0167)	(0.0149)	(0.0519)
Constant	1.041***	0.703***	2.196***
	(0.0846)	(0.0703)	(0.250)
Observations	20,126	18,890	12,683
R-squared	0.467	0.368	0.349
Stkcd Fe	Yes	Yes	Yes
Year Fe	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Exhibit. 3. Heterogeneity Test of Information Disclosure Quality

VARIABLES	(1) in1 NCSKEW_Mdeq	(2) in2 NCSKEW_Mdeq	(3) in3 NCSKEW_Mdeq	(4) in4 NCSKEW_Mdeq
EP	-2.561	0.0278	0.0742	0.189***
	(1.900)	(0.304)	(0.0563)	(0.0636)
ROA	-0.734	-0.690**	-0.220	0.348
	(0.820)	(0.316)	(0.171)	(0.466)
Size	0.893	0.0732	0.0716***	0.0424
	(0.624)	(0.0556)	(0.0225)	(0.0524)
Lev	0.175	-0.424*	-0.141	0.104
	(1.276)	(0.227)	(0.0857)	(0.194)
Cashflow	-1.363	0.199	-0.0385	0.210
	(1.378)	(0.380)	(0.132)	(0.288)
Growth	-0.158	-0.00616	-0.00704	0.0163
	(0.191)	(0.0492)	(0.0203)	(0.0430)
Board	0.199	0.192	0.00816	0.262
	(0.786)	(0.256)	(0.0833)	(0.167)
Indep	0.00963	0.0139*	-0.00113	0.00214
	(0.0302)	(0.00768)	(0.00268)	(0.00441)
SA	4.336	-0.190	-0.402**	-0.147
	(2.902)	(0.438)	(0.182)	(0.258)
Constant	-3.940	-3.474*	-3.483***	-2.671*
	(9.441)	(1.958)	(0.826)	(1.618)
Observations	213	2,277	15,074	4,244
R-squared	0.484	0.355	0.250	0.331
Stkcd Fe	Yes	Yes	Yes	Yes
Year Fe	Yes	Yes	Yes	Yes

Exhibit. 4. Heterogeneity Test in Bull and Bear Markets

VARIABLES	(1) market1 NCSKEW_Mdeq	(2) market0 NCSKEW_Mdeq
EP	0.217***	0.137***
	(0.0347)	(0.0459)
ROA	-0.318*	-0.284
	(0.174)	(0.245)
Size	0.0607***	0.0914***
	(0.0227)	(0.0275)
Lev	-0.0687	-0.166
	(0.0928)	(0.105)
Cashflow	-0.0506	0.276
	(0.139)	(0.175)
Growth	0.00838	-0.0321
	(0.0206)	(0.0276)
Board	-0.0879	-0.0186
	(0.0947)	(0.107)
Indep	0.000413	0.00157
	(0.00281)	(0.00311)
SA	0.0454	-0.0797
	(0.159)	(0.192)
Constant	-1.472*	-2.638***
	(0.873)	(0.884)
Observations	13,942	8,859
R-squared	0.302	0.326
Stkcd Fe	Yes	Yes
Year Fe	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Exhibit. 5. Propensity Score Matching（PSM）

