International Journal of
Financial Studies

MDPI

Article

Do MD&A Risk Disclosures Reduce Stock Price Crash Risk? Evidence from China

Fei Su [1], Lili Zhai [1] and Jianmei Liu [2,*]

[1] College of Economics and Management, Nanjing University of Aeronautics and Astronautics, Nanjing 211106, China; fei.su@nuaa.edu.cn (F.S.); lilizhai2022@163.com (L.Z.)
[2] Department of Accounting, Tianjin University of Finance and Economics, Tianjin 300222, China
* Correspondence: weifangljm@126.com; Tel.: +86-138-2191-6263

Abstract: This study examines whether and how risk disclosures in Management Discussion and Analysis (MD&A) affected the stock price crash risk of China's publicly listed firms over the period of 2017–2021. The empirical results show that risk disclosures within the MD&A section are significantly and negatively associated with the future stock price crash risk, even after controlling for a broad set of well-known factors of crash risk. Additional tests revealed that the impact of MD&A risk disclosures on the stock price crash risk is accentuated when the MD&A disclosure contains more incremental information. The negative association between MD&A risk disclosures and stock price crash risk is also more pronounced for firms with poorer information environments, for firms with weaker external monitoring, and for firms with more investor attention. Our findings are robust to alternative measures of the stock price crash risk, controlling for firm-fixed effects and endogeneity issues, and excluding certain samples. The results indicate that MD&A risk disclosures could help alleviate information asymmetry and mitigate stock price crash risk.

Keywords: MD&A; risk disclosure; stock price crash risk; information asymmetry

Citation: Su, Fei, Lili Zhai, and Jianmei Liu. 2023. Do MD&A Risk Disclosures Reduce Stock Price Crash Risk? Evidence from China. *International Journal of Financial Studies* 11: 147. https://doi.org/10.3390/ijfs11040147

Academic Editor: Zied Ftiti

Received: 31 July 2023
Revised: 30 October 2023
Accepted: 29 November 2023
Published: 12 December 2023

1. Introduction

In the era of big data, descriptive and qualitative information plays an increasingly important role in investment decision making and should be explored more in finance research. Several academic researchers have called for more empirical research on the textual analysis of corporate disclosures by listed firms (Healy and Palepu 2001; Leuz and Wysocki 2016). Among the many types of corporate disclosures, Management Discussion and Analysis (MD&A) provides retrospective information about the firm in narrative language to enable investors to evaluate the firm's operating performance and financial position. MD&A also discloses information about the firm's future development prospects, which is also of great relevance to investors and stakeholders (Liu 2021). In point of fact, the limited amount of accounting and finance research in the area of qualitative information analysis is not surprising given the limited data availability. We seek to fill this void by investigating the impact of MD&A risk disclosures in listed firms' annual financial reports on the future stock price crash risk.

Management Discussion and Analysis (MD&A), which contains a large amount of non-financial information, can play an informative role in mitigating information asymmetry by supplementing traditional accounting statements such as financial ratios and accounting numbers (Liu 2021). To bridge the gap between theory and practice on economic costs and benefits of MD&A disclosure and extend the scope of the extant literature on MD&A disclosure, this paper investigates the impact of MD&A risk disclosures on mitigating the stock price crash risk in the Chinese setting. Unlike prior studies, we focus on the content of MD&A disclosure and its economic meaning. Our analysis allows for a deep understanding of the economic implications of MD&A disclosure beyond general textual readability and sentiment. We provide an initial examination of the corporate risk disclosed within the MD&A section and link it to the future stock price crash risk.

Our contributions are threefold. First, the existing studies on the stock price crash risk have widely explored the determining factors of the stock price crash risk. Researchers in this area have extensively examined the effects of the mandatory adoption of international financial reporting standards (DeFond et al. 2015), accounting conservatism (Kim and Zhang 2016), tax avoidance (Kim et al. 2011a), and management equity incentives (Kim et al. 2011b; Sun et al. 2019) on the stock price crash risk. However, MD&A is also an important venue for investors to evaluate the firm's operating performance and financial position, and to better understand the firm's future risks. To the best of our knowledge, this is the first study that relates MD&A risk disclosures to the stock price crash risk. Our findings provide strong support for the notion that MD&A risk disclosure appears to alleviate information asymmetry and mitigate the stock price crash risk. In this regard, we believe that this study adds an interesting and important piece to the literature on the effectiveness of informative risk disclosure.

Second, we comprehensively analyze the mechanisms underlying the relationship between MD&A risk disclosure and stock price crash risk, which sheds new light on the literature about stock price crash risk and complements the growing literature on the economic benefits of MD&A disclosure. We find that more risk disclosures within the MD&A section are associated with fewer stock price crash risks and less information asymmetry. These findings also contribute to the literature on the effect of informative disclosure on corporate asymmetry. The MD&A section discloses the current status and future prospects of the firm and helps investors obtain incremental information about the firm, and thus reduce information asymmetry and improve corporate transparency (Roberts et al. 2006; Li et al. 2018; Liu 2021).

Third, the financial sector currently supplies a large amount of qualitative textual information. This textual information includes macro policies, regulatory filings, firm announcements, analyst reports, press news, and social media posts, among many others (Huang et al. 2020). Our paper relates to the fast-growing literature on textual analysis in financial markets. We enrich the extant literature by analyzing the economic contents and regulatory implications of MD&A disclosure quality and testing the role of risk disclosures on alleviating stock price crash risk. This study more generally adds to the literature on the informativeness of MD&As (Brown and Tucker 2011; Feldman et al. 2010; Cole and Jones 2005; Mayew et al. 2015). Our paper provides convincing evidence that MD&A disclosure can reduce future stock price crash risks via both its informational and monitoring roles. Therefore, understanding the determinants of the crash risk allows regulators and governance practitioners to design mechanisms to mitigate this risk, which is important for restoring investor confidence, particularly for developing markets (Blanchard 2009; Kim et al. 2013).

The remainder of the paper is organized as follows: Section 2 reviews the literature and develops our hypotheses; Section 3 introduces the sample and proposes the empirical model; Section 4 presents the main empirical findings; several additional robustness checks and further analyses are reported in Section 5; and Section 6 concludes the paper.

2. Literature Review and Hypothesis Development

2.1. Literature on the Stock Price Crash Risk

Prior studies argued that a lack of corporate transparency enables managers to withhold bad news due to managerial opportunism (Kim et al. 2011a), compensation contracts (Graham et al. 2005), option portfolio value (Kim et al. 2011b), career concerns (Kothari et al. 2009; Li and Myers 2006; LaFond and Watts 2008; Verrecchia 2001), and tournament incentives (Sun et al. 2019).[1] The bad news hoarding theory of Li and Myers (2006) suggests that when managers withhold and conceal bad news for an extended period, negative information is likely to be stockpiled within a firm. If managers accumulate and withhold bad news up to a certain threshold, the previously unobserved bad information will likely be released all at once, leading to extremely large, negative stock returns for the firms concerned, also known as stock price crashes (Liu 2021; Li et al. 2022; Hutton et al. 2009; Li and Myers 2006; Yuan et al. 2016). Stock price crashes undoubtedly have a devastating effect on investor welfare and it is therefore important to understand their determinants (Kim et al. 2019).

Following this idea, researchers have subsequently examined the causes and determinants of the stock price crash risk, including the mandatory adoption of certain financial reporting standards (DeFond et al. 2015), aggressive MD&A disclosure (Liu 2021; Li et al. 2022), managerial opportunism (Kim et al. 2011a), accounting conservatism (Kim and Zhang 2016), tax avoidance (Kim et al. 2011b), managers' equity and tournament incentives (Kim et al. 2011b; Sun et al. 2019), analysts' and institutional investors' information acquisition activities (Xu et al. 2013; An and Zhang 2013; Yang et al. 2020), religion and social trust (Callen and Fang 2015), and the purchase of directors' and officers' liability insurance (Yuan et al. 2016). Those studies showed that managers tend to hide bad news for various reasons, such as either keeping their own position (Verrecchia 2001; Graham et al. 2005) or increasing the option portfolio value in the short term (Kim et al. 2011a). Because of information asymmetry, it is difficult for investors to uncover the hidden information, and the strategic bad news hoarding behavior by managers could lead to stock price crashes. The prior studies also suggested that the occurrence of stock price crashes greatly harms the firm value and shareholder interests (Sun et al. 2019).

In addition, Kim et al. (2011a, 2011b) found that tax avoidance and equity incentives are also positively associated with a firm's crash risk. Non-financial reporting activities, such as corporate social responsibility (Kim et al. 2014), religion (Callen and Fang 2015), social trust (Li et al. 2017), and the crackdown on corruption (Chen et al. 2018), have also been shown to impact the stock price crash risk. Moreover, some of the literature relates internal and external control and monitoring mechanisms to the crash risk. For example, it has been documented that independent directors' monitoring incentives (Petra 2005; Tang et al. 2013), institutional investors' stability (Callen and Fang 2013), industry-specialist auditors (Robin and Zhang 2015), and D&O insurance coverage (Yuan et al. 2016) can attenuate the firm-level stock price crash risk, whereas weak internal controls (Chen et al. 2017) and analyst herding (Xu et al. 2013; Xu et al. 2017) increase the stock price crash risk. In summary, as documented in the prior literature, the most important causes of stock price crash risk include information asymmetry between insiders and outsiders, the principal-agent problem, and the lack of effective regulation (Callen and Fang 2015; Li et al. 2017; Yang et al. 2020).

2.2. Literature on Textual Analysis of Corporate Disclosure

Extant research has shown that the length, readability, and tone of corporate disclosures including annual reports, corporate news and announcements, and periodic material event filings are all related to different aspects of firms, and in particular to stock returns (Huang et al. 2020). For example, Tetlock et al. (2008) examined the sentiment of corporate news (by counting negative and positive words), and found that the "tone" predicts the cross-section of stock returns. Zhao (2017) found that higher Form 8-K filing frequency is associated with lower future returns. Prior studies have also linked the content of news to stock return momentum and reversals (Chan 2003; Tetlock 2007, 2011). Loughran and McDonald (2016) provided a comprehensive survey of text mining in the academic accounting and finance literature in the US market. In addition, managements' disclosures in their 10-K filing can ascertain managements' perception of product market competition (Li et al. 2013; Li and Zheng 2017).

The textual analysis of corporate disclosures provides incremental information about the firm, and arguably facilitates more intelligent decision making. Questionnaire survey results show that most investors believe that descriptive qualitative information plays an important role in making investment decisions and should be disclosed more often and more thoroughly in financial reports. For example, Mayew and Venkatachalam (2012) found that the audio tone displayed by managers is informative about the firm's future financial performance such as ROA. Zhu and Xu (2018) found that managers' tone of optimism (or pessimism) in annual reports is associated with upward (or downward) earning management. However, managers may use corporate disclosure as a strategic tool to pursue their own interests by manipulating the disclosure timing (Lang and Lundholm 2000) or disclosure tone (Huang et al. 2014). Hutton et al. (2009) found that the opacity of a firm's financial reports is positively related to its future crash risk. Similarly, Kim et al. (2019) showed that less readable 10-K reports are associated with higher stock price crash risk. By contrast, Luo et al. (2018) found that firms with better annual report readability experience lower agency costs.

While the textual analysis of corporate disclosures is becoming a promising research direction in finance research, its application in MD&A disclosures is still limited. There are two MD&A disclosure papers that are closely related to our study. Mayew et al. (2015) explored the role of MD&A textual disclosures in predicting a firm's ability to continue as a going concern. In addition, Liu (2021) documented that the linguistic tone of the MD&As does not necessarily predict the future stock price crash risk, and only highly readable negative information can alleviate information asymmetry and reduce the crash risk. Unlike these two studies that mainly explored the sentiment and readability of the text, we focus on the economic content of MD&A textual disclosures that specifically relates to risks. The quality of MD&A risk disclosure is measured by whether management discloses related risks, and whether such disclosures reduce the future stock price crash risk. Our study complements and extends their work by conducting a more in-depth textual analysis and showing that risks disclosed within the MD&A section can prevent the hoarding of bad news and reduce the stock price crash risk.

2.3. Hypothesis Development

Corporate managers have an informational advantage over investors regarding the profitability and risks of their firms' business. Regulators have traditionally responded to such a dilemma by encouraging corporations to make more meaningful risk disclosures (Jorgensen and Kirschenheiter 2003; Kravet and Muslu 2013). These disclosure requirements, such as disclosing risk factors that may impair firms' future operating and financial performance within the MD&A section of annual reports, could alleviate information asymmetry and reduce the future stock price crash risk. In this study, we examine the quality and informativeness of MD&A risk disclosure in terms of alleviating stock price crash risk. Our paper directly contributes to the debate on the informativeness of MD&A disclosures by assessing whether and how an existing disclosure in a firm's MD&A informs about the firm's future stock price crash risks. Therefore, we propose the first testable hypothesis for the impact of MD&A risk disclosures on the stock price crash risk as follows:

Hypothesis 1. *MD&A risk disclosures reduce future stock price crash risks.*

There are several possible ways through which MD&A risk disclosures mitigate stock price crash risk. For example, by assessing MD&A qualitative disclosures, investors can obtain incremental information or confirm their pre-existing beliefs about the firm, which will alleviate information asymmetry problems. However, a number of scholars have argued that when the managers disclose bad news, they will intentionally increase its complexity and reduce its readability (i.e., making the information ambiguous and obscure) (Asay et al. 2018; Li 2008; Kim et al. 2019). Because the text information has a large amount of qualitative information and poor verifiability, when the management discloses negative information, they may strategically reduce the statements' readability, making the information hard or even impossible to be absorbed by investors and thereby unable to timely convey negative information to the market (Luo et al. 2018; Liu 2021). Therefore, compared to the firms with less readable MD&A risk disclosure, the information provided by the firms with higher readability of MD&A section has a stronger negative association with future crash risk. Similarly, a lower textual similarity in MD&A provides significant incremental information about a firm's future prospect. Accordingly, we propose the second and third hypotheses as follows:

Hypothesis 2. *The negative association between MD&A risk disclosures and the stock price crash risk is more pronounced when the MD&A risk disclosure contains more incremental information (i.e., the disclosure is more readable, while less similar), ceteris paribus.*

Intuitively, the benefits of acquiring firm-specific risk information through the text analysis of MD&A disclosures would be higher if the firm concerned is inclined to withhold negative information. For example, more valuable-but-hidden firm-specific risk information may be discovered in the MD&As for firms with poorer information environments (Liu et al. 2017; Cheng et al. 2019). By contrast, for firms with good information environments, textual information tagged in the MD&A section may not be that useful since the information required has been made public and available to market participants. Based on the above arguments, we propose our third hypothesis as follows:

Hypothesis 3. *The negative association between MD&A risk disclosure and the stock price crash risk is more pronounced for firms with poorer information environments, ceteris paribus.*

As one of the most important external monitoring mechanisms, high audit quality can substantially improve audited firms' information environments with auditors' information search behavior and their professional auditing capacity (DeAngelo 1981; Khurana and Raman 2004). MD&A is a critical component of the communication between management and investors, and the benefits of such communication will be greater when the firm faces weak internal and external monitoring since the issue of the stock price crash risk of listed firms will be more severe when the monitoring mechanism is not functioning well (Jiang and Yuan 2018). Therefore, MD&A risk disclosures can better complement the monitoring function and mitigate the stock price crash risk when the firms face more severe agency problems and weaker internal and external monitoring. Hence, the above arguments lead to the following hypothesis:

Hypothesis 4. *The negative association between MD&A risk disclosures and the stock price crash risk is more pronounced for firms with weaker monitoring, ceteris paribus.*

Investor attention is a scarce resource (Kahneman 1973) and will influence stock trading and firm valuation in the capital markets (An and Su 2021). For example, listed firms that have been followed by more analysts are more likely to gain investors' attention. Similarly, larger firms tend to attract more attention from investors where information transmission is more frictionless and more accurately reflected in stock prices. Therefore, we predict that the negative association between MD&A risk disclosures and stock crash risk is more pronounced for firms with more investor attention. That is, for firms that are larger and observed by more analysts, the inhibitory effect of MD&A risk disclosure on the stock price crash risk may be accentuated:

Hypothesis 5. *The negative association between MD&A risk disclosures and the stock price crash risk is more pronounced for firms with more investor attention, ceteris paribus.*

3. Data and Model Specification

3.1. Sample and Data

Our sample comprises A shares listed on the Shanghai and Shenzhen Stock Exchange that were traded in renminbi (CNY) during the period from 2017 to 2021, which represents around 75% of all listed firms (i.e., 2407 out of 3436 in 2018, 3025 out of 3693 in 2019, 3163 out of 4071 in 2020, and 3174 out of 4595 in 2021) in Mainland China. However, firms in the financial industry are eliminated. We collected data on the stock price crash risk from the China Stock Market and Accounting Research (CSMAR) database. In addition, to control for other factors affecting the stock price crash risk, we obtained data on ownership structure, firm characteristics, stock trading, and media and analyst coverage from the CSMAR database. Definitions of the main variables are provided in Appendix A.1. After merging all variables and eliminating the observations with one or more missing control variables, we obtained 11,769 firm-year observations spanning the period from 2017 to 2021. To minimize the impacts of outliers, we winsorized all continuous variables at the 1% and 99% quantile levels.

3.2. Variable Definition: Stock Price Crash Risk

To measure the stock price crash risk, referring to the previous literature (Kim et al. 2011a, 2011b; Xu et al. 2014; Callen and Fang 2015), we performed the following regression of an expanded market model for our sample firms in each year:

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

where $r_{i,t}$ is the weekly stock return of firm i in week t, and $r_{m,t}$ is the weekly return of the capitalization-weighted market portfolio in week t. Leading and lagging weekly market returns are added to control for nonsynchronous trading (Dimson 1979). Here, the natural logarithm of one plus the residual ($\varepsilon_{i,t}$) from the above equation is defined as the firm-specific weekly return (Hutton et al. 2009).

This paper uses three variables to measure the stock price crash risk of firm i in year t. The first one is the negative coefficient of skewness (NCSKEW), calculated by taking the negative value of the third moment of firm-specific weekly returns of firm i for each year and normalizing it by the standard deviation of firm i's weekly returns in year t raised to the third power. Therefore, a larger NCSKEW indicates a higher negative skewness of stock i's return distribution and hence corresponds to stock i being more "crash prone" (Chen et al. 2001; Xu et al. 2014). The second proxy is the down-to-up volatility (DUVOL). For each firm i over year t, trading weeks can be separated into down weeks when the firm-specific weekly returns are below the annual average return, and up weeks when they are above their annual mean. The standard deviations of firm-specific weekly returns are calculated separately for down weeks and up weeks. Down-to-up volatility is then defined as the natural logarithm of the ratio of the standard deviation of firm-specific weekly returns in the down weeks to the standard deviation in the up weeks. In the robustness checks, we also utilize the extremely negative return as an alternative proxy for stock price crash risk. Namely, CRASH equals 1 if at least one of firm i's firm-specific weekly returns is three standard deviations below its mean firm-specific weekly return over the entire fiscal year t, and 0 otherwise.

3.3. Variable Definition: MD&A Risk Disclosure

MD&A disclosures were manually collected form annual financial reports of China's listed firms. The sample period is from 2017 to 2021. We referred to Li (2010) and Liu (2021) and used machine learning methods to conduct text analysis on MD&A information. Specifically, we measured risk disclosures by counting the frequency of words related to risk in the MD&As of firm i's annual reports.[2]

In addition, we adopted the naïve Bayes algorithm to classify the text information in the MD&A section into positive and negative information (Li 2010; Liu 2021)[3]:

$$Neg\_Tone_{i,t} = \frac{N\_Neg_{i,t} - N\_Pos_{i,t}}{N\_Neg_{i,t} + N\_Pos_{i,t} + N\_Neu_{i,t}} \quad (2)$$

where $N\_Neg_{i,t}$, $N\_Pos_{i,t}$, and $N\_Neu_{i,t}$ stand for the number of positive, negative, and neutral sentences within the MD&A section of firm i's annual reports in year t. This variable ranges between -1 and 1. For example, it equals -1 if all the sentences within the MD&A section are positive and equals 1 if all the sentences are negative.

3.4. Model Specification: Baseline Model

To test the impact of MD&A risk disclosures on the future stock price crash risk, we implemented the following regression model:

$$\text{CRisk}_{i,t+1} = \beta_0 + \beta_1 \text{RiskDis}_{i,t} + \sum \gamma \text{Controls} + \text{Industry} + \text{Year} + \epsilon_{i,t+1} \quad (3)$$

where the dependent variable CRisk is proxied by either NCSKEW or DUVOL in the main regression, and by the CRASH dummy in our robustness test. We ran OLS regressions for NCSKEW and DUVOL and logistic regressions for CRASH. Our main hypothesis would be supported if β_1 is negative and significant. All the independent variables were one-year lagged from the dependent variables to account for the bi-directional causality, i.e., whether MD&A risk disclosure at the end of financial year t can alleviate the stock price crash risk in year t + 1. Here, to ensure the robustness of our analysis, we adopted both the number of words related to risk in the MD&A section and the ratio of words related to risk to the total number of words within the MD&A section (RiskDis). In addition, we also controlled for the percentage difference of negative and positive words divided by the total number of words in the MD&A section for firm i in year t (NegTone) (Liu 2021). Industry and Year stand for the industry fixed effect and year fixed effect, respectively.

Previous literature showed that large firms and growth firms are more likely to experience stock price crashes (e.g., Kim et al. 2011a; Kim and Zhang 2016). Hutton et al. (2009) and Kim et al. (2011a, 2011b) also suggested that better firm operating performance is associated with lower crash risk. In addition, stocks with higher turnover, return volatility, or past returns are more susceptible to crash risk (e.g., Chen et al. 2001; Kim et al. 2011a, 2011b; Xu 2012; Kim and Zhang 2016; Su et al. 2021). Following these prior studies, we controlled for a comprehensive array of independent variables that may affect the stock price crash risk including the detrended annual stock turnover (Turnover), average monthly stock returns (Ret), firm size (Size), book-to-market ratio (B/M), return on assets (ROA), leverage ratio (Leverage), and the ratio of independent directors (Indep). Since volatile stocks are more likely to undergo crash risk, we included the standard deviation of weekly firm-specific returns (Sigma) as a control variable (Wen et al. 2019). We also controlled for variables regarding firms' ownership structure, such as managerial ownership (ManOwn), institutional ownership (InstOwn), and ownership concentration (Conc). In addition, we took account of internal and external monitoring by controlling for news coverage (News), analyst coverage (Analyst), whether the firm was audited by a Big 4 auditing firm (Big 4), and whether the firm is a state-owned enterprise (SOE). All of the control variables as described in Appendix A.1 were obtained from the China Stock Market and Accounting Research Database (CSMAR) and the Chinese Research Data Services (CNRDS) database.

4. Empirical Results

4.1. Descriptive Statistics

Panel A of Table 1 presents the descriptive statistics for the variables used in our study. The mean values of crash risk measures including NCSKEW, DUVOL, and CRASH are −0.3504, −0.2409, and 0.1168, respectively. The mean value of CRASH indicates that 11.68% of the firm-year observations in our sample experienced at least one crash week during our sample period. These statistics are consistent with those of prior studies in the MD&A disclosure literature (e.g., Liu 2021), suggesting that our crash risk measures are reliable compared to other studies. MD&A risk disclosure, denoted by RiskDis, has a mean (median) value of 0.4217 (0.4000), with a standard deviation of 0.1882, indicating that on average, 0.42% of MD&A statements in the annual reports of listed firms are risk-related sentences. The mean value of NegTone is −0.2537, indicating that statements in the MD&As are generally more pessimistic, i.e., there are more negative words than positive words used in the MD&A statements of Chinese listed firms.

Table 1. Descriptive statistics.

Panel A: Summary Statistics								
Variable	**Obs**	**Mean**	**Std Dev**	**Median**	**Min**	**Max**	**Skew**	**Kurt**
NCSKEW	11,769	−0.3504	0.8359	−0.3270	−5.1729	5.0779	0.1344	3.0612
DUVOL	11,769	−0.2409	0.5126	−0.2548	−2.5246	3.3754	0.3177	1.2317
CRASH	11,769	0.1168	0.3212	0.0000	0.0000	1.0000	2.3860	3.6936
RiskDis	11,769	0.4217	0.1882	0.4000	0.0000	1.5300	0.9159	1.6292
NegTone	11,769	0.2537	0.1258	0.2636	−0.6136	0.6908	−0.5097	0.7672
Turnover	11,769	2.4603	2.3335	1.7097	0.0298	22.8908	2.5511	9.5761
Ret	11,769	0.0212	0.5078	−0.0773	−0.8259	14.2426	4.2991	64.8407
Sigma	11,769	42.5960	14.6950	40.5673	10.1265	147.2803	1.0293	1.9756
News	11,769	2.9770	0.8762	2.9957	0.6931	7.2738	0.0980	0.5318
Indep	11,769	0.1592	0.0289	0.1540	0.0814	0.3466	0.5665	0.4034
ManOwn	11,769	0.1422	0.1946	0.0164	0.0000	0.9000	1.2127	0.2722
InstOwn	11,769	0.3849	0.2359	0.3883	0.0000	3.2673	0.2893	1.0570
Conc	11,769	0.5860	0.1460	0.5927	0.1459	0.9793	−0.1379	−0.4724
SOE	11,769	0.3113	0.4631	0.0000	0.0000	1.0000	0.8150	−1.3359
Size	11,769	22.8284	1.1723	22.6275	20.4482	29.7878	1.0271	1.5208
MB	11,769	0.6605	0.2548	0.6602	0.0227	1.4838	0.0008	−0.5557
ROA	11,769	0.04109	0.3128	0.0504	−29.2880	8.1491	−69.1115	6619.9400
Big4	11,769	0.0546	0.2271	0.0000	0.0000	1.0000	3.9234	13.3957
Analyst	11,769	2.0312	0.9710	1.9459	0.6931	4.3307	0.1862	−1.1235
Readability	11,769	4.2101	1.0615	4.2649	−0.4501	8.2121	−0.2092	0.2004
Similarity	11,769	94.6825	4.0085	95.5900	39.9000	99.7600	−3.8401	26.4284
SYN	11,769	0.4316	0.1876	0.4317	0.0004	1.0000	0.0419	−0.6209
IVOL	11,769	0.0809	0.0257	0.0784	0.0214	0.2256	0.5375	0.3137
VPIN	11,698	0.2426	0.0409	0.2446	0.0000	0.3774	−0.6629	2.3230

Panel B: Pearson Correlation Coefficients								
Variable	**NCSKEW**	**DUVOL**	**CRASH**	**RiskDis**	**NegTone**	**Turnover**	**Ret**	**Sigma**
NCSKEW	1.0000	0.8775 ***	0.5219 ***	−0.0255 ***	−0.0079	−0.0974 ***	−0.1669 ***	−0.2107 ***
DUVOL		1.0000	0.4405 ***	−0.0275 ***	−0.0090	−0.1030 ***	−0.1975 ***	−0.1994 ***
CRASH			1.0000	0.0191 **	−0.0365 ***	−0.0294 ***	−0.1463 ***	−0.0019
RiskDis				1.0000	−0.1613 ***	0.0191 **	−0.0235 **	0.0257 ***
NegTone				−0.1613 ***	1.0000	−0.0079	0.0567 ***	−0.0939 ***
Turnover				0.0191 **	−0.0079	1.0000	0.1309 ***	0.6023 ***
Ret				−0.0235 **	0.0567 ***	0.1309 ***	1.0000	0.2579 ***
Sigma				0.0257 ***	−0.0939 ***	0.6023 ***	0.2579 ***	1.0000
Variable	**News**	**Indep**	**Manown**	**Instown**	**Conc**	**SOE**	**Size**	**MB**
NCSKEW	0.0264 ***	−0.0036	0.0271 ***	0.0211 **	0.0618 ***	−0.0687 ***	0.0193 **	−0.0037
DUVOL	0.0196 **	0.0010	0.0290 ***	0.0156 *	0.0641 ***	−0.0695 ***	0.0079	0.0177 *
CRASH	0.0021	−0.0099	0.0006	−0.0408 ***	0.0023	−0.0406 ***	−0.0783 ***	0.0319 ***
RiskDis	−0.0982 ***	−0.0046	−0.0147	−0.0269 ***	−0.0296 ***	0.0242 ***	−0.0295 ***	0.0456 ***
NegTone	−0.0058	0.0124	0.0974 ***	0.0264 ***	0.0833 ***	0.0293 ***	0.1054 ***	−0.0161 *
Turnover	0.0214 **	0.1473 ***	0.3255 ***	−0.4081 ***	−0.01234	−0.2336 ***	−0.3634 ***	−0.2276 ***
Ret	0.2930 ***	0.0271 ***	0.0246 ***	0.1093 ***	0.0268 ***	−0.0163 *	0.2482 ***	−0.3149 ***
Sigma	0.2326 ***	0.0779 ***	0.1457 ***	−0.1991 ***	−0.0714 ***	−0.1763 ***	−0.2235 ***	−0.2802 ***
News	1.0000	−0.0491 ***	−0.0420 ***	0.1080 ***	0.0083	−0.1161 ***	0.4012 ***	−0.0402 ***
Indep		1.0000	0.2624 ***	−0.2021 ***	0.0360 ***	−0.2820 ***	−0.1792 ***	−0.1382 ***
ManOwn			1.0000	−0.5313 ***	0.1864 ***	−0.4574 ***	−0.3365 ***	−0.1673 ***
InstOwn				1.0000	0.3804 ***	0.4013 ***	0.5289 ***	0.0717 ***
Conc					1.0000	−0.0062	0.1499 ***	0.0387 ***
SOE						1.0000	0.3120 ***	0.2610 ***
Size							1.0000	0.2464 ***
MB								1.0000

Table 1. *Cont.*

Variable	ROA	Big4	Readability	Analyst	Similarity	SYN	IVOL	VPIN
NCSKEW	−0.0113	0.0148	0.0321 ***	0.1397 ***	−0.0136	0.0087	−0.1000 ***	0.0393 ***
DUVOL	−0.0109	0.0122	0.0258 **	0.1227 ***	−0.0144	0.0001	−0.1282 ***	0.0390 ***
CRASH	−0.0254 ***	−0.0291 ***	0.0290 ***	−0.0714 ***	0.0011	−0.0694 ***	−0.0459 ***	−0.0127
RiskDis	−0.0324 ***	0.0008	−0.0273 **	−0.0490 ***	0.0528 ***	0.0514 ***	0.0002	−0.0427 ***
NegTone	0.1058 ***	0.0166 *	−0.1183 ***	0.09111 ***	0.0578 ***	0.0423 ***	−0.0811 ***	0.0732 ***
Turnover	−0.1080	−0.1034 ***	0.2190 ***	−0.1784 ***	0.0638 ***	−0.1645 ***	0.6393 ***	0.1040 ***
Ret	0.0942 ***	0.0470 ***	−0.0347 ***	0.2319 ***	−0.0056	−0.2802 ***	0.3604 ***	−0.0379 ***
Sigma	−0.0511 ***	−0.0952 ***	0.1820 ***	−0.0846 ***	−0.0062	−0.2122 ***	0.8565 ***	0.0654 ***
News	−0.0328 ***	0.1368 ***	−0.0129	0.2643 ***	−0.0653 ***	−0.1628 ***	0.2734 ***	−0.1011 ***
Indep	0.0320 ***	−0.0390 ***	0.1576 ***	0.0086	0.0842 ***	−0.0266 ***	0.0952 ***	0.0742 ***
ManOwn	0.0409 ***	−0.1143 ***	0.3100 ***	−0.0100	0.1249 ***	−0.0694 ***	0.1875 ***	0.1614 ***
InstOwn	0.0512 ***	0.2260 ***	−0.2924 ***	0.2792 ***	−0.0671 ***	−0.0062	−0.1786 ***	−0.0855 ***
Conc	0.0687 ***	0.1687 ***	−0.0062	0.1073 ***	0.0158*	−0.0887 ***	−0.0161 *	0.0948 ***
SOE	0.0022	0.1213 ***	−0.4207 ***	−0.0054	−0.0858 ***	0.1707 ***	−0.2387 ***	−0.1094 ***
Size	0.0586 ***	0.3449 ***	−0.3144 ***	0.4731 ***	−0.0749 ***	−0.0310 ***	−0.1963 ***	−0.2203 ***
MB	−0.0087	0.0968 ***	−0.2448 ***	−0.2319 ***	−0.0207 **	0.3310 ***	−0.4167 ***	−0.1688 ***
ROA	1.0000	0.0198 **	−0.0148	0.3004 ***	0.0319 ***	−0.0190 **	−0.0300 ***	0.0786 ***
Big4		1.0000	−0.0926 ***	0.1658 ***	−0.0139	−0.109	−0.0915 ***	−0.0707 ***
Readability			1.0000	−0.0300 **	0.1287 ***	−0.1277 ***	0.2309 ***	0.1325 ***
Analyst				1.0000	−0.0089	−0.1560 ***	0.0338 ***	0.0216 *
Similarity					1.0000	0.0488 **	−0.0185 **	0.0332 ***
SYN						1.0000	−0.3763 ***	−0.0416 ***
IVOL							1.0000	0.0865 ***
VPIN								1.0000

This table reports descriptive statistics for the main variables in Panel A, and their correlation matrix in Panel B. The sample period is from 2017 to 2021 for independent variables. However, the dependent variables NCSKEW, DUVOL, and CRASH are one year ahead of other variables. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% significance levels, respectively. All variables are defined in Appendix A.1. Panel B of Table 1 presents the Pearson correlation matrix for the main variables.

The results in Panel B of Table 1 indicate a significantly negative relationship between MD&A risk disclosures and stock price crash risk. In addition, the correlation between MD&A risk disclosures and the information asymmetry proxy (VPIN) is negative and statistically significant, indicating that disclosing more risk information is associated with lower information asymmetry.[4]

4.2. Baseline Regression Results

Table 2 reports the multivariate regression results regarding the relationship between MD&A risk disclosure and stock price crash risk. The variable of interest β_1, which measures the impact of risk disclosure within the MD&A section on the future stock price crash risk, is expected to be negative. As shown in columns (1) to (4) of Table 2, MD&A risk disclosure (RiksDist) and firms' future stock price crash risk ($NCSKEW_{t+1}$) are negatively correlated at the 1% (5%) significance level, depending on whether control variables are included in the regressions; RiksDist and $DUVOL_{t+1}$ are also negatively correlated at the 1% significance level, even after controlling for a set of control variables that may influence stock price crash risk. The economic effect of MD&A risk disclosure on crash risk is comparable to that of other determinants of crash risk identified in prior research. For example, the average marginal effects of MD&A risk disclosures on the stock price crash risk are −0.0873 and −0.0666 for NCSKEW and DUVOL, respectively, which indicates that a 1% increase in MD&A risk disclosure is associated with a decrease of 0.0873 (0.0666) in the probability of stock price crashes.

Table 2. Relationship between MD&A risk disclosure and stock price crash risk: baseline regression.

Indep. Var.	**Dep. Var.**			
	NCSKEW$_{t+1}$	**NCSKEW$_{t+1}$**	**DUVOL$_{t+1}$**	**DUVOL$_{t+1}$**
	(1)	**(2)**	**(3)**	**(4)**
RiskDis$_t$	−0.14617 *** (−3.63)	−0.0873 ** (−2.15)	−0.1037 *** (−4.23)	−0.0666 *** (−2.69)
NegTone$_t$		−0.1432 ** (−2.31)		−0.0772 ** (−2.04)
Turnover$_t$		0.0077 (1.70)		0.0057 ** (2.07)
Ret$_t$		0.1610 *** (8.08)		0.1099 *** (9.05)
Sigma$_t$		−0.0040 *** (−5.26)		−0.0027 ** (−5.94)
News$_t$		0.0244 ** (2.12)		0.0165 ** (2.35)
Indep$_t$		−0.5917 ** (−2.16)		−0.2894 * (−1.73)
ManOwn$_t$		−0.0267 (−0.48)		−0.0153 (−0.45)
InstOwn$_t$		−0.0800 (−1.51)		−0.0402 (−1.24)
Conc$_t$		0.2539 *** (3.88)		0.1257 *** (3.15)
SOE$_t$		−0.1121*** (−5.63)		−0.0698 *** (−5.76)
Size$_t$		0.0593 *** (5.75)		0.0317 *** (5.05)
ROA$_t$		−0.0201 (−0.84)		−0.0249 (−1.68)
MB$_t$		−0.3032 *** (−8.36)		−0.1732 *** (−7.83)
Big4$_t$		−0.0176 (−0.50)		−0.0168 (−0.78)
Constant	−0.3772 −16.57	−1.4593 (−6.55)	−0.2389 *** −17.23	−0.7988 *** (−5.88)
Observations	11,767	11,767	11,767	11,767
Year FE	Yes	Yes	Yes	Yes
Ind FE	Yes	Yes	Yes	Yes
Adj. R-squared	0.0208	0.0527	0.0247	0.0565

This table reports the results regarding the impact of risk disclosures within MD&A section on the stock price crash risk of China's publicly listed firms, where columns (1) and (2) report the results using NCSKEW as the dependent variable, while columns (3) and (4) report the results using DUVOL as the dependent variable. All variables are defined in Appendix A.1. The t-statistics reported in parentheses are based on standard errors clustered by firm. In all regressions, we controlled for industry and year fixed effects. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% significance levels, respectively.

The majority of the control variables have statistically significant coefficients that are mostly consistent with our conjectures. For example, the tone of MD&As has a negative and significant impact on the future stock price crash risk, which is in the same line as that of Liu (2021). The estimated coefficients on other control variables are also generally consistent with previous findings. The results in Table 2 indicate that larger average monthly turnover is associated with a higher propensity of price crash, and past returns are also positively associated with crash risks. However, we found that the return volatility and crash risk are negatively correlated. Furthermore, board independence may improve the quality of monitoring and hence reduce agency costs. Therefore, having more independent directors on board can significantly reduce the crash risk, which is consistent with the existing findings (Petra 2005; Tang et al. 2013). However, neither managerial ownership nor institutional ownership is significantly related to crash risk. These results suggest that the ownership structure does not naturally play its role in monitoring the firm's operation and management. In addition, state-owned enterprises (SOEs) have a lower probability of stock price crash risk compared to that of non-SOEs. This is because, in addition to maximizing shareholder wealth, SOEs also have to fulfill their social responsibilities and accept political and economic oversight, which reduces the management's ability to hide bad news. Furthermore, firms with more news coverage are associated with a higher propensity for price crash risk, probably due to their high visibility and more scrutiny from the public, which is consistent with the findings of Peng and Xiong (2006) and An and Su (2021).

Our findings generally indicate that risk disclosures in the MD&As convey significant incremental information over what can be discerned from financial and market variables. We also implemented a dynamic panel GMM regression, which suggests that the MD&A disclosures have incremental and relative predictive power as early as three years prior to stock price crashes.[5] The results presented in this subsection confirm our first hypothesis (H1).

4.3. 2SLS-IV Regression Results

In this study, we examine the relationship between corporate risk information disclosure within the MD&A section and the risk of stock price crash. However, risk disclosure in the MD&A section and stock price crash risk may be mutually determined or determined by an unknown factor. Previous studies have found that the firm's information disclosure level is significantly affected by the information environments of peer firms in the same industry (Campbell et al. 2014). Therefore, we chose the median value of MD&A risk disclosures of peer firms in the same industry as the instrumental variable, and used the two-stage least squares method to deal with the possible endogeneity issue.

According to the first-stage results of the 2SLS-IV regression in Table 3, it can be seen that the instrumental variables are all significantly and positively related to MD&A risk disclosure at the 1% significance level, indicating the profound association between the overall risk disclosure level of the industry and firm-specific risk disclosures. Furthermore, the *p*-value for the statistic of the Hausman test is 0.068, which confirms the endogeneity of the variable MD&A risk disclosure. The regression results of the second stage show that the instrumented variable MD&A risk disclosure ($\widehat{\text{RiskDist}}$) and future stock price crash risk (NCSKEW_{t+1} or DUVOL_{t+1}) are significantly and negatively related at the 1% significance level. This result is consistent with the baseline regression results and proves the robustness of our main findings that risk disclosures are significantly negatively related to the stock price crash risk, even after controlling for potential endogeneity concerns.

Table 3. Relationship between MD&A risk disclosure and stock price crash risk: IV-2SLS approach.

	IV-2SLS Dep. Var.			
Indep. Var.	**RiskDis_t**	**NCSKEW_{t+1}**	**RiskDis_t**	**DUVOL_{t+1}**
	1st Stage	**2nd Stage**	**1st Stage**	**2nd Stage**
IV	0.6646 *** (15.87)		0.6639 *** (15.86)	
Predicted RiskDis_t		−2.0201 *** (−3.66)		−1.3610 *** (−4.02)

Table 3. *Cont.*

	IV-2SLS Dep. Var.			
Indep. Var.	**$RiskDis_t$**	**$NCSKEW_{t+1}$**	**$RiskDis_t$**	**$DUVOL_{t+1}$**
	1st Stage	**2nd Stage**	**1st Stage**	**2nd Stage**
$NegTone_t$	−0.2249 *** (−15.79)	−0.2568 (−1.40)	−0.2250 *** (−15.79)	−0.2098 * (−1.86)
$Turnover_t$	0.0016 ** (2.06)	0.0112 (1.56)	0.00177 ** (2.06)	0.0098 ** (2.22)
Ret_t	0.0004 (0.14)	0.0364 (1.53)	0.0004 (0.14)	0.0245 * (1.68)
$Sigma_t$	−0.0002 (−1.46)	0.0009 (1.00)	−0.0002 (−1.46)	0.0001 (0.18)
$News_t$	−0.0026 (−1.44)	−0.0876 *** (−5.63)	−0.0026 (−1.44)	−0.0651 *** (−6.82)
$Indep_t$	0.0262 (0.42)	−0.4229 (−0.77)	0.0262 (0.42)	−0.1705 (−0.51)
$ManOwn_t$	−0.0418 * (−1.85)	0.5386 *** (2.68)	−0.0418 * (−1.85)	0.2686 ** (2.18)
$InstOwn_t$	−0.0027 (−0.25)	−0.3781 *** (−4.08)	−0.0027 (−0.25)	−0.1880 *** (−3.30)
$Conc_t$	−0.1116 *** (−4.60)	0.6296 *** (2.76)	−0.1116 *** (−4.60)	0.3113 ** (2.23)
SOE_t	0.0054 (0.58)	−0.1125 (−1.39)	0.0054 (0.58)	−0.0720 (−1.45)
$Size_t$	−0.0085 ** (−2.01)	0.1079 *** (2.91)	−0.0085 ** (−2.01)	0.0958 *** (4.21)
ROA_t	−0.0011 (−0.30)	0.0272 (0.82)	−0.0011 (−0.30)	0.0066 (0.32)
MB_t	0.0245 ** (2.27)	−1.0614 *** (−10.91)	0.0245 ** (2.27)	−0.6502 *** (−10.89)
$Big4_t$	−0.0004 (−0.03)	0.1165 (0.91)	−0.0004 (−0.03)	0.1002 (1.27)
Observations	11,537	11,537	11,537	11,537
Year FE	Yes	Yes	Yes	Yes
Ind FE	Yes	Yes	Yes	Yes
Adj. R2		0.0141		0.0170

This table reports the results regarding the impact of risk disclosures within the MD&A section on the future stock price crash risk of Chinese listed firms by adopting an instrumental variable (IV) approach. We adopted the median value of MD&A risk disclosure for peer firms in the same industry as the instrumental variable in the two-stage least squares (2SLS) analysis. All variables are defined in Appendix A.1. The t-statistics reported in parentheses are based on standard errors clustered by firm. In all regressions, we controlled for industry and year fixed effects. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% significance levels, respectively.

4.4. Effects of Textual Readability and Similarity

In this subsection, we examine the relationship between MD&A risk disclosure and stock price crash risk conditioned on MD&A textual readability and similarity. Here, we refer to Yang (1971) and Liu (2021) and measure the readability of relevant information in MD&As using the seven-factor calculation method.[6] To measure the texture similarity of MD&As, we refer to Lang and Stice-Lawrence (2015) and define text similarity as the cosine similarity of MD&A texts, by taking the dot product of their documents' word vectors scaled by the product of their word lengths.[7]

To test Hypothesis 2, we divided the whole sample into two groups, one having high readability and the other having low readability, according to the median value of texture readability of MD&A disclosures, and tested the relationship between MD&A risk disclosures and stock price crash risk separately. As shown in panel A of Table 4, for firms with more readable MD&As, risk disclosure (RiskDist) and stock price crash risk ($NCSKEW_{t+1}$) are significantly and negatively correlated at the 10% significance level; by contrast, for firms with less readable MD&As, the relationship between risk disclosure (RiskDist) and stock price crash risk ($NCSKEW_{t+1}$) is insignificant. To test whether the difference between the coefficients of the group regressions is significant, we conducted a coefficient test based on the chunked self-help method (i.e., bootstrap). The test obtained a p-value of 0.044, indicating a significant difference between the coefficients of the two groups at the 5% significance level. Furthermore, we obtained similar results regarding the relationship between MD&A risk disclosures and the stock price crash risk as proxied by $DUVOL_{t+1}$ in panel B of Table 4. We show that more readable risk disclosures within MD&As are associated with a lower stock price crash risk, suggesting that managers can strategically withhold negative information by issuing more complex and ambiguous reports. The empirical results here generally support our second hypotheses (H2). Our results also confirm that investors face significant information processing costs but that more readable MD&A disclosures help reduce these costs, leading to improvements in MD&A informativeness (Lee and Zhong 2022).

Table 4. Relationship between MD&A risk disclosure and stock price crash risk conditional on textual similarity and readability.

	Similarity		**Readability**	
	Similarity = High	**Similarity = Low**	**Readability = High**	**Readability = Low**
	Panel A: Dep. Var. = $NCSKEW_{t+1}$			
$RiskDis_t$	−0.0703	−0.1043 *	−0.0977 *	−0.0660
	(−1.22)	(−1.82)	(−1.97)	(−0.93)
Controls	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES
N	5873	5896	7368	4393
Pseudo-R2	0.0509	0.0570	0.0549	0.0502
	Panel B: Dep. Var. = $DUVOL_{t+1}$			
$RiskDis_t$	−0.0541	−0.0791 **	−0.0669 **	−0.0632
	(−1.55)	(−2.24)	(−2.20)	(−1.47)
Controls	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES
N	5873	5896	7368	4393
Pseudo-R2	0.0537	0.0615	0.0548	0.0614

This table reports the results for the relationship between MD&A risk disclosure and stock price crash risk for firms with low and high MD&A textural similarity. In addition, we examined the relationship between MD&A risk disclosure and stock price crash risk for firms with low and high MD&A readability. Our sample firms were partitioned into two groups based on the median value of similarity (readability) of the MD&A section of annual reports for all listed firms in China each year. All variables are defined in Appendix A.1. The t-statistics reported in parentheses are based on standard errors clustered by firm. In all regressions, we controlled for industry and year fixed effects. ** and * indicate statistical significance at the 5% and 10% significance levels, respectively.

Similarly, to test Hypothesis 2, we divided the whole sample into a group with high texture similarity of MD&As and a group with low similarity of MD&As according to the median value of MD&A similarity of our sample, and retested the relationship between MD&A risk disclosures and stock price crash risk separately. As shown in panel A of Table 4, risk disclosure and stock price crash risk ($NCSKEW_{t+1}$ or $DUVOL_{t+1}$) are significantly and negatively correlated at the 10% or 5% significance levels for firms with less

MD&A similarity; however, for firms having more similarity in MD&As, risk disclosure and future stock price crash risk are not significantly correlated. To test whether the difference between the coefficients of the group regressions is significant, we again conducted a coefficient test based on the chunked self-help method (i.e., bootstrap). The test obtained a p-value of 0.021, indicating a significant difference between the coefficients of the two groups at the 5% significance level. To conclude, we show that risk disclosures within less similar MD&As are associated with a lower stock price crash risk, suggesting that newly disclosed risk information has more incremental information value and can alleviate the stock price crash risk to a greater extent. The empirical results here generally support our second hypotheses (H2).

4.5. *Effects of Information Environments*

To test Hypothesis 3, referring to Morck et al. (2000) and Durnev et al. (2003), we employed stock price synchronicity (SYN) and idiosyncratic volatilities (IVOL) to quantitatively measure firm-specific information environments. Stock price synchronicity (SYN) and idiosyncratic volatilities (IVOL) can reflect the degree to which the idiosyncratic information of listed firms has been integrated into the stock prices, and are popular indices used to measure the efficiency of stock pricing and firms' information environment. A high (low) stock price synchronicity (idiosyncratic volatility) suggests that the stock price of a particular firm is highly correlated with the market and less firm-specific information is being incorporated into its stock price. For the calculation of stock price synchronicity and idiosyncratic volatility, please refer to Appendix B.

Therefore, we partitioned the sample firms into two groups based on the median values of firms' information environments as proxied by stock price synchronicity (SYN) and idiosyncratic volatility (IVOL) in a given year, with a lower (higher) value of SYN (IVOL) representing firms having a better information environment. We then compared if the relationship between MD&A risk disclosures and the stock price crash risk differs across the two sub-groups.

As shown in panel A of Table 5, for firms with high stock price synchronicity (SYN) or low idiosyncratic volatilities (IVOL), i.e., firms with poor information environments, MD&A risk disclosures and $NCSKEW_{t+1}$ are significantly and negatively correlated at the 1% (10%) significance level; however, for those firms with low SYN or high IVOL, i.e., firms facing good information environments, risk disclosure and $NCSKEW_{t+1}$ are negatively while insignificantly correlated. Similarly, to test whether the difference between the coefficients of the group regressions is significant, we conducted a coefficient test based on the bootstrap method and obtained a p-value of 0.048, indicating a significant difference between the coefficients of the two groups at the significance level of 5%. We obtained similar results regarding the relationship between MD&A risk disclosures and the stock price crash risk as proxied by $DUVOL_{t+1}$ in panel B of Table 5. The results presented in Table 5 suggest that the relationship between MD&A risk disclosures and the stock price crash risk are statistically different across these two sub-groups, which confirms our third hypothesis (H3).

Table 5. Relationship between MD&A risk disclosure and stock price crash risk conditional on information environments.

	SYN		**IVOL**	
	SYN = Low	**SYN = High**	**IVOL = Low**	**IVOL = High**
Panel A: Dep. Var. = $NCSKEW_{t+1}$				
$RiskDis_t$	−0.0044	−0.1481 ***	−0.1109 *	−0.0458
	(−0.07)	(−2.69)	(−1.91)	(−0.77)
Controls	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES

Table 5. *Cont.*

	SYN		IVOL	
	SYN = Low	**SYN = High**	**IVOL = Low**	**IVOL = High**
N	5884	5885	6515	5246
Pseudo-R2	0.0614	0.0400	0.0618	0.0458
Panel B: Dep. Var. = $DUVOL_{t+1}$				
$RiskDis_t$	−0.0381 (−1.03)	−0.0823 ** (−2.49)	−0.1035 *** (−2.86)	−0.0426 (−1.08)
Controls	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES
N	5884	5885	6515	5246
Pseudo-R2	0.0649	0.0424	0.0661	0.0489

This table reports the results for the relationship between MD&A risk disclosure and stock price crash risk for firms with poor and good information environments. We used two variables, synchronicity (SYN) and idiosyncratic volatility (IVOL), to proxy for the quality of information environments. Our sample firms were partitioned into two groups based on the median value of synchronicity of all listed firms in China each year. Similarly, the sample firms were divided into two groups according to the median value of idiosyncratic volatility of all listed firms in China each year. All variables are defined in Appendix A.1. The t-statistics reported in parentheses are based on standard errors clustered by firm. In all regressions, we controlled for industry and year fixed effects. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% significance levels, respectively.

4.6. *Effects of Monitoring Mechanisms*

In this subsection, we investigate whether monitoring mechanisms can affect the relationship between MD&A risk disclosures and stock price crash risk. We expect that the effect of MD&A risk disclosures in reducing stock price crash risk could be attenuated when the external audit quality is high. In addition, it is generally believed that SOE firms face more severe agency problems and are more prone to foster forms of fraud, corruption and lax regulation. Therefore, the effect of MD&A risk disclosures on reducing the stock price crash risk could be more pronounced in SOE firms.

To examine Hypothesis 4, following DeFond and Zhang (2014) and Tang et al. (2021), we employed a dummy variable representing whether the firm is audited by a Big 4 auditing firm to capture the effect of audit quality. Similarly, we also employed the dummy variable of whether the firm is a state-owned-enterprise (SOE) to capture the effect of external monitoring on the relationship between risk disclosures and stock price crash risk. Therefore, we partitioned our sample into two groups based on whether the auditor is from a Big 4 audit firm or whether the firm is a SOE firm and examined their differential effects separately.

As shown in Panel A of Table 6, for firms with non-Big 4 auditors or SOE firms, MD&A risk disclosures and $NCSKEW_{t+1}$ are significantly and negatively correlated at the 5% or 10% significance level; however, for firms audited by a Big 4 audit firm or non-SOE firms, risk disclosure and $NCSKEW_{t+1}$ are negatively while insignificantly correlated. To test whether the difference between the coefficients of the group regressions is significant, we performed a coefficient test based on the bootstrap method. The test obtained a p-value of 0.062, indicating a significant difference between the coefficients of the two groups at the 10% significance level. In addition, the results regarding the relationship between MD&A risk disclosures and stock price crash risk as proxied by $DUVOL_{t+1}$ in panel B of Table 6 are similar to those reported in panel A of Table 6. The empirical results here generally support our fourth hypotheses (H4).

Table 6. Relationship between MD&A risk disclosure and stock price crash risk conditional on external monitoring.

	Big4		**SOE**	
	Big4 = 0	**Big4 = 1**	**SOE = 0**	**SOE = 1**
Panel A: Dep. Var. = $NCSKEW_{t+1}$				
$RiskDis_t$	−0.0837 **	−0.1582	−0.0669	−0.1229 *
	(−1.98)	(−1.05)	(−1.33)	(−1.76)
Controls	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES
N	11,127	642	8105	3664
Pseudo-R2	0.0508	0.1114	0.0532	0.0546
Panel B: Dep. Var. = $DUVOL_{t+1}$				
$RiskDis_t$	−0.0670 ***	−0.0864	−0.05010 *	−0.1018 **
	(−2.61)	(−0.90)	(−1.66)	(−2.42)
Controls	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES
N	11,127	642	8105	3664
Pseudo-R2	0.0546	0.1193	0.0557	0.0605

This table reports the results for the relationship between MD&A risk disclosure and the stock price crash risk for firms with different levels of external monitoring. We used two constructs, audit quality (Big4) and state-owned enterprises (SOE), to proxy for the quality of external monitoring. Big4 is a dummy variable that equals 1 when the auditor for firm i is one of the Big 4 audit firms or their predecessors, and 0 otherwise. Similarly, SOE is also a dummy variable that equals 1 if the firm is a state-owned enterprise, and 0 otherwise. All variables are defined in Appendix A.1. The t-statistics reported in parentheses are based on standard errors clustered by firm. In all regressions, we controlled for industry and year fixed effects. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% significance levels, respectively.

4.7. Effects of Investor Attention

In addition, we predicted that the negative association between MD&A risk disclosures and the stock crash risk could be more pronounced for firms with more investor attention. To examine Hypothesis 5, we employed analyst following (Analyst) and firm size (Size) to quantitatively measure the degree of investor attention. Namely, we divided the whole sample into a high analyst following (or larger size) group and a low analyst following (or smaller size) group according to the median value of analyst following (or firm size) of our sample, and tested the relationship between MD&A risk disclosures and the stock price crash risk separately. As shown in panel A of Table 7, for firms with high analyst coverage (or a larger size), their MD&A risk disclosures and $NCSKEW_{t+1}$ are significantly and negatively correlated at the 1% or 5% significance levels; however, for firms with low analyst coverage (or a smaller size), MD&A risk disclosure and $NCSKEW_{t+1}$ are negatively while insignificantly correlated. Similarly, we also performed a coefficient test based on the bootstrap method to obtain a *p*-value of 0.043, indicating that the regression coefficients for subgrouping according to the degrees of investor attention are also significantly different at the significance level of 5%. In addition, we obtained similar results regarding the relationship between MD&A risk disclosures and stock price crash risk as proxied by $DUVOL_{t+1}$ in panel B of Table 7. Therefore, our last hypothesis (H5) is supported.

Table 7. Relationship between MD&A risk disclosure and stock price crash risk conditional on investor attention.

	Analyst		Size	
	Analyst = Low	**Analyst = High**	**Size = Small**	**Size = Large**
Panel A: Dep. Var. = $NCSKEW_{t+1}$				
$RiskDis_t$	−0.0485	−0.1934 ***	−0.0517	−0.1310 **
	(−0.92)	(−3.25)	(−0.89)	(−2.35)
Controls	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES
N	8161	3608	6736	5033
Pseudo-R2	0.0299	0.0871	0.0314	0.0920
Panel B: Dep. Var. = $DUVOL_{t+1}$				
$RiskDis_t$	−0.0289	−0.1659 ***	−0.0292	−0.1165 ***
	(−0.93)	(−4.14)	(−0.85)	(−3.28)
Controls	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES
N	8161	3608	6736	5033
Pseudo-R2	0.0334	0.0921	0.0302	0.0991

This table reports the results for the relationship between MD&A risk disclosure and the stock price crash risk for firms with different levels of investor attention. We used two constructs, analyst coverage (Analyst) and firm size (Size), to proxy for the level of investor attention. Analyst is the number of analysts covering a particular firm. Therefore, our sample firms were partitioned into two groups based on the median value of analyst coverage for all listed firms in China each year. The sample firms were also divided into two groups according to the median value of firm size of all listed firms in China each year. All variables are defined in Appendix A.1. The t-statistics reported in parentheses are based on standard errors clustered by firm. In all regressions, we controlled for industry and year fixed effects. *** and ** indicate statistical significance at the 1% and 5% significance levels, respectively.

5. Robustness Checks and Further Analysis

As detailed in this section, we performed several additional robustness checks to confirm the validity of our results and conducted further analyses to better understand the impacts of MD&A disclosure on the stock price crash risk.

5.1. Alternative Proxies for Stock Price Crash Risk

To examine the sensitivity of our results, we reran the baseline regression model and measured crash risk with the dummy variable $Crash_{i,t+1}$ that indicates the occurrences of extremely low firm-specific weekly returns (Hutton et al. 2009; Yang et al. 2020). Namely, $Crash_{i,t+1}$ equals 1 if at least one of firm *i*'s firm-specific weekly returns is three standard deviations below its mean firm-specific weekly return over year $t + 1$, and 0 otherwise. We subsequently ran logit regression with $Crash_{i,t+1}$ as the dependent variable. We observe that MD&A disclosure is still significantly and negatively related to this alternative crash risk proxy.[8]

5.2. Controlling for Firm Fixed Effect

To further consider the possibility of correlated omitted variables, we examined the sensitivity of our results to the firm-fixed effect, which controls for the impact of time-invariant unobservable omitted variables at the firm level. Empirical results show that our overall findings are qualitatively unaffected by including the firm fixed effect, although the relationship between MD&A risk disclosures and the stock price crash risk becomes a little bit weaker after controlling for the firm fixed effect.[9]

5.3. Subgroup Analysis

We have to bear in mind that some exogenous accidental events that are beyond the control of firms can also induce a huge crash in stock price. While such events are rare, it would be ideal to purge our results of any confounding effects from such disasters. Unfortunately, it is difficult to identify the entire population of accidental events that could trigger larger falls in stock prices. Nonetheless, we sought to mitigate this concern by excluding firms that are more prone to exogenous hazardous events, natural disasters, or circumstances that are outside of the control of the managers. Following An et al. (2020), we excluded firms within the mining, chemical, and petroleum industries, as most major accidents are closely related to these industries, and therefore their stock prices are more prone to crashes (Mihailidou et al. 2012). We have also excluded firms in the financial services industry because financial firms have different accounting and disclosure requirements and are more prone to extreme financial risks (Jiang and Yuan 2018; Su et al. 2021). However, our results remain qualitatively unchanged.

In addition, many studies addressed the economic and financial impacts of the recent COVID-19 pandemic, particularly regarding the catalyst role of this unprecedented shock in stock market crashes (i.e., Corbet et al. 2020a, 2020b, 2021; Goodell 2020; Yarovaya et al. 2022a, 2022b; Sharif et al. 2020). Therefore, we excluded samples covering the COVID-19 crisis period (i.e., 2020–2021) and re-estimated the main regression. The results remain intact. Furthermore, our results remain robust if we exclude the years when the global financial crisis took hold (2008–2009) from our sample, suggesting that our findings are immune to those exogenous accidental events.[10]

6. Concluding Remarks

The textual analysis of MD&A disclosure arguably can alleviate information asymmetry and facilitate more intelligent decision making by providing incremental information about the firm. Our results consistently show that risk disclosures within the MD&A section are significantly and negatively associated with the future stock price crash risk, which approves Hypothesis 1. We also provide evidence on the possible channels through which the effect of MD&A risk disclosures on the stock price crash risk occurs. Namely, we performed several additional tests to assess whether MD&A risk disclosures reduce the stock price crash risk through fulfilling the informational function and/or monitoring function. We found that MD&A risk disclosures play a more important role in reducing the future stock price crash risk when the MD&A disclosure contains more incremental information, and Hypothesis 2 has been approved. The results suggest that the negative association between MD&A risk disclosures and the stock price crash risk is more pronounced for firms with poorer information environments, for firms with weaker internal and external monitoring, and for firms with more investor attention, and the negative relationship is not driven by exogenous negative events, which approves Hypotheses 3–5.

Similar to Mayew et al. (2015), our findings suggest that the MD&A section of firms' annual reports provides important insights over accounting numbers in assessing firms' financial constraints and risks. Therefore, our findings have important implications for regulators as they deliberate on whether to encourage or mandate qualitative disclosures about the management's assessment of the firm's risk. However, our study is subject to several caveats. First, like most empirical finance studies, our study ultimately provides evidence of an association and not causation between MD&A risk disclosures and the stock price crash risk. We conducted a number of robustness tests to address potential endogeneity problems. We believe that our additional tests can, to a great extent, support the informational and monitoring role of MD&A risk disclosures in alleviating information asymmetry and suppressing the stock price crash risk. Second, our results can also be affected by negative exogenous events that lead to a stock price crash risk (An et al. 2020). While we attempted to mitigate this concern by excluding firms in industries that are more prone to natural disasters, accidents, and financial risks and excluding the COVID-19 crisis period, we acknowledge that it is still possible that our findings are affected by exogenous events that are beyond the control of firms. We hope to be able to carry out further research to address these issues in the future.

Author Contributions: Conceptualization, F.S.; methodology, J.L.; software, L.Z.; validation, F.S. and J.L; formal analysis, J.L.; investigation, F.S., L.Z. and J.L.; resources, F.S. and J.L.; data curation, L.Z.; writing—original draft preparation, L.Z. and J.L.; writing—review and editing, F.S.; visualization, L.Z.; supervision, F.S.; project administration, F.S.; funding acquisition, F.S. and J.L. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the National Natural Science Foundation of China, grant number 71901087, 71702123; and the Fundamental Research Funds for the Central Universities (No. NR2022004).

Informed Consent Statement: Not applicable.

Data Availability Statement: The data presented in this study are available upon request from the corresponding author.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Appendix A.1. Variable Definition

This table presents the definitions of all variables used in this study.

Type	Variable	Description
Dependent Variable	NCSKEW	The negative coefficient of skewness, calculated by taking the negative of the third moment of firm-specific weekly returns and normalizing it by the standard deviation of firm-specific weekly returns raised to the third power for firm *i* in year $t+1$.
	DUVOL	The natural logarithm of the ratio of the standard deviation of firm-specific weekly returns in the down weeks to the standard deviation in the up weeks for firm i in year $t+1$, and a firm-week is defined as a down (up) week if the firm-specific weekly return is below (above) its annual mean.
	CRASH	A dummy variable that equals 1 if at least one of firm *i*'s firm-specific weekly returns is three standard deviations below its mean firm-specific weekly return over year $t+1$, and 0 otherwise.
Mediating Variable	VPIN	Volume-weighted probability of informed trading for firm *i* in year *t*, which is calculated as $VPIN = \frac{\sum_{\tau=1}^{n}\left|V_\tau^B - V_\tau^S\right|}{nV}$. For the details, please refer to Note 7.
	Divergence	Heterogeneous investors' beliefs are calculated as $Divergence_{i,t} = \left[\left(\frac{Vol_{i,t}}{Share_{i,t}}\right) - \left(\frac{Vol_t}{Share_t}\right)\right] - \frac{1}{N}\sum_N\left[\left(\frac{Vol_{i,t}}{Share_{i,t}}\right) - \left(\frac{Vol_t}{Share_t}\right)\right]$. For the details, please refer to Note 8.
Control Variable	RiskDis	The number of words related to risk divided by the total number of words within the MD&A section for firm *i* in year *t*.
	NegTone	The percentage difference of positive and negative words divided by the total number of words in the MD&A section for firm *i* in year *t*.
	Similarity	Text similarity of MD&As for firm *i* in year *t*. For more details about the measurement of texture similarity, please refer to Lang and Stice-Lawrence (2015).
	Readability	Texture readability of MD&As for firm *i* in year *t*. For the calculation, please refer to Note 4 in the main text.
	Conc	The percentage of ownership held by the top five shareholders for firm *i* at the beginning of year *t*.
	InstOwn	The percentage of ownership held by institutional investors for firm *i* in year *t*.
	ManOwn	The sum of managerial share ownership divided by the number of shares outstanding in year *t*.
	Indep	The natural logarithm of 1 plus the number of independent directors, divided by the total number of directors on the board for firm *i* in year *t*.
	SOE	A dummy variable equal to 1 when firm *i* is a state-owned enterprise (SOE), and 0 otherwise.
	Size	Natural logarithm of firm *i*'s book value of total assets at the beginning of year *t*.
	Leverage	The sum of firm *i*'s short- and long-term debt divided by the book value of its total assets in year *t*.
	ROA	The net profits divided the total assets of firm *i* in year *t*.
	MB	The market value of common equity plus the book value of total liabilities divided by the book value of total assets of firm *i* in year *t*.
	Big4	A dummy variable equal to 1 when the auditor for firm *i* is one of the Big 4 audit firms or their predecessors, and 0 otherwise.
	Ret	Annualized market-adjusted buy-and-hold stock return for firm *i* in year *t*.
	Turnover	The total number of shares traded divided by the average number of shares outstanding for firm *i* in year *t*.
	Sigma	The standard deviation of weekly firm-specific returns in year *t*.
	News	Natural logarithm of 1 plus the number of news reports related to firm *i* in year *t*.
	Analyst	Natural logarithm of 1 plus the number of analysts following firm *i* in year *t*.
	SYN	Stock price synchronicity of firm *i* in year *t*; for the calculation, please refer to Appendix B.
	IVOL	Idiosyncratic volatility of firm *i* in year *t*; for more details about the calculation, please refer to Appendix B.

Appendix A.2. Risk-Related Keywords

This table includes a list of risk-related keywords that appeared in the MD&A section of annual reports of Chinese listed firms, which are adopted in our study.

Keywords in Chinese	Keywords in English	Keywords in Chinese	Keywords in English
危机	Crisis	经营风险	Operating risk
过期	Overdue	困难	Difficult
失灵	Dysfunction	密切关注	Concern
债务	Debt	失败	Failure
失效	Invalid/invalidity	难度	Difficulty
缺陷	Default	难以	Hardness
落后	Fall behind	偏离	Deflect
风险	Risk/Risky	瓶颈	Bottleneck
困境	Trap	破产	Bankruptcy
失控	Out of control	缺乏	Absence
宏观风险	Macroeconomic risk	缺点	Deficiency
汇率波动	Exchange rate risk	失望	Disappointment
流动性风险	Liquidity risk	亏空	Shortfall
波动	Volatile/Volatility	市场风险	Market risk
不利	Disadvantage	损失	Loss
不确定	Uncertain	下降	Decline
不确定性	Uncertainty	下行	Downturn
不足	Deficit	削弱	Erosion
过剩	Redundancy	降级	Degrade
冲击	Shock	压力	Stress
低迷	Downturn	严峻	Severity
动荡	Turbulence	信用风险	Credit risk
放缓	Slowdown	严重	Severity
故障	Fault	意外	Accident
价格波动	Price fluctuation	隐患	Pitfall
经济下行	Economic downturn	暂缓	Postpone
预警	Warning	制约	Constraint
灾难	Disaster	过期	Expiration
重创	Heavy losses	难题	Trouble

Appendix B. Calculation of Stock Price Synchronicity and Idiosyncratic Volatility References

Following Morck et al. (2000), we measure stock price synchronicity (SYN) as the co-movement with market returns. We first calculate the coefficient of determination R^2 of the following equation for each firm in each year:

$$r_{i,\tau} = \alpha_i + \beta_{1,i} r_{m,\tau} + \varepsilon_{i,\tau} \quad \text{(A1)}$$

where $r_{i,\tau}$ is the stock return of firm i in week τ of year t, and $r_{m,\tau}$ is the week τ value-weighted market return in year t.

To deal with the bounded nature of R^2 within [0, 1], we take a logistic transformation of R^2:

$$SYN_{i,t} = \ln\left(\frac{R^2}{1-R^2}\right) \quad \text{(A2)}$$

where $SYN_{i,t}$ is the measure of stock price synchronicity of firm i in year t and R^2 is the coefficient of determination estimated from Equation (A1) for firm i in year t. A high SYN means that the stock price of firm i is highly correlated with the market and less firm-specific information has been impounded into its stock price.

In addition, following Durnev et al. (2003), we calculate a variation of the price synchronicity as co-movement with industry and market returns by estimating the following equation:

$$r_{i,\tau} = \alpha_i + \beta_{1,i} r_{m,\tau} + \beta_{2,i} r_{m,\tau-1} + \beta_{3,i} r_{k,\tau} + \beta_{4,i} r_{k,\tau-1} + \beta_{5,i} \text{RiskFactor}_\tau + \varepsilon_{i,\tau} \quad \text{(A3)}$$

where $r_{i,\tau}$ is the stock return of firm i in week τ of year t, $r_{m,\tau}$ is the week-τ value-weighted market return in year t, and $r_{k,\tau}$ is the week-τ return of the industry to which firm i belongs in year t, calculated as the value-weighted return of all the firms within the same industry as firm i, omitting the weekly return of firm i. We include the lag terms of the weekly industry return and market return to control for potential nonsynchronous trading biases (French et al. 1987). We also include market risk factors and popular common risk factors in the regression (Fama and French 1995).

Therefore, we calculate the idiosyncratic volatility (IVOL) as follows:

$$IV_{i,t} = std(\varepsilon_{i,\tau}) \times \sqrt{N_t} \quad \text{(A4)}$$

where $std(\varepsilon_{i,\tau})$ is the standard deviation of the error terms from Equation (A3) for firm i in year t, and N_t is the number of trading days in year t. A low IVOL means that less firm-specific information has been impounded into the stock price of firm i.

Notes

1. The incentive to withhold bad news may be much stronger when under these circumstances mentioned above. However, releasing more bad news may prevail due to desire to reduce expected costs of shareholder litigation (Skinner 1994), motivation to guide analysts to beatable forecasts of earnings per share (Richardson et al. 2004) or to deter product market competitors (Darrough and Stoughton 1990).
2. To identify such statements, we read each firm's MD&A and locate sentences explicitly referencing the terms related to risk. We manually identify such references because there is no established automated tool for this purpose. A full list of keywords related to risk adopted in this study is provided in the Appendix A.2.
3. In addition to word segmentation and counting, studies on textual information have extended to the sentence- or message-level sentiment analysis using advanced machine learning classification methods, such as Naïve Bayesian, support vector machine (SVM) and K-nearest neighbor classification (KNN) to analyze the text contents (Huang et al. 2020).
4. For the definition and calculation of VPIN, please refer to Appendix A.1.
5. Due to space limitation, we omit the results regarding the dynamic panel GMM regression which are available upon request.
6. Texture readability of MD&As is calculated based on the following equation:

$$\begin{aligned} READABILITY_{7-\text{factor}} = \; & 13.90963 + 1.54461 \times FULLSEN + 39.01497 \times WORDLIST \\ & -2.52206 \times STROKES + 0.29809 \times COUNT5 + 0.36192 \times COUNT12 \\ & +0.99363 \times COUNT22 - 1.64671 \times COUNT25 \end{aligned}$$

   where FULLSEN is the proportion of complete sentences in all sentences in the paragraph. A complete sentence is defined as the sentence with subject-predicate structure. WORDLIST is the proportion of words within the basic vocabulary list in all the words in the paragraph, and the basic vocabulary list is the vocabulary of HSK (Chinese Proficiency Test) Level 1–3; STROKES is the average number of strokes of Chinese characters in the paragraph. COUNT5 is the proportion of characters with a stroke count of 5; COUNT12 is the proportion of characters with a stroke count of 12; COUNT22 is the proportion of characters with a stroke count of 22 and COUNT25 is the proportion of characters with a stroke count of 25.
7. For more details about the measurement of texture similarity, please refer to Lang and Stice-Lawrence (2015).
8. Detailed empirical results and table are not presented here which are available upon request.
9. See Note 8 above.
10. See Note 8 above.

References

An, Heng, and Ting Zhang. 2013. Stock price synchronicity, crash risk, and institutional investors. *Journal of Corporate Finance* 21: 1–15. [CrossRef]

An, Yahui, and Fei Su. 2021. Do internet stock message boards influence firm value? evidence from China. *Asia-Pacific Journal of Accounting and Economics* 30: 1–27. [CrossRef]

An, Zhe, Chen Chen, Vic Naiker, and Jun Wang. 2020. Does media coverage deter firms from withholding bad news? Evidence from stock price crash risk. *Journal of Corporate Finance* 64: 101664. [CrossRef]

Asay, H. Scott, Robert Libby, and Kristina Rennekamp. 2018. Firm performance, reporting goals, and language choices in narrative disclosures. *Journal of Accounting and Economics* 65: 380–98. [CrossRef]

Blanchard, Olivier. 2009. Nothing to fear but fear itself. *The Economist*, January 31, p. 84.

Brown, Stephen V., and Jennifer Wu Tucker. 2011. Large-sample evidence on firms' year-over-year MDandA modifications. *Journal of Accounting Research* 49: 309–46. [CrossRef]

Callen, Jeffrey L., and Xiaohua Fang. 2013. Institutional investor stability and crash risk: Monitoring versus short-termism? *Journal of Banking and Finance* 37: 3047–63. [CrossRef]

Callen, Jeffrey L., and Xiaohua Fang. 2015. Religion and stock price crash risk. *Journal of Financial and Quantitative Analysis* 50: 169–95. [CrossRef]

Campbell, John L., Hsinchun Chen, Dan S. Dhaliwal, Hsin-min Lu, and Logan B. Steele. 2014. The information content of mandatory risk factor disclosures in corporate filings. *Review of Accounting Studies* 19: 396–455. [CrossRef]

Chan, Wesley S. 2003. Stock price reaction to news and no-news: Drift and reversal after headlines. *Journal of Financial Economics* 70: 223–60. [CrossRef]

Chen, Joseph, Harrison Hong, and Jeremy C. Stein. 2001. Forecasting crashes: Trading volume, past returns, and conditional skewness in stock prices. *Journal of Financial Economics* 61: 345–81. [CrossRef]

Chen, Jun, Kam C. Chan, Wang Dong, and Feida (Frank) Zhang. 2017. Internal control and stock price crash risk: Evidence from China. *European Accounting Review* 26: 125–52. [CrossRef]

Chen, Yunsen, Yuan Xie, Hong You, and Yanan Zhang. 2018. Does crackdown on corruption reduce stock price crash risk? Evidence from China. *Journal of Corporate Finance* 51: 125–41. [CrossRef]

Cheng, Qiang, Fei Du, Brian Yutao Wang, and Xin Wang. 2019. Do corporate site visits impact stock prices? *Contemporary Accounting Research* 36: 359–88. [CrossRef]

Cole, Cathy J., and Christopher L. Jones. 2005. Management discussion and analysis: A review and implications for future research. *Journal of Accounting Literature* 24: 135.

Corbet, Shaen, Charles Larkin, and Brian Lucey. 2020a. The contagion effects of the COVID-19 pandemic: Evidence from gold and cryptocurrencies. *Finance Research Letters* 35: 101554. [CrossRef]

Corbet, Shaen, John W. Goodell, and Samet Günay. 2020b. Co-movements and spillovers of oil and renewable firms under extreme conditions: New evidence from negative WTI prices during COVID-19. *Energy Economics* 92: 104978. [CrossRef]

Corbet, Shaen, Yang Hou, Yang Hu, Brian Lucey, and L. T. Oxley. 2021. Aye Corona! The contagion effects of being named Corona during the COVID-19 pandemic. *Finance Research Letters* 38: 101591. [CrossRef]

Darrough, Masako N., and Neal M. Stoughton. 1990. Financial Disclosure Policy in an Entry Game. *Journal of Accounting and Economics* 12: 219–43. [CrossRef]

DeAngelo, Linda Elizabeth. 1981. Auditor size and audit quality. *Journal of Accounting and Economics* 3: 183–99. [CrossRef]

DeFond, Mark, and Jieying Zhang. 2014. A review of archival auditing research. *Journal of Accounting and Economics* 58: 275–26. [CrossRef]

DeFond, Mark L., Mingyi Hung, Siqi Li, and Yinghua Li. 2015. Does mandatory IFRS adoption affect crash risk? *The Accounting Review* 90: 265–99. [CrossRef]

Dimson, Elroy. 1979. Risk measurement when shares are subject to infrequent trading. *Journal of Financial Economics* 7: 197–226. [CrossRef]

Durnev, Artyom, Randall Morck, Bernard Yeung, and Paul Zarowin. 2003. Does greater firm-specific return variation mean more or less informed stock pricing? *Journal of Accounting Research* 41: 797–836. [CrossRef]

Fama, Eugene F., and Kenneth R. French. 1995. Size and book-to-market factors in earnings and returns. *The Journal of Finance* 50: 131–55.

Feldman, Ronen, Suresh Govindaraj, Joshua Livnat, and Benjamin Segal. 2010. Management's tone change, post earnings announcement drift and accruals. *Review of Accounting Studies* 15: 915–53. [CrossRef]

French, Kenneth R., G. William Schwert, and Robert F. Stambaugh. 1987. Expected stock returns and volatility. *Journal of financial Economics* 19: 3–29. [CrossRef]

Goodell, John W. 2020. COVID-19 and finance: Agendas for future research. *Finance Research Letters* 35: 101512. [CrossRef]

Graham, John R., Campbell R. Harvey, and Shiva Rajgopal. 2005. The economic implications of corporate financial reporting. *Journal of Accounting and Economics* 40: 3–73. [CrossRef]

Healy, Paul M., and Krishna G. Palepu. 2001. Information asymmetry, corporate disclosure, and the capital markets: A review of the empirical disclosure literature. *Journal of Accounting and Economics* 31: 405–40. [CrossRef]

Huang, Alan, Wenfeng Wu, and Tong Yu. 2020. Textual analysis for China's financial markets: A review and discussion. *China Finance Review International* 10: 1–15. [CrossRef]

Huang, Xuan, Siew Hong Teoh, and Yinglei Zhang. 2014. Tone management. *The Accounting Review* 89: 1083–113. [CrossRef]

Hutton, Amy P., Alan J. Marcus, and Hassan Tehranian. 2009. Opaque financial reports, R^2, and crash risk. *Journal of Financial Economics* 94: 67–86. [CrossRef]

Jiang, Xuanyu, and Qingbo Yuan. 2018. Institutional investors' corporate site visits and corporate innovation. *Journal of Corporate Finance* 48: 148–68. [CrossRef]

Jorgensen, Bjorn N., and Michael T. Kirschenheiter. 2003. Discretionary risk disclosures. *The Accounting Review* 78: 449–69. [CrossRef]

Kahneman, Daniel. 1973. *Attention and Effort*. Englewood Cliffs: Prentice-Hall, vol. 1063, pp. 218–226.

Khurana, Inder K., and K. K. Raman. 2004. Litigation risk and the financial reporting credibility of Big 4 versus non-Big 4 audits: Evidence from Anglo-American countries. *The Accounting Review* 79: 473–95. [CrossRef]

Kim, Chansog (Francis), Ke Wang, and Liandong Zhang. 2019. Readability of 10-K reports and stock price crash risk. *Contemporary Accounting Research* 36: 1184–216. [CrossRef]

Kim, Jeong-Bon, and Liandong Zhang. 2016. Accounting conservatism and stock price crash risk: Firm-level evidence. *Contemporary Accounting Research* 33: 412–41. [CrossRef]

Kim, Jeong-Bon, Joung W. Kim, and Jee-Hae Lim. 2013. Does XBRL adoption constrain managerial opportunism in financial reporting? Evidence from mandated US filers. Paper presented at CAAA Annual Conference, Montreal, AC, Cananda, May 30–June 2.

Kim, Jeong-Bon, Yinghua Li, and Liandong Zhang. 2011a. Corporate tax avoidance and stock price crash risk: Firm-level analysis. *Journal of Financial Economics* 100: 639–62. [CrossRef]

Kim, Jeong-Bon, Yinghua Li, and Liandong Zhang. 2011b. CFOs versus CEOs: Equity incentives and crashes. *Journal of Financial Economics* 101: 713–30. [CrossRef]

Kim, Yongtae, Haidan Li, and Siqi Li. 2014. Corporate social responsibility and stock price crash risk. *Journal of Banking and Finance* 43: 1–13. [CrossRef]

Kothari, S. P., Susan Shu, and Peter D. Wysocki. 2009. Do managers withhold bad news? *Journal of Accounting Research* 47: 241–76. [CrossRef]

Kravet, Todd, and Volkan Muslu. 2013. Textual risk disclosures and investors' risk perceptions. *Review of Accounting Studies* 18: 1088–122. [CrossRef]

LaFond, Ryan, and Ross L. Watts. 2008. The information role of conservatism. *The Accounting Review* 83: 447–78. [CrossRef]

Lang, Mark, and Lorien Stice-Lawrence. 2015. Textual analysis and international financial reporting: Large sample evidence. *Journal of Accounting and Economics* 60: 110–35. [CrossRef]

Lang, Mark H., and Russell J. Lundholm. 2000. Voluntary disclosure and equity offerings: Reducing information asymmetry or hyping the stock? *Contemporary Accounting Research* 17: 623–62. [CrossRef]

Lee, Charles M. C., and Qinlin Zhong. 2022. Shall we talk? The role of interactive investor platforms in corporate communication. *Journal of Accounting and Economics* 74: 101524. [CrossRef]

Leuz, Christian, and Peter Wysocki. 2016. The economics of disclosure and financial reporting regulation: Evidence and suggestions for future research. *Journal of Accounting Research* 54: 525–622. [CrossRef]

Li, Feng. 2008. Annual report readability, current earnings, and earnings persistence. *Journal of Accounting and Economics* 45: 221–47. [CrossRef]

Li, Feng. 2010. The information content of forward-looking statements in corporate filings—A naïve Bayesian machine learning approach. *Journal of Accounting Research* 48: 1049–102. [CrossRef]

Li, Feng, Russell Lundholm, and Michael Minnis. 2013. A measure of competition based on 10-K filings. *Journal of Accounting Research* 51: 399–436. [CrossRef]

Li, Haoyang, Xiaoke Cheng, and Lijie Yao. 2018. Does institutional investor research inhibit corporate tax avoidance behavior? An analysis based on the intermediary effect of information disclosure level. *The Accounting Research* 9: 56–63. (In Chinese)

Li, Jin, and Stewart Myers. 2006. R^2 around the world: New theory and new tests. *Journal of Financial Economics* 79: 257–92.

Li, Lidan, Wenbin Long, Jun Hu, and Xianzhong Song. 2022. The provincial border, information costs, and stock price crash risk. *China Journal of Accounting Studies* 10: 228–50. [CrossRef]

Li, Wu-Lung, and Kenneth Zheng. 2017. Product market competition and cost stickiness. *Review of quantitative finance and accounting* 49: 283–313. [CrossRef]

Li, Xiaorong, Steven Shuye Wang, and Xue Wang. 2017. Trust and stock price crash risk: Evidence from China. *Journal of Banking and Finance* 76: 74–91. [CrossRef]

Liu, Jianmei. 2021. Does negative information in MD&A can reduce stock crash risk? *Nankai Business Review International* 12: 537–52.

Liu, Shasha, Yunhao Dai, and Dongmin Kong. 2017. Does it pay to communicate with firms? Evidence from firm site visits of mutual funds. *Journal of Business Finance and Accounting* 44: 611–45. [CrossRef]

Loughran, Tim, and Bill McDonald. 2016. Textual analysis in accounting and finance: A survey. *Journal of Accounting Research* 54: 1187–230. [CrossRef]

Luo, Jin-hui, Xue Li, and Huayang Chen. 2018. Annual report readability and corporate agency costs. *China Journal of Accounting Research* 11: 187–212. [CrossRef]

Mayew, William J., and Mohan Venkatachalam. 2012. The power of voice: Managerial affective states and future firm performance. *The Journal of Finance* 67: 1–43. [CrossRef]

Mayew, William J., Mani Sethuraman, and Mohan Venkatachalam. 2015. MD&A Disclosure and the Firm's Ability to Continue as a Going Concern. *The Accounting Review* 90: 1621–51.

Mihailidou, Efthimia K., Konstantinos D. Antoniadis, and Marc J. Assael. 2012. The 319 major industrial accidents since 1917. *International Review of Chemical Engineering* 4: 529–40.

Morck, Randall, Bernard Yeung, and Wayne Yu. 2000. The information content of stock markets: Why do emerging markets have synchronous stock price movements? *Journal of Financial Economics* 58: 215–60. [CrossRef]

Peng, Lin, and Wei Xiong. 2006. Investor attention, overconfidence and category learning. *Journal of Financial Economics* 80: 563–602. [CrossRef]

Petra, Steven T. 2005. Do outside independent directors strengthen corporate boards? *Corporate Governance: The International Journal of Business in Society* 5: 55–64. [CrossRef]

Richardson, Scott, Siew Hong Teoh, and Peter D. Wysocki. 2004. The Walk-Down to Beatable Analysts' Forecasts: The Role of Equity Issuance and Insider Trading Incentives. *Contemporary Accounting Research* 21: 885–924. [CrossRef]

Roberts, John, Paul Sanderson, Richard Barker, and John Hendry. 2006. In the mirror of the market: The disciplinary effects of company/fund manager meetings. *Accounting, Organizations and Society* 31: 277–94. [CrossRef]

Robin, Ashok J., and Hao Zhang. 2015. Do industry-specialist auditors influence stock price crash risk? *Auditing: A Journal of Practice and Theory* 34: 47–79. [CrossRef]

Sharif, Arshian, Chaker Aloui, and Larisa Yarovaya. 2020. COVID-19 pandemic, oil prices, stock market and policy uncertainty nexus in the us economy: Fresh evidence from the wavelet-based approach. *International Review of Financial Analysis* 70: 70. [CrossRef]

Skinner, Douglas J. 1994. Why Firms Voluntarily Disclose Bad News. *Journal of Accounting Research* 32: 38–60. [CrossRef]

Su, Fei, Xu Feng, and Songlian Tang. 2021. Do site visits mitigate corporate fraudulence? Evidence from China. *International Review of Financial Analysis* 78: 101940. [CrossRef]

Sun, Sophia Li, Ahsan Habib, and Hedy Jiaying Huang. 2019. Tournament incentives and stock price crash risk: Evidence from China. *Pacific-Basin Finance Journal* 54: 93–117. [CrossRef]

Tang, Xuesong, Jun Du, and Qingchuan Hou. 2013. The effectiveness of the mandatory disclosure of independent directors' opinions: Empirical evidence from China. *Journal of Accounting and Public Policy* 32: 89–125. [CrossRef]

Tang, Yingkai, Aswad Akram, Lucian-Ionel Cioca, Syed Ghulam Meran Shah, and Muhammad Asim Ali Qureshi. 2021. Whether an innovation act as a catalytic moderator between corporate social responsibility performance and stated owned and non-state owned enterprises' performance or not? An evidence from Pakistani listed firms. *Corporate Social Responsibility and Environmental Management* 28: 1127–41. [CrossRef]

Tetlock, Paul C. 2007. Giving content to investor sentiment: The role of media in the stock market. *The Journal of Finance* 62: 1139–68. [CrossRef]

Tetlock, Paul C. 2011. All the news that's fit to reprint: Do investors react to stale information? *The Review of Financial Studies* 24: 1481–512. [CrossRef]

Tetlock, Paul C., Maytal Saar-Tsechansky, and Sofus Macskassy. 2008. More than words: Quantifying language to measure firms' fundamentals. *The Journal of Finance* 63: 1437–67. [CrossRef]

Verrecchia, Robert E. 2001. Essays on disclosure. *Journal of Accounting and Economics* 32: 97–180. [CrossRef]

Wen, Fenghua, Longhao Xu, Guangda Ouyang, and Gang Kou. 2019. Retail investor attention and stock price crash risk: Evidence from China. *International Review of Financial Analysis* 65: 101376. [CrossRef]

Xu, Jin. 2012. Profitability and capital structure: Evidence from import penetration. *Journal of Financial Economics* 106: 427–46. [CrossRef]

Xu, Nianhang, Xiaorong Li, Qingbo Yuan, and Kam C. Chan. 2014. Excess perks and stock price crash risk: Evidence from China. *Journal of Corporate Finance* 25: 419–34. [CrossRef]

Xu, Nianhang, Xuanyu Jiang, Kam C. Chan, and Shinong Wu. 2017. Analyst herding and stock price crash risk: Evidence from China. *Journal of International Financial Management and Accounting* 28: 308–48. [CrossRef]

Xu, Nianhang, Xuanyu Jiang, Kam C. Chan, and Zhihong Yi. 2013. Analyst coverage, optimism, and stock price crash risk: Evidence from China. *Pacific-Basin Finance Journal* 25: 217–39. [CrossRef]

Yang, Jun, Jing Lu, and Cheng Xiang. 2020. Company visits and stock price crash risk: Evidence from China. *Emerging Markets Review* 44: 100723. [CrossRef]

Yang, Shou-jung. 1971. A Readability Formula for Chinese Language. Ph.D. thesis, University of Wisconsin, Madison, WI, USA.

Yarovaya, Larisa, Janusz Brzeszczyński, John W. Goodell, Brian Lucey, and Chi Keung Marco Lau. 2022a. Rethinking financial contagion: Information transmission mechanism during the COVID-19 pandemic. *Journal of International Financial Markets, Institutions and Money* 79: 101589. [CrossRef]

Yarovaya, Larisa, Roman Matkovskyy, and Akanksha Jalan. 2022b. The COVID-19 black swan crisis: Reaction and recovery of various financial markets. *Research in International Business and Finance* 59: 101521. [CrossRef]

Yuan, Rongli, Jian Sun, and Feng Cao. 2016. Directors' and officers' liability insurance and stock price crash risk. *Journal of Corporate Finance* 37: 173–92. [CrossRef]

Zhao, Xiaofei. 2017. Does information intensity matter for stock returns? Evidence from Form 8-K filings. *Management Science* 63: 1382–404. [CrossRef]

Zhu, Zhaohui, and Wenhan Xu. 2018. Tone management, inefficient investment and earning management. *Journal of Audit and Economics* 33: 63–72. (In Chinese)