The impact of environmental information disclosure on the risk of stock price crash—take the pharmaceutical industry as an example

Haoyang Chen*

School of Social Science, University of California, Irvine, USA

*Corresponding author e-mail: haoyac2@uci.edu

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Abstract: Disclosure of environmental information is helpful for investors to evaluate the effectiveness of enterprise internal control, and reducing the degree of information asymmetry between investors and companies, so as to reduce the risk of stock price crash. In this paper, the listed companies of traditional Chinese medicine industry in China's A-share market from 2011 to 2019 are taken as objects to analyze the impact of environmental information disclosure on the risk of corporate stock price crash, and attempts to verify that the quality of environmental information disclosure is negatively correlated with the risk of corporate stock price crash.

1. Introduction

Stock price crash risk refers to the probability that a market index or the price of an individual stock will suddenly fall sharply. The risk of stock price crash is mainly caused by the management's concealment of the company's main risks and adverse information [1]. Therefore, how to avoid the corresponding risks in securities investment decision-making has attracted the attention of many experts and scholars across the globe. Previous studies have analyzed the influencing factors of stock price crash risk from the perspectives of managers' overconfidence [2], information concealment [3] and corporate governance level [4]. Different from the above studies, this paper mainly discusses the impact of environmental information disclosure on the stock price behavior of listed companies.

The reasons for choosing China's A-share market as the research object are as follows. First, China's capital market is in the stage of rapid development, and has developed into the world's second largest capital market after the United States market and the largest emerging capital market in the world. Near the end of 2020, China's three major A-share indexes rose in unison, marking unique October in global markets. In the first three quarters, 294 new shares were listed and the financing scale of over 350 billion yuan reached the highest level since 2010 [5]. Exploring its market characteristics is of great significance for understanding the steady operation of global capital markets (especially emerging markets). Second, China's capital market is dominated by retail investors, with obvious market speculative properties. By the end of 2018, there were 145,827,300 A-share investors in China's A-share market, and the number of individual accounts reached 145,496,600, accounting for more than 99.77% of total investors. Most of the retail investors follow the rise and fall, place more emphasis on trading than investment, and regard buying stocks as speculation and gambling [6]. Finally, the relatively weak information disclosure environment in China's capital market is helpful to observe the impact of environmental information disclosure on the risk of stock price crash. In particular, China's current securities market supervision system is not yet perfect, for the operating performance of listed companies, requirements of environmental protection of public disclosure of such information are not regulated; in recent years, investors have suffered heavy losses due to exposure of negative news regarding environmental information of listed companies. Thus, by studying the management level of environmental information disclosure of listed companies, to a certain extent can help avoid blind investment such that investors can further protect their lawful property interests.

The purpose of this paper is to study the internal relationship between the environmental

information disclosure in Environment, social, and government (ESG) evaluation and the risk of stock price crash of listed companies. Starting from the theoretical basis, this paper combs the theories related to the risk factors of stock price crash of domestic and foreign. It illustrates the necessity of improving the quality of environmental information disclosure of listed companies in the pharmaceutical industry through the panel data regression model with double fixed policy suggestions are put forward to provide reference for Chinese listed companies to enhance enterprise value and avoid stock price crash.

2. Theoretical analysis and research hypothesis

Stock price crash refers to the phenomenon that stock holders sell off a large number of stocks in a short time for some reason, leading to a sudden and unlimited decline in the stock price in a short time, while the risk of stock crash refers to the possibility of a stock price crash in the future [7]. The higher the risk of a stock crash, the higher the probability that the stock will crash; but it does not mean that a stock crash has biggest factor that leads to the stock crash is the hiding of negative information. When the negative information of an enterprise accumulates to the extent that it cannot be concealed, the market is in an extremely deteriorating situation, and investors are eager to sell their shares in a large amount, resulting in the stock price crash.

An important factor that leads to stock price crash is the degree of information disclosure. Among them, environmental information disclosure system enters the public eye because of its publicity the environmental information public disclosure system came into effect in 2001.The public's concern for environmental information drives relevant departments and enterprises to urge disclosure, which also arouses many discussions in academic circles. For example, Bi Xi and others believe that corporate environmental information disclosure reflects the compliance and implementation of the environmental information disclosure system of listed companies, and at the same time increases the public's understanding of the behavior of listed , in turn, will prompt listed companies to change some of their [8]. Sun et al. proposed that full disclosure of environmental information is required for the development of modern enterprises and also a key factor for enterprises to realize sustainable development strategies [9].

Based on the information asymmetry theory [10], the party with more information has the right to make its own choice when disclosing information, and often hides part of the information to harm the interests of the other party for its own benefit, while the party with less information is difficult to make a reasonable decision with the existing information, that is, it enters the "information.

3. Research design

3.1 Sample selection and data sources

In this paper, the listed companies of traditional Chinese medicine industry in China's A-share market from 2011 to 2019 are selected. After excluding ST stocks and listed companies with serious missing data, the remaining 154 listed companies in the pharmaceutical industry are obtained from data collected from Wind database, CSMAR database, the official website of the exchange and the official website of China Securities Regulatory Commission.

3.2 Variable Description

1) Explained variables

According to the known literature, there are mainly two indicators measuring the stock crash risk: NCSKEW(NCSKEW$_{i,t}$=$-\frac{n(n-1)^{3/2}\sum W^3_{i,t}}{(n-1)(n-2)(\sum W^2_{i,t})^{3/2}}$) and stock fluctuation volatility DUVOL (DUVOL$_{i,t}$=$\log\frac{(n_u-1)\sum_{down} W^2_{i,t}}{n_d-1)\sum_{up} W^2_{i,t}}$). The two indicators measure the stock crash risk with consistency. The higher the value of both in(dicators, the higher the stock price crash risk is. In this paper, the benchmark regression explanatory variable uses the negative return skew coefficient NCSKEW, while in the robustness analysis, the explanatory variable uses the stock volatility DUVOL. As for

the algorithm of NCSKEW and DUVOL indexes, this paper refers to Jin Hui Yi's Research on The Stock Crash Risk of Listed Companies Based on ESG Evaluation System -- A Case Study of The Pharmaceutical Industry, and does not repeat.

2) Explanatory variables

The explanatory variable of this paper is to measure the environmental information disclosure of enterprises. The measurement index is compiled into the environmental information disclosure index EDI by means of the average value of eight items of environmental information disclosure in the annual report of enterprises. The higher the index of environmental information disclosure, the higher the quality and level of environmental information disclosure. Environmental information disclosure in a timely manner, can effectively influence the investor's investment strategy. According to the **efficient market hypothesis**, for China's current market type there is no definite conclusion, more and more scholars believe that China is in the type from weak to half strong , whatever it is, released by the enterprise information will be reflected in the share price, environmental information disclosure will affect stock price changes, which could cause the crash risk. This paper believes that timely disclosure can reduce this risk, because when potential negative news is not disclosed in a timely manner, the risks involved become more and more intense. Information should be disclosed in a timely manner so that investors can change their strategies and adjust the stock price slowly. Therefore, this relationship is expected to have a negative impact in this paper.

3) Control variables

As for the control variables, this paper mainly considers several variables such as the shareholding structure, management personnel distribution, shareholder return rate, leverage ratio and enterprise scale of listed companies in the pharmaceutical industry.

a) Shareholding ratio of major Ownership)

The shareholding ratio of major shareholders reflects the extent to which shareholders' decisions affect the operation of the company. Generally speaking, shareholders do not participate in the management of the company, but they have the right to make decisions on major resolutions of the company, which truly reflects shareholders' decisions on the company's operating policy and investment, the higher the shareholding ratio of major shareholders is, the stricter the control right of shareholders will be. This standardizes the responsibility of enterprise management to maintain the stability of the company's stock price, so as to protect the maximum interests of shareholders.

b) Number of BD)

For the major issues of the company, the board of directors shall have the duty to disclosure. Generally speaking, shareholders do not participate in the management of the company, but shareholders have the right to decide on major resolutions of the company. This truly reflects the shareholders’operating policy and Decision of investment plan. Therefore, the higher the shareholding ratio of major shareholders, the stricter the shareholders' control over it. This standardizes the corporate management to maintain the company's stock price stability in order to protect the best interests of shareholders.

c) Return on ROE)

Return on equity, which measures the net profit created by each unit of shareholders' equity, reflects the profitability of a company. The level of a company's profitability has a positive effect on the company's stock the return on equity expected in this paper is inversely related to the risk of stock price crash.

d) Return on invested ROIC)

Return on invested capital is a measure used to evaluate the historical performance of a company or its business sector. It is often used to visually assess a company's ability to create value. Higher ROIC values are often taken as evidence of a firm's robustness or high returns on capital can also be a sign of poor management, such as an overemphasis on revenue and ignoring growth opportunities at the expense of long-term value. Therefore, the direction of the impact of the return on invested capital on the risk of stock price collapse is uncertain.

e) Asset-liability LEV)

Asset-liability ratio is a measure of a company's leverage ratio, which can measure a company's

long-term debt paying ability. The higher the company's debt paying ability is, the lower the company's cost in the stock financing market will be, which will stimulate the company's stock to rise, and then reduce the risk of stock price crash. Therefore, this paper expects that the impact of asset-liability ratio and stock price crash risk is negative.

f) Assets (SIZE)

Asset size, a commonly used variable, aims to control enterprises of different sizes for comparative analysis. Generally, the natural logarithm of total assets is taken as a measure of enterprise size.The bigger a company is, the more confidence investors have in it and the less risk share price collapse. Therefore, this paper expects that the impact of asset size and stock price crash risk is negative.

3.3 Model design

Based on the design of relevant theories and variables, the panel number regression model with double fixed effects is adopted, and the design is as follows:

$$NCSKEW_{i,t}=\beta_0+\beta_1 EDI_{i,t}+\beta_2 CONTROL_{i,t}+\lambda_i+\mu_t+\varepsilon_{i,t} \quad (1)$$

here, is the negative return skewness coefficient of the explained variable, is the environmental information disclosure index of the explained variable, and represents the control variable in the model, in proper order, shareholding ratio of major shareholders, number of directors, return on equity (ROE), return on invested capital (ROIC), asset-liability ratio (LEV), and asset SIZE (SIZE).λ_i denotes the individual heterogeneous effect that does not change with time, μ_t denotes the time heterogeneous effect that does not change with time, and $\varepsilon_{i,t}$ denotes the random disturbance term.

4. Empirical analysis

4.1 Descriptive analysis

In this paper, statistical software Eviews10.0 is used for statistical descriptive analysis, which is shown in Table 1.

Table 1. Descriptive analysis of the listed companies of traditional Chinese medicine industry in China's A-share market

Variable	Obs	Mean	Std. Dev.	Min	Max
NCSKEW	1386	1.19	0.22	1.07	3.17
DUVOL	1386	0.54	0.62	-1.47	3.65
EDI	1386	1.43	4.06	0.00	23.00
Ownership	1386	34.21	14.04	3.89	89.09
BD	1386	8.67	1.48	5.00	15.00
ROE	1386	10.56	12.49	-197.76	74.14
ROIC	1386	9.74	8.25	-82.20	54.70
LEV	1386	30.99	18.86	0.75	99.81
SIZE	1386	21.78	0.96	19.21	24.98

It can be seen from Table 1 that the sample size is 1386.The average value of NCSKEW is 1.19, the standard deviation is 0.22, the minimum value is 1.07, and the maximum value is 3.17. The mean value, the standard deviation, the minimum value and the maximum value of DUVOL are 0.54, 0.62, -1.47 and 3.65, respectively.EDI has a mean value of 1.43, standard deviation of 4.06, minimum value of 0.00 and maximum value of 23.00.

Table 2. Correlation analysis of the listed companies of traditional Chinese medicine industry in China's A-share market

	NCSKEW	EDI	Ownership	BD	ROE	ROIC	LEV	SIZE
NCSKEW	1							
EDI	-0.035	1						
Ownership	0.042	0.124	1					
BD	0.003	0.100	0.088	1				
ROE	0.097	0.107	0.107	0.040	1			
ROIC	0.128	0.123	0.160	0.049	0.844	1		
LEV	-0.156	0.011	-0.120	0.106	-0.255	-0.290	1	
SIZE	-0.137	0.182	0.147	0.206	0.069	0.076	0.306	1

4.2 Correlation analysis

Based on Table 2, we can find that NCSKEW is negatively related to EDI, which supports the hypothesis of this paper. Also, the correlation coefficient between explanatory variables and control variables are very small (there is only a strong correlation between ROE and ROIC, which is 0.8448), indicating that the model may have a multicollinearity problem, so the variance inflation factor 2 VIF is referred to further determine the seriousness of the multicollinearity using software EVIEW10.0 multicollinearity inspection. The test results are shown in Table 3.

Table 3. Collinearity test results of the listed companies of traditional Chinese medicine industry in China's A-share market

Variable	VIF	SQRT-VIF	Tolerance	R-Squared
EDI	1.06	1.03	0.9445	0.0555
Ownership	1.08	1.04	0.9253	0.0747
BD	1.06	1.03	0.9456	0.0544
ROE	3.51	1.87	0.2852	0.7148
ROIC	3.64	1.91	0.2746	0.7254
LEV	1.27	1.13	0.7879	0.2121
SIZE	1.23	1.11	0.8109	0.1891
Mean VIF	1.84			

From Table 3 above, it can be found that variance inflation factors are very close to 1, especially EDI, Ownership, BD, LEV, and SIZE. The ROE and ROIC are relatively large, with a value of about 3.5, which is consistent with the conclusion drawn in the correlation analysis. Although higher than other values, they are both less than 10. In general, under 2 VIF is based in 10, can see no multicollinearity problem, at the same time the software also reported 2 VIF is based in the arithmetic square root and tolerance (bottom) of the 2 VIF is based and 2, tolerance range of values between 0 and 1, the smaller the value, indicate that the variable with other variables multicollinearity is smaller, you can see the conclusion with 2 VIF is based in the consistent, so the test pass.

4.3 Regression of benchmark model

Through the analysis of panel data, considering each listed companies in the pharmaceutical industry in terms of the geographical position, economic policy, which in turn leads to the difference of social environment. Considering the changes over time, this paper decides to use fixed effects panel data regression to control time. The regression results are shown in Table 4.

Table 4. Baseline regression analysis

NCSKEW	Coef.	Robust Std. Err.	t	P>t	[95% Conf.	Interval]
EDI	-0.002	0.001	-2.150	0.032	-0.004	0.000
Ownership	0.001	0.000	1.820	0.069	0.000	0.001
BD	0.008	0.005	1.530	0.127	-0.002	0.018
ROE	-0.001	0.001	-1.440	0.150	-0.002	0.000
ROIC	0.004	0.001	3.210	0.001	0.002	0.007
LEV	-0.001	0.000	-3.040	0.002	-0.001	0.000
SIZE	-0.039	0.008	-5.200	0.000	-0.054	-0.025
_cons	1.994	0.156	12.750	0.000	1.687	2.300

According to Table 4, the following analysis can be carried out: (1) Overall significance test and goodness of fir test; (2) Analysis of explanatory variable EDI; and (3) Analysis of control variables. More details will be discussed in the following subsections.

1) Overall significance test and goodness of fit test

F statistic is 1242.2, and the corresponding P value is less than 0.01. Therefore, under the significance level of 1%, the model is significant as a whole. The fitting degree is better than 0.423, which indicates that the constructed model can explain 42.3% of the sample fluctuation, indicating that the model has a good explanatory ability.

2) Analysis of explanatory variable EDI

Explanatory variables EDI measures the quality of environmental information disclosure of listed companies in the pharmaceutical industry. First of all, according to this article, the impact should be negative influence since the regression results show that the regression coefficient is less than zero, which suggests that the model results are consistent with the expected return. Secondly, the T-statistic of the regression coefficient is -2.150, and the corresponding P value is 0.032, which indicates that the null hypothesis with a coefficient of zero can be rejected, so the regression coefficient is statistically significant. Finally, a further explanation on economic meaning and value coefficient of regression coefficient of the EDI is 0.002, it shows that while other conditions remaining unchanged, when the environmental information disclosure index EDI each rose 1 unit, the stock price crash risk NCSKEW will fall by 0.002. The coefficients are small, which may be explained variable value is too small, according to the above descriptive statistics can be found, be explained variable NCSKEW average of only 1.19, it is possible that the scale of EDI unit as a result, with a mean of 1.43, in spite of this, model construction can still provide strong support for the thesis of this paper. The higher the environmental information disclosure index is, the lower the risk of stock price crash will be.

3) Analysis of control variables

According to the regression results, the control variables of Ownership of regression coefficient is 0.001, which is statistically significant at 10% significance level. According to the above theoretical analysis, the Ownership should be negative influence, but the empirical regression results did not support this view, this is probably because the biggest shareholder in pursuit of short-term interests makes a decision unfavorable to the company long-term development, contributing to the rise of risks.Similarly, the regression coefficient of BD of the board of directors is 0.008, positive and insignificant, which is not in line with the previous expectation. This may be because there are too many board members, which leads to the increase of decision-making cost, the extension of decision-making time, and the delay of information disclosure. The regression coefficient of ROE is -0.001, which is negative and insignificant. This is in line with the theoretical expectation mentioned above, which indicates that the regression coefficient of ROE is economically significant, and the rise of ROE will play a restraining role on the risk of stock price crash. The regression coefficient of ROIC is 0.004, which is positive and statistically significant, and the direction of ROIC is uncertain according to the previous expectation, indicating that ROIC will increase the risk of stock price crash. The regression coefficients of LEV and SIZE were -0.001 and -0.039, respectively; both of which were negative and were economically significant and statistically significant, consistent with the

expected signs above, especially that the SIZE of assets had a greater inhibitory effect on the risk of stock price crash.

4.4 Robustness test

In order to ensure the robustness of the model and avoid the wrong empirical results caused by accidental factors, it is necessary to carry out robustness analysis. There are two main types of robustness analysis. The first is substitution variables: Replace with similar variables in the baseline regression to see if the regression results are consistent with the second is the grouping classification regression, which checks whether the attribute classification of different categories is consistent with the original regression results, so as to judge its paper adopts the first method, substitution of mentioned earlier, there are typically two measures of stock price crash risk, NCSKEW and DUVOL. Here, the NCSKEW in the benchmark regression is replaced with DUVOL. In further analyzing the result, you can get the following regression analysis by using the software Eview10.0, as shown in Table 5.

Table 5. Regression of robust analysis

DUVOL	**Coef.**	**Robust Std. Err.**	**t**	**P>t**	**[95% Conf.**	**Interval]**
EDI	-0.011	0.003	-3.410	0.001	-0.018	-0.005
Ownership	0.000	0.001	0.230	0.817	-0.002	0.002
BD	0.007	0.010	0.740	0.457	-0.012	0.027
ROE	-0.005	0.001	-3.990	0.000	-0.007	-0.002
ROIC	0.003	0.003	1.150	0.251	-0.002	0.009
LEV	-0.005	0.001	-5.260	0.000	-0.007	-0.003
SIZE	-0.037	0.020	-1.830	0.067	-0.077	0.003
_cons	1.899	0.396	4.800	0.000	1.123	2.675

Robustness through the above regression, EDI explained variable symbol is negative, coefficient is 0.011, and under 1% significance level is statistically significant, with the benchmark regression model is consistent with the results, and compared with NCSKEW as be explained variables, the regression coefficient of EDI numerical bigger, inhibition of stock price crash risk bigger and more obvious. Compared with other control variables, only ROE and LEV, SIZE are statistically significant and consistent with the symbols in the baseline regression, while other control variables Ownership, BD and ROIC are not significant, but consistent with the coefficient direction of the baseline ,to sum up, the empirical model constructed in this paper is relatively robust, so the negative conclusion of environmental information disclosure quality and stock price crash risk is relatively robust.

5. Conclusion

Adopting the method of empirical analysis, this paper aims to explore the impact of environmental information disclosure on the risk of stock price .The conclusion shows that the quality of environmental information disclosure is negatively correlated with the risk of stock price crash, that is, the higher the quality of environmental information disclosure, the less likely the stock price crash will happen. This is mainly because the higher the quality of environmental information disclosed by a listed company, the more information it contains in its stock price, the less negative information the management can hide, and the lower the possibility of the stock price crash caused by the exposed negative information. The size of assets has a greater inhibitory effect on the risk of stock price crash, that is, the larger the asset size of listed companies, the stronger their ability to resist the risk of stock price crash. This may have something to do with the fact that listed companies with large assets can give people a stronger sense of security and confidence.

The findings of this paper also have important policy implications. From the perspective of the government, government departments should establish a real-time monitoring system for the

securities market, and take ESG indicators such as environmental information disclosure as entry points to further timely observe and supervise market risks, operational risks and purchasing power risks. From the point of view of the actual controller of the listed company, we should have a better understanding of the situation of the listed company, strengthen our sense of responsibility for the enterprise and the society, and set up the corporate image of green development. From the perspective of investors, in the process of making investment decisions, the environmental information disclosure of the enterprise should be fully considered, and the future development potential of the enterprise can be predicted through its environmental information disclosure content.

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