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Study on the Influence of Financial Risk on Financial Fraud in Pharmaceutical Manufacturing Industry

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Abstract

In this paper,A-share listed enterprises in the pharmaceutical manufacturing industry that were punished for financial fraud during 2015-2019 and their matching non-fraud enterprises were selected as the research objects.Combined with the fraud triangle theory and existing research results,the Logistic regression model was used to make an empirical analysis of the relationship between financial risk and financial fraud.The results show that the greater the financial risk,the greater the possibility of financial fraud.

Keywords

Financial malpractice, Financial risk, Logistic regression model, Pharmaceutical manufacturing industry.

1. INTRODUCTION

With the increasingly mature Chinese capital market, more and more companies enter the securities market and become the target of public investment. Especially in recent years, the registration system reform of Science and Technology Innovation Board and Growth Enterprise Board has created opportunities for smes to go public. However, from the fraud of Yinguangxia to the financial fraud of Kangmei in recent years, the financial fraud of Chinese listed enterprises is repeatedly forbidden, and even constantly refresh the scale of fraud. Financial fraud of enterprises will make relevant information distortion, interfere with the normal operation of the securities market, so that investors suffer huge losses, heavy blow to investor confidence; At the same time, various fraud methods also increase the difficulty of supervision, and put forward greater challenges to audit practitioners and relevant regulatory authorities. Therefore, it is of great practical significance to strengthen the research on corporate financial frauds in the context of more open financial markets to help investors, auditors and regulatory authorities accurately identify financial frauds and to warn and restrain corporate frauds.

In addition to financial fraud, the financial risk of enterprises is also one of the areas of concern. Different scholars have different definitions of financial risk. This paper mainly draws on and combines with the narrow definition of decision theorists, and regards financial risk as the uncertainty that may lead to the decline of the solvency of enterprises or the loss caused by the deviation of operating income from expectations. Based on previous studies, it can be found that the motivation of financial fraud in enterprises is often related to the increase of the pressure of going public, maintaining brand, stabilizing stock price or refinancing caused by poor financial condition, and the poor performance of financial condition is one of the big warning signals of financial risk. On this basis, this paper believes that there is a correlation between financial risk and fraudulent behavior, and puts forward a hypothesis based on the

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fraud triangle theory. The listed enterprises in the pharmaceutical manufacturing industry, which is the "hardest hit area" of financial fraud, and the non-fraudulent enterprises matched with them are selected as the research object, and the financial risk is taken as the core explanatory variable. The empirical research on the influence of financial risk on financial fraud of listed companies is carried out in order to provide investors, auditors and relevant supervision departments with a new perspective on identifying and analyzing fraudulent behavior.

2. LITERATURE REVIEW

As for the research on the influencing factors of financial fraud, Zenglian Zhang and Ya Gao(2017), based on the fraud triangle theory, took voluntary information into account on the basis of mandatory information to improve the accuracy of the financial fraud identification model. Based on the fraud risk factor theory and game theory, Yiheng Niu (2020) concluded that the internal factors inducing corporate financial fraud mainly include corporate executives seeking personal gains, avoiding punishment in the securities market and hiding illegal behaviors. Guangqi Ma and Baoping Zhang (2019) empirically analyzed and demonstrated the influence of R&D investment intensity and R&D innovation risk on financial fraud risk based on Chinese A-share market data. Ling Lei Lisic, Sabatino (Dino) Silveri et al. (2015) confirmed the relationship between the size of accounting firms and corporate financial fraud by analyzing the data of Chinese enterprises, that is, companies audited by large accounting firms are less likely to commit financial statement fraud. Liguo Liu and Ying Du (2003) concluded through empirical research that the proportion of legal shares and the size of the board of supervisors were positively correlated with the possibility of financial fraud, while the proportion of tradable shares was negatively correlated with it.Shizhong Huang analyzed the deep-rooted reasons of financial fraud in Chinese listed companies from eight aspects, such as the economic cycle down and governance mechanism failure (2019), and from the perspective of treating both symptoms and root causes, put forward eight countermeasures and suggestions, such as modifying sentencing standards and increasing economic penalties. Some scholars also studied financial fraud in specific industries by considering the influence factors of the industry. For example, Zhongxin Wu and Linglin Chen (2015) analyzed the financial report fraud of listed agricultural companies based on the fraud triangle theory, and drew different conclusions from the existing studies on partial and comprehensive analysis of all listed companies, indicating the necessity of building an industry-specific model.Hongmin Ai , Guichun Wang,Qian Liu and Jie Chen (2012) adopted the empirical research method and established the Logistic model to identify and study the fraudulent phenomena in financial reports of listed real estate companies, and achieved a high prediction accuracy.

Financial risk is one of the common risks in the process of enterprise operation. Especially in the environment of information technology change and accelerated economic globalization, enterprises are facing more dynamic environment and more fierce competition, so the study of financial risk is more important. For this reason, Lichun Deng and Weiyong Du (2020) establish Cox proportional risk model based on survival analysis to systematically discuss and analyze the generation of financial risks, and obtain four guardian factors related to financial crisis, including working capital ratio, after-tax profit, operating leverage coefficient and operating income cash ratio through the model. Ziqin Feng (2011) established a matrix recognition model for identifying enterprises' three-dimensional financial risks, and illustrated the validity of the research results with examples. Youtang Zhang and Yang Huang(2011) realized the organic combination of financial early warning and risk control through simulation technology; Dezhong Huang and Chaoqun Zhu (2016) introduced the asset quality index into the financial risk early warning model to improve the accuracy of the model. Fusheng Yu(2008) et al proved through empirical analysis that corporate governance structure of Chinese listed companies has

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an impact on corporate financial risk. In addition, some scholars have analyzed specific industries. Xuhua Hou and Botao Liu (2019) took Taikang Online as an example to analyze the main characteristics and performance of financial risks of Internet insurance companies. Bihong Yan, Guangqi Ma(2011) conducted an empirical analysis of the financial risks of listed real estate companies based on Z-Score model; Di Lu and Guanhua Wang (2019) conducted an empirical study on the financial risk early warning of listed agricultural enterprises by using factor analysis method and cluster analysis method, and found that 62.79% of listed agricultural companies were in a state of warning, and the overall financial situation of listed agricultural companies was worrying.

A comprehensive literature analysis shows that although the existing studies do not directly show the relationship between financial risk and financial fraud, they indirectly reflect some internal links between financial risk and financial fraud from the perspective of influencing factors, measurement indicators and moderating effects of financial risk. Accordingly, the following hypothesis is proposed in this study:

H0: Financial risk is significantly correlated with the occurrence of financial fraud, and the higher the financial risk, the more likely the occurrence of financial fraud.

H1: Financial risk is not related to the occurrence of financial fraud.

3. EMPIRICAL STUDY

3.1. Sample selection and data sources

According to the industry classification and punishment announcement of China Securities Regulatory Commission, this paper selects the data of A-share listed companies punished by China Securities Regulatory Commission in pharmaceutical manufacturing industry from 2015 to 2019 as samples of fraudulent companies. After screening, 49 samples of fraudulent companies and 49 samples of non-fraudulent companies were obtained, with a total of 98 samples. All data in this paper are from the official website of Guotai 'an Research Service Center and China Securities Regulatory Commission. python3.7 and SPSS26.0 software were used for data processing.

3.2. Variables and models

(1) Explained variable

The explained variable of this study is financial fraud, and its quantitative index is dummy variable, that is, the explained variable is 1 when financial fraud occurs, otherwise it is 0.

(2) Core explanatory variable

The core explanatory variable of this study is financial risk, and there are mainly two types of variables to measure corporate financial risk. One is based on market data, such as stock return volatility, beta coefficient, etc. The other is based on accounting data. Since our securities market is not perfect, the investors have stronger speculative factors, compared with the risk measurement based on market data, the risk measurement based on accounting data is more suitable for the actual situation of Chinese enterprises (Xiaobo Yuan, 2010). Among such methods, Z-score model proposed by American Professor Edward Altman in 1968 is more famous. This model captures financial data by analyzing enterprise financial statements and establishes five-variable linear equation for early warning research. The data of this method is real, objective and easy to obtain, and the method is scientific and rigorous and has wide practical application significance. For this reason, Chinese scholars applied it to analyze and explain the financial risks of Chinese enterprises, and supported the validity of this model in Chinese stock market through empirical research (Dewei Xiang, 2002). In addition to Z-score model, domestic scholars also build an index system that affects financial risk, and use SVM

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(Jinji Zhang et al., 2017) optimized based on particle swarm optimization (PSO), BP neural network algorithm (Haifeng Wang, 2018), factor analysis and cluster analysis (Di Lu et al., 2017), 2019) and others have built models with good explanatory effect. This paper draws on the excellent research achievements of domestic and foreign scholars, constructs a financial index system affecting financial risk from five aspects: solvency, profitability, development ability, operation ability, and per share index, and uses the principal component analysis method to combine the indicators in the index system with the Z-score model. The financial risk index system established is as follows:

Table 1. Financial risk index system

Analysis index	symbol	Financial index	Calculation formula
solvency	X1	Current ratio	Current assets/Current liabilities
	X2	Quick ratio	(Current assets - inventory)/Current liabilities
	X3	Net cash flows from operating activities / current liabilities	Net cash flows from operating activities/Total current liabilities
	X4	Equity multiplier	Total assets/Total owners' equity
	X5	Long-term debt to equity ratio	Total non-current liabilities/Total owners' equity
profitability	X6	Return on assets	(Total profit + finance expense)/Average total assets
	X7	Net profit rate on total assets (ROA)	Net profit/average balance of total assets; Average balance of Total assets = (Total Assets ending balance + Total Assets beginning balance) /2
	X8	Return on equity(ROE)	Net profit/average balance of shareholders' equity; Average balance of shareholders' equity = (ending balance of shareholders' equity + beginning balance of shareholders' equity) /2
	X9	Operating margin	Operating profit/Revenue
	X10	Profit rate of cost expense	(Total profit)/(Operating cost + selling expense + administrative expense + finance expense)
Development ability	X11	Growth rate of fixed assets	(End value of net fixed Assets of the current period -- end value of net fixed assets of the same period of last year)/(End value of net fixed assets of the same period of last year)
	X12	Growth rate of total assets	(Total assets at the end of the current period -- total assets at the end of the same period last year)/(Total assets at the end of the same period last year)
	X13	Net profit growth rate	(Net profit Amount of the current period of this year -- Net profit amount of the same period of last year)/(Net profit amount of the same period of last year)
Operational capacity	X14	Turnover rate of fixed assets	Average net operating income/fixed assets Average net fixed assets = (ending balance of fixed assets + beginning balance of fixed assets) /2
	X15	Turnover of total assets	Operating income/average total assets; Average Total Assets = (Total Assets ending balance + Total Assets beginning balance) /2
Per share indicator	X16	Earnings per share	Current net profit value/paid-in capital value at the end of the current period

After the index system was constructed, this paper used SPSS 26.0 software for correlation analysis of the above indicators. The analysis results showed that there was a significant

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correlation between some indicators, for example, the correlation coefficient between the flow ratio and the quick ratio was as high as 0.983, showing a strong correlation. In order to avoid the mutual influence of the explanatory power of each index and improve the fitting reliability of the early warning model, principal component analysis method should be adopted to recombine the scattered explanatory information and find out the new linear grouping cooperation main component, so that the new comprehensive index can load the effective explanatory information of the original index to the maximum extent (Xiang Wang ,2019). Pass. KMO and Bartlett sphericity test is the prerequisite for principal component analysis. The test results of 98 data samples show that the KMO statistical value is 0.779, greater than the critical value 0.5, and the significance coefficient of Bartlett sphericity test is 0.000, less than 0.05, indicating that the sample data is suitable for principal component analysis.

Through principal component analysis, it can be seen that the information interpretation effect of the four principal components reaches 76.210%, which can explain most of the information of all indicators more ideal. The four principal components are expressed as follows:

$$Y_1 = -0.073X_1 - 0.066X_2 - 0.049X_3 + 0.039X_4 + 0.000X_5 + 0.176X_6 + 0.169X_7 + 0.193X_8 + 0.202X_9 + 0.196X_{10} + 0.176X_{11} + 0.135X_{12} + 0.057X_{13} - 0.098X_{14} - 0.073X_{15} + 0.137X_{16}$$

$$Y_2 = 0.335X_1 + 0.336X_2 + 0.309X_3 - 0.062X_4 - 0.001X_5 - 0.010X_6 + 0.001X_7 - 0.076X_8 - 0.020X_9 + 0.052X_{10} + 0.058X_{11} - 0.067X_{12} - 0.094X_{13} + 0.056X_{14} - 0.036X_{15} - 0.056X_{16}$$

$$Y_3 = -0.006X_1 - 0.008X_2 + 0.073X_3 + 0.049X_4 + 0.000X_5 + 0.043X_6 + 0.032X_7 + 0.006X_8 - 0.131X_9 - 0.161X_{10} - 0.131X_{11} - 0.054X_{12} - 0.087X_{13} + 0.482X_{14} + 0.493X_{15} + 0.142X_{16}$$

$$Y_4 = -0.006X_1 + 0.015X_2 + 0.094X_3 + 0.491X_4 + 0.457X_5 + 0.081X_6 + 0.046X_7 + 0.050X_8 + 0.006X_9 + 0.074X_{10} + 0.499X_{11} + 0.076X_{12} - 0.164X_{13} - 0.027X_{14} - 0.018X_{15} + 0.080X_{16}$$

By weighting the ratio of the characteristic roots of each principal component and the sum of the four characteristic roots, the quantitative index of financial risk can be obtained, namely the improved Z-score model index:

$$Z = 0.553Y_1 + 0.213Y_2 + 0.137Y_3 + 0.097Y_4$$

The calculation result of Z value of sample data is shown in Table n. The mean value 0.000 of Z value of sample data is the lower limit critical value, and the median value 0.018 is the upper limit critical value. When Z value is greater than 0.018, it indicates that the enterprise is a high-quality low-risk enterprise; when Z value is between 0.000 and 0.018, it indicates that the enterprise is in an unstable area of risk. When Z value is greater than 0.018, it indicates that the company is facing high financial risk. The results show that among the 98 samples, the only sample whose Z value is ST enterprise in the data selection year is -0.180, which belongs to the enterprise with high financial risk. In order to further verify the explanatory power of the model, this study randomly selected the financial data of 30 pharmaceutical manufacturing enterprises in 2019 to calculate the corresponding Z value. The results show that the Z value of 6 ST or *ST enterprises in the 30 sample data is lower than 0.000, belonging to high financial risk enterprises. It shows that the Z value calculated by this model can better represent the financial risk of the enterprise.

(3) Control variable

Based on existing literature, this study draws on previous research results and combines the fraud triangle theory to select the following indicators that may have an impact on financial fraud from the three aspects of pressure, opportunity and self-rationalization. In order to make

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the indicator system of the causes of financial fraud more complete, financial risk is also included (Table 3).

Table 2. Index system of influencing factors of financial fraud

Variable classification	Variable property	Variable name	symbol	Variable definition
	Explained variable	Financial malpractice	Fraud	Fraud is 1, otherwise 0
pressure	Core explanatory variable	Financial risk	Z	Z值
	Control variable	Management's shareholding ratio	C1	Management shares/total shares
opportunity		Number of shareholder meetings held	C2	The average number of annual general meetings for the current period and the preceding year
		Number of board meetings	C3	The average number of annual board meetings for the current period and the previous year
		Board shareholding ratio	C4	Total number of shares held by the board of directors
		Proportion of independent directors	C5	Number of independent directors/total number of board members
		Change of chairman/General manager	C6	Fraud Change of chairman or general manager in the current period and the previous year to 1, otherwise 0
		Number of meetings of the Board of supervisors	C7	The average number of meetings of the Board of Supervisors in each year of the current period and the preceding year
		Shareholding ratio of the board of supervisors	C8	Total number of shares held by the supervisory Board/total number of shares
		The fourth committee establishes the number	C9	The number of audit , strategy , Nominating committee,compensation and appraisal committee
		The proportion of legal shares	C10	Number of legal person shares (including domestic, overseas and raised legal person shares)/total number of shares
		Proportion of shares outstanding	C11	Number of outstanding shares/total shares
		Accounting firm size	C12	According to the "Top 100 Accounting Firms by Business Revenue in 2018", the audit unit of an enterprise is 1 of the top 30 accounting firms in China, otherwise 0
		Ownership concentration	C13	Shareholding ratio of the largest shareholder of the company
self-rationalization		Whether to change auditors	C14	Change auditor is 1, otherwise 0
		Whether to change accounting firms	C15	Change accounting firm is 1, otherwise 0

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A K-S test was conducted on the fraud samples and non-fraud samples of the above indicators, and the results showed that they did not conform to the normal distribution. Therefore, Wilcoxon test was adopted to test the paired samples of the above control variables, and the results showed that, Only the significance coefficients of the number of set up (C9), the proportion of legal shares (C10), the proportion of tradable shares (C11) and the index of equity concentration (C13) are significant at the 5% or 10% level. Therefore, this paper finally selects four indicators significant in the Wilcoxon test as control variables.

(4) Model construction

Logistic Regression analysis is a generalized linear regression analysis model, which is an effective method to deal with the problem that the explained variable is classified variable. The explanatory variable of this model can be classified variable or continuous numerical variable. Since the explained variable studied in this paper is a binary dependent variable, the Logistic regression model is adopted for analysis, and the following model is constructed according to the study variable:

$$\text{Fraud} = \ln(\frac{p}{1-p}) = \beta_0 + \beta_1 Z + \beta_2 C9 + \beta_3 C10 + \beta_4 C11 + \beta_5 C13 + \varepsilon$$

Among them， Fraud is the explained variable, p is the probability of fraud occurring in listed companies, and Z is the core explanatory variable, C9, C10, C11, C13 are the control variable, β_1, β_2, β_3, β_4, β_5 are the coefficient, β_0 is a constant term, ε is the random error term.

3.3. Empirical analysis

(1) Descriptive statistics

Through the K-S test on the above samples, it can be seen that the sample data do not follow the normal distribution, and the T-test cannot be used to conduct univariate significance test on the sample asset size. Therefore, this paper conducts non-parametric test on the sample data through Wilcoxon test, and the results show that the two-tailed asymptotic probability p of the sample asset size is 0.423 at the significance level of 5%. If the size of the two samples is greater than 0.05, it indicates that there is no significant difference in the size of the two samples. The selection of sample data meets the research requirements, and the possible influence of the size factor on financial reporting fraud is excluded.

Table 3. Descriptive statistics and Wilcoxon test of asset size of fraudulent and non-fraudulent samples

		Average value	Standard deviation	Minimum value	Maximum value	median	Z-test value	Progressive significanceAsymp.Sig (2-tailed)
Total assets	Fraud sample	5239755875.02	4897077769.28	280382217.55	20611211079.40	3588283170.23	-0.801	0.423
	Non-fraudulent sample	5323531540.38	5266587314.04	338832319.12	20025001188.04	3565181479.68		

Note: The Wilcoxonsignedrank test was used to test the statistical significance level of the median of each variable. It was a two-sided test.

(2) Logistic Regression analysis

Logistic regression analysis results show that the overall significance coefficient of the regression model is 0.000048, less than 0.05, indicating that the whole regression model is meaningful. Data were substituted into the model, and the results of fraud classification test were obtained (Table n). When using this model for identification, the overall recognition accuracy is 72.45%, and the prediction effect is acceptable, indicating that this regression model has explanatory power for analyzing the relationship between core variables.

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Table 4. Logistic regression processing results

Variable	Coefficient	Std.Error	z-Statistic	Prob.
C	2.343552	4.689411	0.499754	0.6172
Z	-0.981667	0.498367	-1.969766	0.0489**
C9	-0.655609	1.116473	-0.587214	0.5571
C10	1.344362	1.763719	0.762231	0.4459
C11	2.540282	1.220791	2.080849	0.0374**
C13	-0.050968	0.018592	-2.741455	0.0061***

Note: *** and ** are significant when the significance level is 1% and 5%, respectively.

Based on the results of regression analysis, it can be seen that the Logistic regression model constructed in this study and the relationship between the study variables are as follows:

$$\text{Fraud} = 2.3436 - 0.9817 * \text{Z} \pm 0.6556 * \text{C9} + 1.3444 * \text{C10}$$
$$+2.5403 * \text{C11} - 0.0510 * \text{C13}$$

As the significance coefficient of core explanatory variable (Z) is 0.0489, less than 0.05, it indicates that there is a significant correlation between Z and explained variable (Fraud), that is, between financial risk and financial fraud. Moreover, the regression coefficient corresponding to the core explanatory variable (Z) is -0.9817, which is less than 0, indicating that Z has a negative impact on Fraud. The larger Z is, the smaller Fraud is. The larger the Z value is, the smaller the financial risk the enterprise faces. Therefore, the correlation between the core explanatory variable and the explained variable confirms the hypothesis of this paper, that is, the financial risk is significantly correlated with the occurrence of financial fraud, and the higher the financial risk, the more likely the occurrence of financial fraud.

Table 5. Prediction of empirical results

	EstimatedEquation			Constant Probability		
	Dep=0	Dep=1	Total	Dep=0	Dep=1	Total
P (Dep=1) <=C	34	12	46	49	49	98
P (Dep=1) >C	15	37	52	0	0	0
Total	49	49	98	49	49	98
Correct	34	37	71	49	0	49
%Correct	69.39	75.51	72.45	100.00	0.00	50.00
%Incorrect	30.61	24.49	27.55	0.00	100.00	50.00
TotalGain*	-30.61	75.51	22.45			
PercentGain**	NA	75.51	44.90			

4. CONCLUSIONS AND SUGGESTIONS

Based on the fraud triangle theory and the existing research results on the influencing factors of financial fraud, this paper regards financial risk as one of the pressure factors in the cause of financial fraud behavior, and puts forward the hypothesis accordingly. With the occurrence of financial fraud as the explained variable and financial risk as the core explanatory variable, the hypothesis is verified by Logistic regression analysis. The empirical results show that there is A

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significant correlation between the financial risk of A-share listed companies in the pharmaceutical manufacturing industry and the occurrence of financial fraud, and the higher the financial risk, the greater the probability of financial fraud.

Accordingly, the research inspiration and relevant suggestions of this paper can be summarized into three aspects:

(1) Strengthen the internal monitoring of enterprises

The prevention of financial risk and financial fraud should start from within the enterprise. For listed enterprises, we should pay close attention to the healthy development of the company's ability to prevent the income loss caused by too high financial risk; When high financial risks have appeared, corresponding measures should be taken in time to avoid, control or transfer risks to reduce losses.

(2) Quantifying the financial risks of enterprises

For auditors and relevant regulatory authorities, the research ideas of this paper can be used for reference. Financial risks faced by enterprises can be quantified by systematically combining financial indicators such as solvency, profitability, development capacity, operating capacity and per share index, and supervision of high-risk enterprises can be strengthened to prevent the occurrence of fraud.

(3) Cautious attitude towards investment in enterprises with high financial risks

For investors or creditors, they can preliminarily judge the possibility of fraud of the target company through the financial risk of the enterprise, and they should be more cautious in the investment decisions of enterprises with high financial risk to prevent their own interests from being damaged.

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