

# Empirical Research on Impact of Competitive Intensity on Safety Investment in High-Dangerous Industries

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**Abstract.** This paper takes the listed companies in high-dangerous industries as the research object, and constructs an empirical test model based on the theoretical derivation from the perspective of safety investment. The impact of competition intensity on the safety investment level of listed companies in high-dangerous industries was systematically analyzed theoretically, and this model was used to empirically test this effect. The research results show that under the same conditions of other factors, the competition intensity and the safety investment level are in an inverted U-shaped relationship, that is, as the competition intensity increases, the level of safety investment rises first and then falls. According to the research conclusions, this paper puts forward the policy recommendations to ensure the enterprises of high-dangerous industry to effectively invest in safety resources, and provides a good reference for regulating the safety investment of listed companies in high-dangerous industries.

## Introduction

In order to ensure the safety in production of enterprises, the Ministry of Finance and the State Administration of Safety Supervision of China jointly issued a legal document entitled “Administrative Measures for the Extraction and Use of Safety Production Costs of Enterprises” in 2012, which stipulates that nine major industries of coal production, non-coal mining, construction engineering, dangerous goods production and storage, transportation, fireworks and firecrackers production, metallurgy, machinery manufacturing, weapons and equipment development, production and testing (including civil aviation and nuclear fuel) are high- dangerous production industries. At the same time, it also stipulates the requirements for the extraction of resources for safety investment in high- dangerous industries and the standards for the use of safety resources. As a key issue in the field of safe production, safety investment has received extensive attention in practice and theory. When studying safety problems, it is inevitable to contact the external environment in which the enterprise is located. In recent years, the external environment of the industry in which Chinese enterprises are located has been constantly changing. Will the intensity of competition affect the level of safety investment in high-dangerous enterprises? This issue is the focus of the research in this paper.

## Literature Review and Hypothesis

The existing literature on safety research mainly regards safety as an aspect of social responsibility of enterprises [1]. From the motivation theory of social responsibility fulfillment, corporate social responsibility mainly depends on the remaining resources that enterprises can use and needs to meet the economic motivation of social responsibility. The intensity of competitive in an industry in which an enterprise is located is the intensity of competitive. As a medium-sized factor affecting corporate behavior, competitive intensity plays a vital role in the study of corporate behavior. Due to the intensified competition in the industry in which companies are located, companies will face pressure from price competition and the emergence of alternatives, so companies have to make some

speculative behaviors to maintain performance. Campbell believes that due to resource constraints, companies in a highly competitive environment put resources on strategies that promote business performance, such as advertising, and social responsibility is not the first choice for enterprise resources [2]. There will be behaviors that are not responsible for the society, such as extending working hours, harming employees' interests, and polluting the environment.

Xing-Ping Jia obtained an empirical analysis of 11 industries in the steel industry and engineering machinery, and concluded that the relationship between the competition intensity of the industry in which the enterprise is located and the existence curve of social responsibility showed a trend of rising first and then decreasing [3]. That is, as the intensity of competitive increases, the burden of social responsibility first rises and then falls. At the same time, Li-Yang Ruan distinguishes the nature of social responsibility, and the intensity of competitive has a linear impact on commercial social responsibility, while for environmental social responsibility, it shows a curve relationship [4]. According to the theoretical research and empirical results of the predecessors, it is found that with the increase of competitive, enterprises actively carry out safety investment, enhance the safety protection of employees, avoid negative externalities, and actively fulfill the social responsibility of safe enterprises. However, as the intensity of competitive in the industry reaches a certain point, the industry may have a large number of vicious competitive phenomena, such as maliciously lowering prices to carry out "price wars". Due to limited resources, fierce competitive in the industry and low profit margins, survival may be the most concerned issue of the enterprise compared with safety investment, and the potential characteristics of the economic benefits of safe investment will also significantly affect the enthusiasm of enterprises for safe investment. Therefore, enterprises may reduce safety investment while ensuring normal operation. Accordingly, the main hypothesis of this research is as follows:

H: The competitive intensity and the level of safety investment in high-dangerous enterprise are in an inverted U-shaped curve. That is, as the competitive intensity increases, the enterprise safety investment first rises and then falls.

## Data and Research Design

### Sample Selection

To empirically investigate the relationship between competitive intensity and safety investment, sample of this research is drawn from CSMAR (China Stock Market Accounting Research) database, which can provide almost all kinds of financial information of companies listed on the A-share market. The high-dangerous enterprises are mainly distributed in nine major industries such as coal production, non-coal mining, construction engineering, etc. In order to construct our sample, all high-dangerous companies listed on the A-share market from CSMAR for the period between 2012 and 2016 have been chosen. But, the listed companies with the risk of delisting were excluded because the companies were losing money continuously and the financial data was abnormal, and samples with missing other financial data are also deleted. Finally, a total of 2,444 observations were selected as samples for this research. The software used for empirical testing mainly includes Excel 2010 and Stata15. To avoid the effects of extreme values on the results, 1% tail processing is performed on all continuous variables.

### Variable Definitions

#### *Safety Investment.*

There is no unified consensus on the measurement methods of safety investment. According to the regulations of the "Administrative Measures on the Extraction and Use of Safety Production Costs of Enterprises" issued by the Ministry of Finance, enterprises in high-dangerous industries should extract safety production costs according to a certain proportion, and first count them into accounting subjects of special reserve, and then use them to ensure the safety production of enterprises. Therefore, in this study, the amount of safety investment is measured by the current use of the special reserve or by the current reduction of the special reserve [5]. Specifically, it is the reduction of the special

reserve for the current period divided by the total amount of the company's assets at the end of the period as a proxy variable for safe investment.

**Competitive Strength.**

In this study, the famous Herfindahl-Hirschman Index (*HHI*) was used to measure the intensity of competition in the industry in which the company is located. The specific formula is as follows:

$$HHI = \sum \left( \frac{X_i}{X} \right)^2 \tag{1}$$

*X* is the total business income of the entire industry, and *X<sub>i</sub>* is the individual business income of the specific No. *i* listed company. The competitive intensity index is a reverse indicator. The larger the value, the smaller the market competitive intensity, and vice versa.

**Control Variables.**

Considering that the company's safety investment may be related to financial leverage, the profitability, the size of the enterprise, the age of the enterprise, the nature of the property rights, etc., in addition to controlling the year, this study also controls other characteristic variables that may affect the safety investment. When studying the safety investment problem of such Chinese enterprises, the impact of the property rights nature of enterprises should not be ignored. The difference in the nature of corporate property rights has led to differences in resource acquisition and responsibility commitments between state-owned and non-state-owned enterprises. Therefore, it is necessary to add attributes of property rights as control variables to the regression model. The specific definition and measurement contents of the variables for the regression model are shown in Table 1 below.

Table1. Variable definition and measurement

Variable	Definition
<i>SI</i>	Total current reserve reduction divided by total assets at the end of the period
<i>HHI</i>	The sum of the square of the ratio of the income of the main business of the enterprise at the beginning of the period to the income of the main business of the beginning of the period
<i>LEV</i>	Total liabilities at the end of the period divided by total assets at the end of the period
<i>ROA</i>	Current net profit divided by total assets at the end of the period
<i>SIZE</i>	The total assets at the end of the period take the natural logarithm
<i>AGE</i>	Company's listing period
<i>STATE</i>	Virtual variable: When the enterprise is state-owned or national and local government holding, the value is 1; otherwise, the value is 0
<i>YEAR</i>	Virtual variable: 2012-2016 a total of 5 years, set 4 dummy variables

**Model Building**

In order to test the impact of competitive intensity on the safety investment level of listed companies in high-dangerous industries, the following model (2) was constructed and used to test the hypothesis *H* proposed in the previous section, namely the addition of *HHI* and *HHI2*. At the same time, this model is also used to verify the inverse U-shaped relationship between competition intensity and safety investment.

$$SI = \alpha_0 + \alpha_1 HHI + \alpha_2 HHI^2 + \alpha_3 LEV + \alpha_4 ROA + \alpha_5 SIZE + \alpha_6 AGE + \alpha_7 STATE + \sum YEAR + \epsilon \tag{2}$$

The variables involved in the above model (2) are specifically defined and measured in Table 1, where  $\epsilon$  is the residual term. In this research, the regression analysis is performed by the ordinary least squares method (OLS).

## Empirical Analysis

### Descriptive Statistics

As shown in the following table, Table 2 is a descriptive statistical result for all variables. It can be seen that there is a large difference in the SI of each company's special reserve. The minimum value is 0, the maximum value is 0.045, and the standard deviation is 0.007. There is a significant difference in the level of safety investment between listed companies in high-dangerous industries. The competitive intensity *HHI* is different. Because it is a reverse index, the maximum value is 0.4, the competitive intensity in the sample is at a relatively high level, and the competitive within the industry is more severe.

Table2 Descriptive statistics

Variable	N	Mean	Median	SD	Min	Max
<i>SI</i>	2444	0.004	0.002	0.007	0	0.045
<i>HHI</i>	2444	0.104	0.080	0.087	0.017	0.494
<i>LEV</i>	2444	0.489	0.494	0.214	0.067	0.949
<i>ROA</i>	2444	0.028	0.024	0.051	-0.157	0.184
<i>SIZE</i>	2444	22.65	22.48	1.439	20.07	26.96
<i>AGE</i>	2444	10.45	11	6.404	0	23
<i>STATE</i>	2444	0.590	1	0.492	0	1

### Correlation Analysis

In order to ensure the accuracy of the parameter estimation, the correlation between the variables was analyzed by Pearson correlation. Competitive intensity and safety investment showed a significant negative correlation at the 1% significance level. That is, as the intensity of competitive increased, the level of safety investment decreased, which is in good agreement with the assumption “H” in this paper. Since this research does not control the impact of other variables on safety investments, the relationships in Table 3 do not represent a true relationship between variables.

Table 3. Pearson correlation coefficients between the variables

	<i>SI</i>	<i>HHI</i>	<i>LEV</i>	<i>ROA</i>	<i>SIZE</i>	<i>AGE</i>	<i>STATE</i>
<i>SI</i>	1						
<i>HHI</i>	0.229***	1					
<i>LEV</i>	0.056***	0.086***	1				
<i>ROA</i>	0.003	-0.034*	-0.448***	1			
<i>SIZE</i>	0.119***	0.246***	0.507***	-0.122***	1		
<i>AGE</i>	0.016	0.150***	0.294***	-0.200***	0.228***	1	
<i>STATE</i>	0.125***	0.196***	0.318***	-0.218***	0.411***	0.435***	1

Note: \*\*\*, \*\*, and \* denote statistical significance at the 1%, 5%, and 10% levels, respectively

### Results of Regression and Its Analysis

Table 4 is based on the empirical results of the previous hypotheses, and the Column 2 in Table 4 is the symbol prediction for each variable. It can be seen that the regression results are in line with expectations. The Column 3 in Table 4 is the regression result of competitive intensity to the safety investment of listed companies in high-dangerous industries. The variance inflation factor test was performed after each regression and the results were all less than 5, so there was no Multi-co-linearity in the regression. It can also be seen from the third column of Table 4 that the coefficient of

competition intensity (*HHI*) and safety investment is 0.031 and the regression of the secondary of the competitive intensity (*HHI2*) and the safety investment is -0.087. The primary of the competitive intensity (*HHI*) is significantly positively correlated with the safety investment (*SI*) at the 1% significant level, while the secondary of the competitive intensity (*HHI2*) and the safety investment (*SI*) are significantly negative at 1% significant level. There is a significantly negative correlation at the significant level, which indicates that there is not a simple linear relationship between the competitive intensity and the safety investment level, but an inverse U-shaped curve relationship. Therefore, when the competitive intensity is low, the safety investment increases with the increase of the competitive intensity. However, when the competitive intensity is at a high level, the safety investment will decrease as the competitive intensity is further increased. The hypothesis of this study has been tested.

Table 4. Empirical results

Variable	Symbol prediction	Main test <i>SI</i>	Robustness test <i>LNSI</i>	Endogenous relief <i>SI</i>
<i>HHI</i>		0.031*** (11.34)	0.036*** (8.76)	
<i>HHI2</i>	-	-0.087*** (-8.15)	-0.097*** (-6.16)	
<i>L.HHI</i>				0.034*** (8.75)
<i>L.HHI2</i>	-			-0.099*** (-6.57)
<i>LEV</i>	-	-0.001* (-2.57)	-0.001 (-0.56)	-0.001 (-0.99)
<i>ROA</i>	+	0.001*** (4.12)	0.014** (2.85)	-0.003 (-0.89)
<i>SIZE</i>	-	-0.001 (-0.59)	0.001 (1.59)	0.001 (1.09)
<i>AGE</i>	+	0.003 (0.96)	-0.000 (-0.52)	-0.000 (-1.62)
<i>STATE</i>	+	0.000 (1.49)	0.001* (2.54)	0.001** (3.07)
<i>YEAR</i>		control	control	control
<i>_cons</i>		0.002 (0.64)	-0.001 (-0.39)	0.003 (1.01)
<i>N</i>		2444	2444	1786
<i>r2</i>		0.094	0.105	0.093
<i>F</i>		14.666***	11.431***	11.986***

Note: \*\*\*, \*\*, and \* denote statistical significance at the 1%, 5%, and 10% levels, respectively

### Robustness Checks

Different measures of safety investments may lead to different conclusions. Therefore, based on the rigor of the conclusion of this article, this research uses other means to measure the degree of safety investment. Using the natural logarithm of the reduction in special reserves to re-measure the level of safety inputs and bring them into the model for regression. As shown in the fourth column of the Table 4, the secondary of the competitive intensity (*HHI2*) and the safety investment (*LNSI*) are significantly negative still at the 1% significant level. It can be seen that the intensity of competitive is also related to the safety investment curve. This conclusion is also consistent with the empirical results.

When studying the impact of competitive intensity on safety investments, the lag model is used to mitigate possible endogenous problems caused by reverse causality. On the one hand, in the

definition of competition intensity, the measurement of operating income at the end of the delay phase is used, and on the other hand, the hypothesis proposed in this paper is studied by using the competitive advantage of the lagging phase. The empirical result in the fifth column of the Table 4 is the result obtained after the lag period. From the results of the fifth column, it can be seen that the quadratic term of competition intensity ( $L. HHI2$ ) is significantly consistent with the expected result at the 1% significant level, indicating that the endogenous problem has been alleviated to some extent, so the previous conclusions are still valid.

### **Research Conclusions**

In order to explore the influencing factors of the level of safety investment, the data of listed companies in high-dangerous industries in Shanghai and Shenzhen stocks were selected from 2012 to 2016 in this study. The aim of this paper's empirical study is to test the impact of different competition intensity on the safety investment of listed companies in high-dangerous industries. It is found that the impact of competitive intensity on the safety investment level of high-dangerous industries presents an inverted U-shaped curve relationship by this research. The conclusion of this study indicates that enterprises in different competitive strength industries have different degrees of safety investment, on the other hand, also reflects the important influence of competitive intensity on safety investment.

### **Summary**

The focus of this research is to explore the impact of competition intensity on safety investment around high-dangerous industries. The main contributions of this paper are as follows: Firstly, this study examines the role of competition intensity in the safety investment of listed companies in high-dangerous enterprises, and enriches the theoretical research that affects the safety investment behavior of enterprises. Secondly, the hypothesis proposed in this paper has been initially verified. The research conclusions not only provide a high reference value for related theoretical analysis, but also provide a favorable basis for government to formulate relevant institutional policies for management in safety investment of enterprises in high-dangerous industries.

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