

Research on the Evaluation of Competitiveness of Steel Industry Enterprises

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Abstract: The steel industry, as a fundamental industry in the organic development framework of China's economy, has been facing the long-standing problems of production exceeding consumption, high asset liability ratio, severe product homogenization competition, and high pollution and carbon emissions in the production process in recent times. At the same time, due to the impact of the sluggish demand caused by the COVID-19, the rapid rise in the cost of raw materials such as iron ore, and the gradual disappearance of a series of policy dividends such as supply side reform, the financial situation of steel enterprises is becoming more and more pessimistic. How to cope with the increasing financial risks and gain competitive advantages through strengthening financial competitiveness in the fierce market competition has become a major issue that China's steel enterprises urgently need to solve. This article selects steel industry enterprises as the research object for analysis. By reviewing relevant literature on enterprise competitiveness, the relevant concepts of enterprise competitiveness are extracted, and the research results and evaluation system are organized. Based on factor analysis, 16 targeted indicators are selected based on scale, efficiency, growth, operational capacity, debt paying capacity, and research and development capacity. An analysis model is constructed and analysis conclusions are drawn. In the analysis results, problems are identified regarding the poor competitiveness of steel industry enterprises. The following research results were obtained: 1) The overall competitiveness score of enterprises in the industry is not high, all less than 1. Among them, operational capability has the greatest impact on the competitiveness of steel industry enterprises, followed by scale, debt paying ability, efficiency, research and development ability, and growth. 2) The worst scoring indicators among the six enterprise competitiveness indicators are the scale indicator and the growth indicator. There is a significant gap in industry scale, with 12 companies scoring positive in the scale factor, accounting for 34.29% of the industry; The scale factor score of 23 enterprises is negative, with an industry proportion of 65.71%. In addition, there are growth indicators, with 12 companies in the industry having positive growth factor scores and 23 companies having negative growth factor scores, indicating a significant head effect on overall growth capacity.

Keywords: Steel Industry Enterprises, Enterprise competitiveness.

1. Introduction

If a company wants to achieve long-term survival and development, not be eliminated in fierce market competition, and have its own long-term competitive advantage, it must have its own corporate competitiveness. Therefore, enterprises urgently need to know how to identify and evaluate their competitiveness in order to enhance their own competitiveness. After the reform and opening up, especially during the period of rapid economic growth and high-speed development, China's steel enterprises have achieved remarkable achievements that have attracted worldwide attention. According to statistics, the production capacity of China's steel enterprises has approached 40% of the world's total, making it a major steel country. However, the development of China's steel enterprises is not optimistic, especially under the influence of the 2008 economic crisis, the development of steel enterprises has entered a difficult situation. At present, the contradiction of oversupply in the production of steel enterprises nationwide has become prominent, and the competition between enterprises is becoming increasingly fierce and brutal. How to survive has become a major challenge for steel enterprises in the future, and whether they can stand out in the current fierce competition has also become an opportunity for enterprises, which largely depends on their competitiveness. From the current development status of China's steel enterprises, it can be seen that their production is high, but their demand is

relatively low, leading to an increase in inventory; At present, most steel companies are experiencing a continuous decrease in sales revenue, an increase in expenses, and a general decline in sales profit margins. Loss making companies account for more than 50% of their losses, and the amount of losses is relatively large. The price of products is low, but the decrease in procurement costs is significantly lower than the decrease in product prices, resulting in a decrease in profit margins. The proportion of funds recovered by companies is low, and the difficulty of recovery is also relatively high. At present, steel enterprises are facing so many difficulties and problems that urgently need to be solved. In order for steel enterprises to smoothly overcome these difficulties, their development is entering a new era where improving their competitiveness is the main focus. The strength of the competitiveness of various steel enterprises has become a new focus of attention for the entire steel industry.

Therefore, this article uses quantitative indicators to visually describe the competitiveness of enterprises, establishes a comprehensive and scientific competitiveness evaluation index system, obtains objective and direct indicators and weights that can reflect the strength of enterprise competitiveness, evaluates the competitiveness of steel enterprises, and makes a correct analysis. The analysis results are used as information and basis for the continued development of enterprises, in order to establish a theoretical basis for enterprises to refer to and achieve long-term development. Establishing an evaluation index system for the

competitiveness of steel enterprises and evaluating their comprehensive competitiveness has theoretical and practical significance.

2. Industry Overview

The steel industry is a symbol of China's comprehensive national strength and an important foundational industry of the national economy. It was a key focus of development in China for about 30 years after the founding of the People's Republic of China. At that time, the foundation of China's steel industry was very weak. In that era, the Central Committee of the Communist Party of China put forward the development guidance policy of "taking steel as the key". After laying such a foundation, the steel industry in China has entered a stage of steady and then rapid development since the 1980s. However, environmental issues, especially climate change, have become increasingly a global concern in recent years. If the consequences of climate change are not controlled, they will be devastating. Countries around the world are calling for "green", "environmental protection", and "low-carbon", and have introduced relevant policies to address the impact of climate change. Many developed countries have even achieved carbon peak in the 1990s. Under the dual pressure of developed countries' emission reduction achievements and China's "dual carbon" strategy, energy conservation and carbon reduction work is still a long way to go.

From the perspective of energy consumption, the steel industry has always had the characteristic of "high input, low output", which has led to a huge overall energy consumption and belongs to a high energy consumption and high pollution industry. The energy loss of the entire industry has accounted for as much as 10% of the national energy loss. From the perspective of energy consumption types within the industry, the energy consumption structure of China's steel industry since 2002 is roughly as follows: coal accounts for 72.19%, electricity accounts for 23.52%, fuel oil accounts for 1.90%, and natural gas accounts for 0.31%.

In addition, from the perspective of pollution, as a typical long process manufacturing industry, the steel industry has many pollution generating links and a large amount of pollutant emissions. At the same time, as a resource and energy intensive industry, it requires a large amount of resource and energy consumption in the production process, and 75% of the energy comes directly or indirectly from coal. The energy structure is significantly high in carbonization, and there is a lack of alternative clean energy use, which will lead to the generation of a large amount of industrial solid waste, causing great pressure on resources, energy, and the ecological environment.

Based on this, China has implemented relevant policies and released the "14th Five Year Plan for Industrial Green Development" in 2021, proposing to reduce the emission intensity of major pollutants in the industry by 10%, deepen

the ultra-low emission transformation of the steel industry, implement technology and equipment transformation such as coke oven gas desulfurization, high proportion pellet smelting, coking negative pressure distillation, and coking full process optimization, and strive to complete the ultra-low emission transformation of 80% of enterprises and 530 million tons of steel production capacity by 2025. This is an important measure to help win the battle to protect the blue sky. In 2023, relevant ministries and commissions of the country successively issued regulations and policies such as the "Guiding Opinions on Coordinating Energy Conservation, Carbon Reduction, and Recycling to Accelerate the Upgrading and Transformation of Key Product Equipment" and the "Notice on Doing a Good Job in the Management of Greenhouse Gas Emission Reports for Power Generation Enterprises from 2023 to 2025", mainly focusing on environmental protection governance, energy conservation and carbon reduction, and orderly promoting the green and low-carbon development of the steel industry.

However, in recent years, the proportion of sulfur dioxide, nitrogen oxides, and particulate matter emissions in the steel industry to the national industrial source emissions has not shown a significant downward trend or even increased. The reason for this is that according to the environmental protection investment situation in the steel industry, there are significant differences in the level of environmental protection investment among enterprises in the industry. Although a small number of enterprises insist on taking environmental protection as their own responsibility, they are influenced by objective factors such as enterprise size and subjective environmental awareness, and most enterprises have not taken on environmental protection responsibilities, resulting in a low overall green level in the industry and a high proportion of industry pollutant emissions.

Based on the above analysis, it can be seen that although the steel industry has achieved certain results in environmental protection in recent years, due to the fact that the steel industry already has more pollution emissions and pollution links than other industries, the current achievements are not enough to cover the amount of pollution emissions. Therefore, the steel industry still needs to continue to strengthen investment, update technological processes, and the environmental protection task is still a long way to go.

3. Construction of Enterprise Competitiveness Evaluation System

3.1. Data Sources

This article selects steel industry companies listed and traded on the Shanghai Stock Exchange and Shenzhen Stock Exchange as research samples. After excluding companies listed after 2015 and those with ST and * ST, data from 35 steel companies from 2015 to 2023 remain as the research sample. The specific companies are shown in the table 3-1:

Table 3-1. Research Samples

Enterprise code	Enterprise Name	Enterprise code	Enterprise Name
000629.SZ	Vanadium Titanium	60010.SH	Baosteel Group
000655.SZ	Jinling Mining	60019.SH	Baosteel
000708.SZ	CITIC Special Steel	60022.SH	Shandong Iron and Steel
000709.SZ	Hebei Iron and Steel	600126.SH	Hanggang
000717.SZ	Zhongnan Corporation	600231.SH	Linggang Corporation
000761.SZ	Ben Steel Plate	600282.SH	Nangang Corporation
000778.SZ	Emerging cast pipes	600295.SH	Erdos
000825.SZ	TISCO Stainless Steel	600307.SH	Jiugang Hongxing
000898.SZ	Ansteel Corporation	600399.SH	Fushun Special Steel
000923.SZ	Hebei Iron and Steel Resources	600507.SH	Fangda Special Steel
000932.SZ	Hualing Steel	600569.SH	Anyang Iron and Steel
000959.SZ	Shougang Corporation	600581.SH	Bayi Iron and Steel
002075.SZ	Shagang	600782.SH	New Steel Corporation
002110.SZ	San Gang Min Guang	600808.SH	Ma Steel
002318.SZ	Jiulite Material	601003.SH	Liugang Corporation
002443.SZ	Jinzhou Pipeline	601005.SH	Chongqing Iron and Steel
002478.SZ	Changbao	601969.SH	Hainan Mining
603878.SH	Wujin Stainless Steel		

3.2. Indicator Selection

The differences in corporate competitiveness are the result of various factors, and scholars at home and abroad have different views on the measurement standards of corporate competitiveness. Therefore, the selection of the evaluation index system in this article is based on the following considerations: firstly, it should objectively reflect the actual situation of the enterprise while ensuring comprehensiveness as much as possible, reflecting both financial data and the ability to generate profits and repay debts, as well as the growth and turnover of the enterprise, reflecting its operational and development capabilities, and not neglecting its innovation capabilities in technology. Based on this, drawing on the approach of Jinbei [] to calculate the score of enterprise competitiveness, and referring to the research of relevant scholars in the industry, while considering the three aspects of scale, growth, and efficiency, debt paying ability, operational ability, and research and development ability have been added. In the end, this article designed and selected a total of 16 indicators to evaluate the competitiveness level of enterprises. By using factor analysis, common factors were extracted to replace the evaluation indicators of enterprise competitiveness, reducing the dimensions of enterprise competitiveness indicators and constructing comprehensive evaluation indicators of enterprise competitiveness (as shown in Table 3-2).

As one of the evaluation methods for enterprise competitiveness, factor analysis has many advantages. Firstly, factor analysis determines weights based on the variance contribution rate of each common factor, which is more objective; Secondly, standardization processing eliminates the correlation between financial performance indicators and the differences caused by indicator values, improving the quality of financial performance evaluation.

Table 3-2. Evaluation Index System for Enterprise Competitiveness

type	name	data sources
scale	sales revenue	Financial statement data
	net assets	
	Net profit	
increase	Revenue growth rate	Current year's operating income/Last year's operating income
	net profit growth rate	Total assets of the year/Total assets of last year
efficiency	Net asset profit margin	Net profit/net assets
	Total asset contribution rate	Net profit/total assets
	Overall labor efficiency	Revenue/Total number of employees
operation capacity	Inventory turnover rate	Operating costs/average inventory balance
	Net asset turnover ratio	Operating revenue/average net assets
	Total Asset turnover	Operating revenue/total assets
solvency	quick ratio	(Current Assets - Inventory)/Current Liabilities
	current ratio	Current assets/current liabilities x 100%
	Asset liability ratio	Total liabilities/total assets x 100%
R & D capabilities	Proportion of R&D personnel	Number of R&D personnel/total number of employees
	Proportion of R&D investment	R&D investment/operating income

3.3. Construction of Evaluation System

3.3.1. Data standardization

The measurement units of the indicators we selected are different, and factor analysis is used to obtain different covariance or correlation matrices. The dimension of competitiveness indicators has a significant impact on the process of factor analysis. In order to make the analysis results more accurate and scientific, the data must be

standardized before factor analysis. There are many methods for standardization, and the commonly used method in this article is to standardize the raw data. The calculation of this process can be directly completed through SPSS software.

3.3.2. KMO and Bartlett's test

Before conducting factor analysis, we usually need to perform KMO and Bartlett sphericity tests to test whether the conditions for conducting factor analysis are met, that is, whether there is a high correlation between various indicators. Validate the raw data using SPSS software. The conclusion obtained through KMO and Bartlett's test is that the KMO measurement value is 0.620, which is greater than 0.5 and meets the feasibility criteria of factor analysis. The significance level of Bartlett's sphericity test is 0.000, which is less than the significance level of 0.05. This fully indicates that the selected variables are highly correlated and suitable for factor analysis methods. The test results are shown below.

Table 3-3. KMO and Bartlett sphericity test

KMO and Bartlett inspection		
KMO sampling suitability quantity.		.620
Bartlett sphericity test	Approximate chi square	4201.181
	freedom	120
	significance	.000

3.3.3. Analysis of Variable Commonality

Variable communality refers to the variance of common factors, which represents the proportion of variance explained by common factors. It reflects the degree to which the original information contained in each variable has been extracted. An extracted value greater than 0.6 is considered to have strong explanatory power. If the communality of most variables is higher than 0.8, it indicates that only a small amount of information is lost and the factor analysis effect is good. Using SPSS software to extract common factors, the results

are shown in the following table.

Table 3-4. variance results of common factors

communalities		
	initial	extract
Zscore (sales revenue)	1.000	.958
Zscore (net assets)	1.000	.952
Zscore (Net profit)	1.000	.854
Zscore (Revenue growth rate)	1.000	.760
Zscore (net profit growth rate)	1.000	.752
Zscore (Net asset profit margin)	1.000	.678
Zscore (Total asset contribution rate)	1.000	.797
Zscore (Overall labor efficiency)	1.000	.768
Zscore (Inventory turnover rate)	1.000	.801
Zscore (current asset turnover)	1.000	.804
Zscore (Total Asset turnover)	1.000	.828
Zscore (quick ratio)	1.000	.934
Zscore (current ratio)	1.000	.950
Zscore (Asset liability ratio)	1.000	.737
Zscore (The proportion of researchers to the total number of personnel)	1.000	.770
Zscore (Research and development as a percentage of operating revenue)	1.000	.795

Through SPSS analysis, the overall extraction rate of 15 indicators reached over 70%, and 8 indicators reached over 80%, indicating that the extraction degree of each indicator was relatively good, and the extracted common factors explained the degree of the original variables relatively high.

3.4. Determine Common Factors

The variance contribution rate and cumulative variance contribution rate of each factor were obtained through spass analysis to determine the number of factors. The results are shown in the table below.

Table 3-5. Explanation of Total Variance

	initial eigenvalue			Extract the sum of squared loads			Sum of squared rotational loads		
	total	Variance percentage	Accumulated%	total	Variance percentage	Accumulated%	total	Variance percentage	Accumulated%
1	3.866	24.166	24.166	3.866	24.166	24.166	2.839	17.745	17.745
2	2.968	18.549	42.714	2.968	18.549	42.714	2.763	17.271	35.017
3	2.168	13.552	56.266	2.168	13.552	56.266	2.746	17.164	52.181
4	1.645	10.283	66.549	1.645	10.283	66.549	1.701	10.631	62.811
5	1.365	8.531	75.080	1.365	8.531	75.080	1.547	9.667	72.478
6	1.125	7.029	82.109	1.125	7.029	82.109	1.541	9.632	82.109
7	.610	3.812	85.921						
8	.492	3.074	88.995						
9	.465	2.904	91.899						
10	.401	2.506	94.405						
11	.277	1.733	96.138						
12	.267	1.669	97.807						
13	.184	1.150	98.956						
14	.132	.825	99.781						
15	.028	.178	99.959						
16	.007	.041	100.000						

From the table, it can be seen that there are 6 factors with eigenvalues greater than 1, and the variance contribution rates after rotation are 17.745%, 17.271%, 17.164%, 10.631%, 9.667%, and 9.632%, respectively. The total variance explanation is 82.109%, indicating that if the original 16

variables are not used to evaluate the competitiveness level of enterprises, these 6 factors can represent the information of the original 16 variables. Therefore, 6 principal components are extracted as common factors.

In addition, the importance of these six common factors can

be more intuitively displayed through the gravel plot, as shown in the figure below. The horizontal axis of the gravel plot represents the factor number, and the vertical axis represents the characteristic value. From the graph, it can be seen that the characteristic values of the first six factors are

all greater than and located on steep slopes, while the other factors tend to be gentle slopes and have relatively small characteristic values. Through variance contribution rate and scree plot, it can be confirmed that selecting the top 6 principal components for factor analysis is effective.

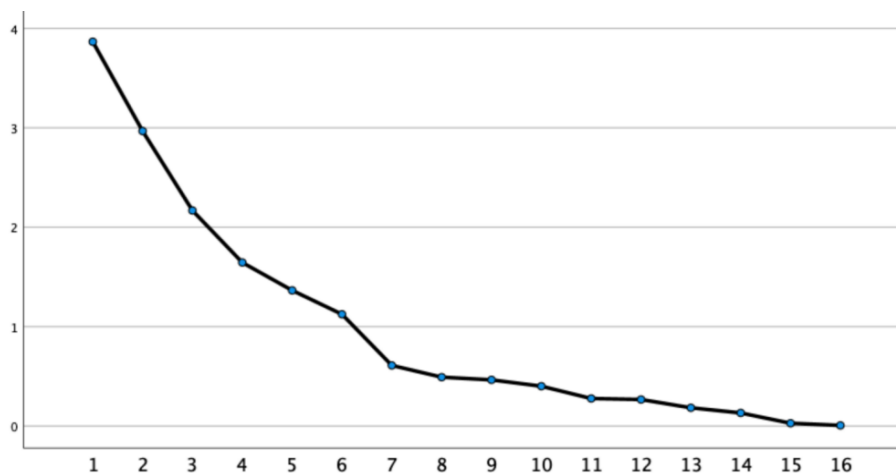


Figure 3-1. Gravel Diagram

Table 3-6. Rotated component matrix

	component					
	1	2	3	4	5	6
Zscore (Inventory turnover rate)	.870	.029	.173	-.059	-.090	-.045
Zscore (Total Asset turnover)	.834	-.012	-.091	.333	.107	-.005
Zscore (current asset turnover)	.829	.042	-.334	.051	.018	-.007
Zscore (Overall labor efficiency)	.726	.438	-.081	-.019	.202	.037
Zscore (net assets)	-.010	.971	-.082	-.048	.012	-.018
Zscore (operating revenue)	.175	.943	-.178	-.049	.065	-.025
Zscore (Net profit)	.091	.832	.047	.369	.021	.121
Zscore (quick ratio)	-.123	-.112	.952	.011	.008	.010
Zscore (current ratio)	-.160	-.130	.947	.064	.075	.015
Zscore (Asset liability ratio)	-.072	-.013	-.816	-.250	-.042	-.044
Zscore (Net asset profit margin)	.028	.054	.052	.819	.013	.013
Zscore (Total asset contribution rate)	.154	.064	.257	.817	.055	.184
Zscore (Research and development as a percentage of operating revenue)	-.103	.070	.008	.067	.872	-.115
Zscore (The proportion of researchers to the total number of personnel)	.225	.018	.100	-.003	.838	.083
Zscore (Revenue growth rate)	-.012	-.013	.022	-.016	-.074	.868
Zscore (net profit growth rate)	-.018	.059	.029	.183	.043	.844

3.5. Factor Rotation and Naming

After determining the number of factors, select the maximum variance method that comes with SPSS, rotate and sort the factor loading matrix to better classify the raw data represented by each factor, and facilitate factor interpretation of the original variables. The rotated component matrix is shown in the table below:

After rotating the component matrix, the original data was reorganized. As shown in the table above, the first common factor has a high load on inventory turnover rate (X9), total asset turnover rate (X11), current asset turnover rate (X10), and overall labor efficiency (X8). The indicators reflect more in terms of operational capability. Therefore, the first common factor F1 is named the operational capability factor; The second factor shows a high load on net assets (X2),

operating income (X1), and net profit (X3), all of which are indicators reflecting the size of the enterprise. Therefore, it is named scale factor F2; The third common factor has a high load on quick ratio (X12), current ratio (X13), and asset liability ratio (X14), so it is named debt paying ability factor F3; The fourth common factor has a high load on net asset profit margin (X6) and total asset contribution rate (X7), hence it is named F4 efficiency factor; The fifth factor has a high load on the proportion of R&D investment (X16) and the proportion of researchers to the total number of people (X15), so it is named F5 R&D capability factor; The sixth factor has a high load on revenue growth rate (X4) and net profit growth rate (X5), hence it is named F6 growth factor.

3.6. Factor Score Situation

The factor scores are shown in the table:

Table 3-7. Component score coefficient matrix

	component					
	1	2	3	4	5	6
Zscore (sales revenue)	-.003	.355	.011	-.090	-.006	-.024
Zscore (net assets)	-.068	.388	.042	-.085	-.037	-.026
Zscore (Net profit)	-.053	.303	.029	.169	-.047	.014
Zscore (Revenue growth rate)	.017	-.018	-.002	-.131	-.020	.594
Zscore (net profit growth rate)	-.018	-.007	-.029	.003	.047	.552
Zscore (Net asset profit margin)	-.077	-.033	-.094	.560	-.029	-.107
Zscore (Total asset contribution rate)	-.012	-.028	-.003	.488	-.014	.010
Zscore (Overall labor efficiency)	.247	.113	.044	-.123	.077	.038
Zscore (Inventory turnover rate)	.370	-.022	.154	-.153	-.121	-.016
Zscore (current asset turnover)	.297	-.065	-.083	-.007	-.023	.007
Zscore (Total Asset turnover)	.285	-.093	-.031	.156	.017	-.031
Zscore (quick ratio)	.028	.030	.379	-.113	-.031	-.011
Zscore (current ratio)	.005	.018	.362	-.073	.016	-.013
Zscore (Asset liability ratio)	-.061	-.039	-.309	-.039	.027	.017
Zscore (The proportion of researchers to the total number of personnel)	.049	-.046	.015	-.086	.550	.087
Zscore (Research and development as a percentage of operating revenue)	-.105	-.013	-.052	.035	.585	-.062

Calculate the scores of each factor and the overall score of the enterprise from the component score coefficient matrix, as follows:

$$F1 = -0.003X1 - 0.068X2 - 0.053X3 + 0.017X4 - 0.018X5 - 0.077X6 - 0.012X7 + 0.247X8 + 0.370X9 + 0.297X10 + 0.285X11 + 0.028X12 + 0.005X13 - 0.061X14 + 0.049X15 - 0.105X16$$

$$F2 = 0.355X1 + 0.388X2 + 0.303X3 - 0.018X4 - 0.007X5 - 0.033X6 - 0.28X7 + 0.113X8 - 0.022X9 - 0.065X10 - 0.093X11 + 0.030X12 + 0.018X13 - 0.309X14 - 0.046X15 - 0.013X16$$

$$F3 = 0.011X1 + 0.042X2 + 0.029X3 - 0.002X4 - 0.029X5 - 0.094X6 - 0.003X7 + 0.044X8 + 0.154X9 - 0.083X10 - 0.031X11 + 0.379X12 + 0.362X13 - 0.309X14 + 0.015X15 - 0.052X16$$

$$F4 = -0.090X1 - 0.085X2 + 0.169X3 - 0.131X4 + 0.003X5 + 0.560X6 + 0.488X7 - 0.123X8 - 0.153X9 -$$

$$0.007X10 + 0.156X11 - 0.113X12 - 0.073X13 - 0.039X14 - 0.086X15 + 0.035X16$$

$$F5 = -0.006X1 - 0.037X2 - 0.047X3 - 0.020X4 + 0.047X5 - 0.029X6 - 0.014X7 + 0.077X8 - 0.121X9 - 0.023X10 + 0.017X11 - 0.031X12 + 0.016X13 + 0.027X14 + 0.550X15 + 0.585X16$$

$$F6 = -0.024X1 - 0.026X2 + 0.014X3 + 0.594X4 + 0.552X5 - 0.107X6 + 0.010X7 + 0.038X8 - 0.016X9 + 0.007X10 - 0.031X11 - 0.011X12 - 0.013X13 + 0.017X14 + 0.087X15 - 0.062X16$$

The overall score is:

$$F = (17.745F1 + 17.271F2 + 17.164F3 + 10.631F4 + 9.667F5 + 9.632F6) / 82.109$$

4. Evaluation of Enterprise Competitiveness

4.1. Evaluation of Enterprise Scale

Table 4-1. Average Score and Ranking of Scale Factors for Steel Enterprises from 2015 to 2023

Enterprise Name	score	ranking	Enterprise Name	score	ranking
Baosteel	4.8855	1	Changbao	-0.1708	19
Ansteel Corporation	0.8059	2	Wujin Stainless Steel	-0.1919	20
Hebei Iron and Steel	0.7454	3	San Gang Min Guang	-0.2344	21
Hualing Steel	0.5395	4	Shagang	-0.2692	22
Baosteel Group	0.4051	5	Jiulite Material	-0.2820	23
Hanggang	0.3365	6	Jinzhou Pipeline	-0.2968	24
Jinling Mining	0.2792	7	Vanadium Titanium	-0.3035	25
Shougang Corporation	0.2668	8	Liugang Corporation	-0.3371	26
Ma Steel	0.1461	9	Ben Steel Plate	-0.3717	27
TISCO Stainless Steel	0.1459	10	Chongqing Iron and Steel	-0.3745	28
Shandong Iron and Steel	0.0633	11	Fangda Special Steel	-0.4151	29
CITIC Special Steel	0.0571	12	Linggang Corporation	-0.6264	30
Emerging cast pipes	-0.0045	13	Fushun Special Steel	-0.7397	31
Hebei Iron and Steel Resources	-0.0559	14	Jiugang Hongxing	-0.7645	32
Nangang Corporation	-0.0941	15	Anyang Iron and Steel	-0.7910	33
New Steel Corporation	-0.1045	16	Zhongnan Corporation	-0.8919	34
erdos	-0.1411	17	Bayi Iron and Steel	-1.0485	35
Hainan Mining	-0.1673	18			

From the table, it can be seen that the overall score of the steel industry is not high, with a significant gap in scale. There

are 12 enterprises with positive scale factor scores, accounting for 34.29% of the industry; The scale factor score of 23 enterprises is negative, with an industry proportion of 65.71%. Baosteel Group's scale factor score is 4.8855, ranking first in the industry, while the second ranked Angang Steel's score is only 0.8059, which is 4.0796 higher than the second ranked company, indicating that Baosteel Group has a significant gap in scale compared to other steel enterprises.

The scale indicator accounts for 21.03% of the comprehensive evaluation of enterprise competitiveness, and is the second largest influencing factor of enterprise competitiveness, providing good support for the overall competitiveness level of enterprises.

4.2. Evaluation of Enterprise Growth

Table 4-2. Average scores and rankings of growth factors for steel enterprises from 2015 to 2023

Enterprise Name	score	ranking	Enterprise Name	score	ranking
Hebei Iron and Steel Resources	1.5843	1	Chongqing Iron and Steel	-0.0400	19
Bayi Iron and Steel	0.3810	2	Ben Steel Plate	-0.0431	20
CITIC Special Steel	0.2914	3	San Gang Min Guang	-0.0456	21
New Steel Corporation	0.2196	4	Liugang Corporation	-0.0478	22
Hainan Mining	0.0619	5	Shandong Iron and Steel	-0.0610	23
Shougang Corporation	0.0463	6	Vanadium Titanium	-0.0618	24
Nangang Corporation	0.0393	7	Fangda Special Steel	-0.0714	25
erdos	0.0358	8	Hebei Iron and Steel	-0.1032	26
Zhongnan Corporation	0.0195	9	Emerging cast pipes	-0.1067	27
TISCO Stainless Steel	0.0049	10	Shagang	-0.1097	28
Baosteel Group	0.0024	11	Hanggang	-0.1158	29
Changbao	0.0006	12	Ansteel Corporation	-0.1215	30
Jiulite Material	-0.0069	13	Anyang Iron and Steel	-0.1237	31
Hualing Steel	-0.0084	14	Fushun Special Steel	-0.1352	32
Ma Steel	-0.0181	15	Baosteel	-0.1385	33
Linggang Corporation	-0.0207	16	Jinling Mining	-0.4002	34
Wujin Stainless Steel	-0.0290	17	Jiugang Hongxing	-0.8412	35
Jinzhou Pipeline	-0.0376	18			

The impact of growth capacity factor on the comprehensive evaluation index F of enterprise competitiveness is 11.72%, ranking last among the six factors, indicating that the influence of growth capacity on enterprise competitiveness evaluation is relatively weak. In the steel industry, 12 companies have positive growth factor scores and 23 companies have negative growth factor scores, indicating a

significant head effect on the overall growth capacity of the steel industry. However, most companies do not have very high growth factor scores. Among the top 12 companies, only Hegang Resources scored above 1, while the remaining 11 were between 0 and 0.5.

4.3. Enterprise Efficiency Evaluation

Table 4-3. Average scores and rankings of efficiency factors for steel enterprises from 2015 to 2023

Enterprise Name	score	ranking	Enterprise Name	score	ranking
Fangda Special Steel	1.2143	1	Ansteel Corporation	-0.0665	19
Shagang	0.7324	2	Ma Steel	-0.1052	20
Fushun Special Steel	0.6583	3	Baosteel	-0.1638	21
Jiulite Material	0.6335	4	Anyang Iron and Steel	-0.1750	22
erdos	0.5223	5	Ben Steel Plate	-0.2137	23
Jinzhou Pipeline	0.4597	6	TISCO Stainless Steel	-0.2208	24
CITIC Special Steel	0.4396	7	Hainan Mining	-0.2292	25
San Gang Min Guang	0.4010	8	Hebei Iron and Steel	-0.2409	26
Wujin Stainless Steel	0.4003	9	Baosteel Group	-0.2470	27
Liugang Corporation	0.3179	10	Hebei Iron and Steel Resources	-0.2613	28
Changbao	0.3047	11	Jiugang Hongxing	-0.3032	29
Zhongnan Corporation	0.2946	12	Shandong Iron and Steel	-0.3636	30
Nangang Corporation	0.1810	13	Shougang Corporation	-0.4327	31
Hualing Steel	0.1663	14	Hanggang	-0.7060	32
New Steel Corporation	0.0406	15	Jinling Mining	-0.9102	33
Linggang Corporation	0.0259	16	Chongqing Iron and Steel	-0.9775	34
Vanadium Titanium	0.0209	17	Bayi Iron and Steel	-1.1883	35
Emerging cast pipes	-0.0086	18			

The efficiency factor is the fourth factor in the comprehensive evaluation of enterprise competitiveness, and its impact on enterprise competitiveness is 12.95%, which is

relatively small. From the above table, it can be seen that the efficiency factor scores in the steel industry are also in a two-tier differentiation state, with 17 companies scoring above 0

and 18 companies scoring below 0. The top five Chinese special steel companies occupy a leading position in the industry, with a score of 1.2143. This indicates that the enterprise has created a gap in efficiency compared to other enterprises, contributing to its competitiveness. Next are Shagang Group, Fushun Special Steel, and Jiulite Materials. The difference in efficiency factor scores between them is not very large. In addition, the last five companies are Shougang Group, Hanggang Group, Jinling Mining, Chongqing Iron

and Steel, and Bayi Iron and Steel. Among them, the score of Bayi Iron and Steel is the worst in the industry, with a score of -1.1883. The gap between the first place in the industry is very large. Therefore, Bayi Iron and Steel adopts effective measures to reduce the efficiency gap with other enterprises and enhance the competitiveness of the enterprise.

4.4. Evaluation of Enterprise Operational Capability

Table 4-4. Average scores and rankings of operational capability factors for steel enterprises from 2015 to 2023

Enterprise Name	score	ranking	Enterprise Name	score	ranking
Zhongnan Corporation	1.9543	1	Ma Steel	0.0272	19
Hanggang	1.7871	2	Shagang	0.0031	20
Shandong Iron and Steel	1.2331	3	Jinzhou Pipeline	-0.1073	21
San Gang Min Guang	0.9717	4	Emerging cast pipes	-0.1759	22
New Steel Corporation	0.9690	5	Jinling Mining	-0.3221	23
TISCO Stainless Steel	0.6747	6	Ben Steel Plate	-0.4405	24
Linggang Corporation	0.6449	7	Baosteel	-0.4508	25
Liugang Corporation	0.5467	8	Anyang Iron and Steel	-0.6519	26
Fangda Special Steel	0.4601	9	Changbao	-0.7954	27
Hualing Steel	0.4589	10	Hebei Iron and Steel	-0.9109	28
Vanadium Titanium	0.4413	11	erdos	-0.9308	29
Bayi Iron and Steel	0.3501	12	Jiulite Material	-0.9933	30
Ansteel Corporation	0.3242	13	Hainan Mining	-1.0097	31
Jiugang Hongxing	0.2963	14	Wujin Stainless Steel	-1.0321	32
CITIC Special Steel	0.2575	15	Hebei Iron and Steel Resources	-1.2713	33
Nangang Corporation	0.1559	16	Baosteel Group	-1.2964	34
Chongqing Iron and Steel	0.1175	17	Fushun Special Steel	-1.3841	35
Shougang Corporation	0.0987	18			

Through the analysis of the overall evaluation, we can see that operational capability has the greatest impact on Baosteel Group's competitiveness. From the above table, it can be seen that there are 20 enterprises in the steel industry with positive operating capacity and 15 enterprises with negative operating capacity. The top five companies, Zhongnan Shares, Hanggang Shares, and Shandong Iron and Steel, all scored above 1, occupying a leading position in the industry. The scores of the last five companies, Hainan Mining, Wujin Stainless Steel, Hegang Resources, Baosteel Group, and

Fushun Special Steel, are all less than -1. It can be seen that there is a significant gap in the operational capabilities of steel industry enterprises. In order to enhance their competitiveness and gain a competitive advantage, these enterprises need to strive to be the first in terms of operational capabilities and narrow the gap with other steel enterprises.

4.5. Evaluation of Corporate Debt Repayment Ability

Table 4-5. Average scores and rankings of debt repayment ability factors for steel enterprises from 2015 to 2023

Enterprise Name	score	ranking	Enterprise Name	score	ranking
Jinling Mining	3.4039	1	Ansteel Corporation	-0.2067	19
Hebei Iron and Steel Resources	1.7026	2	Chongqing Iron and Steel	-0.2781	20
Hanggang	0.9686	3	Linggang Corporation	-0.3000	21
Wujin Stainless Steel	0.9360	4	Hualing Steel	-0.4017	22
Jinzhou Pipeline	0.8436	5	TISCO Stainless Steel	-0.4214	23
Changbao	0.6176	6	Nangang Corporation	-0.4581	24
Vanadium Titanium	0.4953	7	Ma Steel	-0.4655	25
Hainan Mining	0.4923	8	erdos	-0.5136	26
Jiulite Material	0.4083	9	Liugang Corporation	-0.6033	27
Baosteel Co., Ltd	0.2735	10	Ben Steel Plate	-0.6348	28
Shagang Co., Ltd	0.1186	11	Baosteel Group	-0.6588	29
Fangda Special Steel	0.1152	12	Shougang Corporation	-0.6958	30
San Gang Min Guang	0.0948	13	Hebei Iron and Steel	-0.7787	31
New Steel Corporation	0.0059	14	Zhongnan Corporation	-0.8004	32
CITIC Special Steel	-0.0944	15	Jiugang Hongxing	-0.8875	33
Emerging cast pipes	-0.1050	16	Anyang Iron and Steel	-0.9173	34
Fushun Special Steel	-0.1148	17	Bayi Iron and Steel	-0.9750	35
Shandong Iron and Steel	-0.1652	18			

The impact of debt paying ability factor on the comprehensive evaluation index F of enterprise competitiveness is 20.9%, indicating that this ability has a certain influence on enterprise competitiveness. From the above table, it can be seen that the debt paying ability of enterprises in the steel industry is funnel-shaped, with a clear polarization. Baosteel Group, which ranks first in industry market value, ranks 10th in this ranking with a value of 0.2735. Although the ranking is still relatively high, it is still

far behind the top ranked Jinling Mining, indicating that in an environment where the head effect of debt paying ability in the steel industry is obvious, Baosteel Group's value is not high despite ranking relatively high. Its debt paying ability performance is average, and it should learn more from top enterprises to improve its debt paying ability.

4.6. Evaluation of R&D Capability

Table 4-6. Average scores and rankings of R&D capability factors for steel enterprises from 2015 to 2023

Enterprise Name	score	ranking	Enterprise Name	score	ranking
Fushun Special Steel	1.3512	1	Ma Steel	0.0779	19
Jiulite Material	0.9996	2	Baosteel Group	-0.0642	20
CITIC Special Steel	0.9595	3	Baosteel	-0.0972	21
Wujin Stainless Steel	0.9517	4	Hebei Iron and Steel Resources	-0.1659	22
Hualing Steel	0.9003	5	Emerging cast pipes	-0.3876	23
TISCO Stainless Steel	0.8955	6	Bayi Iron and Steel	-0.4531	24
New Steel Corporation	0.8187	7	Hanggang	-0.5347	25
Changbao	0.7805	8	Ansteel Corporation	-0.6058	26
Chongqing Iron and Steel	0.7589	9	Linggang Corporation	-0.6299	27
Nangang Corporation	0.6549	10	Jiugang Hongxing	-0.7395	28
Jinzhou Pipeline	0.5987	11	Hebei Iron and Steel	-0.7487	29
Ben Steel Plate	0.5666	12	erdos	-1.0695	30
San Gang Min Guang	0.4964	13	Hainan Mining	-1.1105	31
Vanadium Titanium	0.4855	14	Liugang Corporation	-1.1146	32
Shougang Corporation	0.2985	15	Shandong Iron and Steel	-1.1707	33
Zhongnan Corporation	0.2142	16	Jinling Mining	-1.3153	34
Shagang	0.1106	17	Fangda Special Steel	-1.8066	35
Anyang Iron and Steel	0.0944	18			

It can be clearly seen from the table that more than half of the 35 companies have R&D capability scores above 0, indicating a strong overall awareness of technological innovation in the industry. However, the average score of Baosteel Group's R&D capability factor in the past nine years is not high, ranking 21st in the industry. However, through analysis of the R&D factor scores of the steel industry in each

year, it was found that Baosteel Group's R&D factor score has been continuously increasing, from -0.7834 in 2015 to 2.2582 in 2023, ranking first in the industry, indicating that Baosteel Group is increasingly valuing innovation.

4.7. Comprehensive Evaluation of Enterprise Competitiveness

Table 4-7. Average scores and rankings of comprehensive factors for steel enterprises from 2015 to 2023

Enterprise Name	score	ranking	Enterprise Name	score	ranking
Baosteel	0.9385	1	Jiulite Material	0.0103	19
Hanggang	0.4915	2	Fangda Special Steel	-0.0276	20
Jinling Mining	0.3810	3	Ma Steel	-0.0673	21
New Steel Corporation	0.3161	4	Shougang Corporation	-0.0834	22
San Gang Min Guang	0.2855	5	Emerging cast pipes	-0.1202	23
Hualing Steel	0.2552	6	Linggang Corporation	-0.1283	24
CITIC Special Steel	0.2520	7	Chongqing Iron and Steel	-0.1534	25
Jinzhou Pipeline	0.2163	8	Liugang Corporation	-0.1746	26
Hebei Iron and Steel Resources	0.2019	9	Fushun Special Steel	-0.2503	27
Vanadium Titanium	0.1877	10	Ben Steel Plate	-0.2721	28
TISCO Stainless Steel	0.1658	11	Hainan Mining	-0.3036	29
Zhongnan Corporation	0.1331	12	Hebei Iron and Steel	-0.3343	30
Ansteel Corporation	0.1022	13	Baosteel Group	-0.3719	31
Wujin Stainless Steel	0.0927	14	erdos	-0.3923	32
Shagang	0.0638	15	Jiugang Hongxing	-0.5073	33
Shandong Iron and Steel	0.0532	16	Bayi Iron and Steel	-0.5112	34
Changbao	0.0527	17	Anyang Iron and Steel	-0.5251	35
Nangang Corporation	0.0233	18			

From the table, it can be seen that the overall competitiveness score of enterprises in the industry is not high,

all of which are less than 1. From the distribution of scores, there are 19 companies with scores greater than 0 and 16

companies with scores less than 0. Baosteel Group's comprehensive score is 0.9385, ranking first in the industry. Through the formula F for the comprehensive score of factors, it can be seen that the three aspects of operational ability, debt paying ability, and scale largely determine the competitiveness of steel industry enterprises. Among them, the scale factor score is in an absolute leading position in the industry, and the score has been ranked first in the industry from 2015 to 2023. This is also the main reason why the comprehensive competitiveness score of the enterprise is leading compared to other enterprises in the industry. However, the performance in terms of operational ability and debt paying ability is not good, especially in terms of operational ability, whose average score during the research period is in the bottom few of the industry, which is the main factor leading to the weakening of Baosteel's competitive advantage position and needs to be highly valued by the management.

5. Summary

On the basis of elaborating on the current status of research on the competitiveness evaluation of Chinese steel enterprises, the theory of enterprise competitiveness, and a review of domestic and foreign literature, this article proposes to construct an evaluation index system for the competitiveness of steel enterprises. Based on the principles of constructing the index system, it attempts to construct an evaluation index system for the competitiveness of Chinese steel enterprises from six aspects: scale, efficiency, growth, debt repayment ability, research and development ability, and operational ability. Factor analysis is used to evaluate and analyze the competitiveness of 35 selected steel enterprises listed on the Shanghai and Shenzhen stock markets. Through this study, the following conclusions are drawn:

(1) Literature review. In the literature review section, this article sequentially discusses the concept of enterprise competitiveness, competitiveness theory, and national competitiveness. Review the research on the evaluation system of internal and external enterprise competitiveness. Domestic and foreign institutions and scholars have different levels and perspectives on the concept of enterprise competitiveness and the establishment of theoretical evaluation systems. Different evaluation models and indicator systems have emerged based on the research of research institutions and numerous scholars. The construction of theoretical and evaluation indicator systems for enterprise competitiveness is also constantly developing and improving.

(2) Establish an evaluation index system for the competitiveness of steel enterprises. This article introduces the evaluation indicators for the competitiveness of steel enterprises

On the basis of the selected principles, a competitiveness evaluation index system for steel enterprises was constructed by summarizing and sorting out relevant theoretical research of predecessors, consisting of six elements and 16 indicators: scale, efficiency, growth, debt paying ability, research and development ability, and operational ability. Each indicator was explained and analyzed.

(3) Application of evaluation index system. The article selected 35 steel companies from the Shanghai and Shenzhen stock markets as research objects for factor analysis, which not only obtained the ranking of each company's sub capabilities, but also the ranking order of their comprehensive competitiveness. It can be concluded that the development of

various capabilities in most enterprises is unbalanced, with each having its own competitive advantages and disadvantages. The comprehensive competitiveness is influenced by the sub capability scores, with Baosteel Group, Hangzhou Iron and Steel Group, Jinling Mining Group, New Steel Group, and Sansteel Minguang ranking in the top five, while Baosteel Group, Ordos, Jiuquan Iron and Steel Hongxing, Bayi Iron and Steel, and Anyang Iron and Steel rank in the bottom five, opening up the level of comprehensive competitiveness.

The article analyzes and evaluates the competitiveness of Chinese steel enterprises by constructing an evaluation index system for their competitiveness. The aim is to provide reference for steel enterprises to enhance their competitiveness, and to offer suggestions and countermeasures for government regulatory departments, enterprise investment decisions, and managers. However, due to the limited ability and level of the author, the article has the following shortcomings: the construction of the indicator system is not comprehensive enough, and qualitative indicators could have been added, but due to the difficulty in quantifying and quantifying qualitative indicators, the data is not true and the corporate culture and brand influence have been deleted; The lack of in-depth research on steel enterprises in the article leads to a lack of steel enterprise characteristics in the constructed indicator system, and the indicators are too general; More scientific and rigorous methods can be adopted for analysis in evaluation methods. I hope scholars interested in corporate competitiveness can conduct further analysis and research in these areas, so that the theory and evaluation index system of corporate competitiveness can become increasingly perfect

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