Computer assisted evaluation model established for value analysing through principal component analysis

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Abstract. The iron and steel industry plays a pillar role in China's social economy. It is the material guarantee for the rapid improvement of the national economy. This paper takes Baoshan Iron and Steel Co., LTD as the analysis target and constructs the index evaluation system of investment value analysis of listed iron and steel companies. The three principal components are calculated and the evaluation function is established. The results show that the research method adopted in this paper is feasible. It can provide practical and effective reference for the decision makers and investors of steel enterprises.

Keywords: principal component analysis, accumulating contribution rate, investment value

1. Introduction
As an important basic industry in the national economy, the sustainable development of steel market plays a very prominent role in the growth of social economy. China's crude steel output was only more than 150,000 tons to a historic breakthrough of 100 million tons in 1996. Production has increased 633 times in just over 40 years. Especially since the 21st century, the rapid development of the national economy has driven the domestic steel sales beyond the expected output. Due to the changes in the international economic situation, especially since the 2008 global financial crisis and the European debt crisis, domestic exports have been seriously affected, dragging down the overall domestic economic situation. Moreover, due to the tightening of the state macro-control on the real estate sector, the ability of the real estate industry to drive steel consumption demand is increasingly weak.

By 2015, China's crude steel output reached the highest level of 1.2 billion tons. But at the same time, although the output of crude steel in China is large, the whole is not strong. The industry is very serious vicious competition, product homogeneity, steel industry in the industry chain in the game status continues to decline 2016, China's steel market mainly shows a slight increase in steel production and a rise in crude steel sales. Iron and steel enterprises are more active in production. The favorable social and economic environment has had a positive and positive impact on the steel industry. In recent years, the continuous implementation of capacity cutting in the steel industry has produced obvious effects. The price of steel has fluctuated significantly, and the operating conditions of steel enterprises have improved significantly, and the profitability of steel enterprises has generally improved. Baoshan Iron and Steel Co., LTD. (Baosteel) is China's largest and most modern steel conglomerate. "World Steel Industry Guide" evaluates the comprehensive competitiveness of Baosteel shares in the world steel
industry as the top three, and believes that Baosteel shares are also the most potential steel enterprises in the future.

Through data envelopment analysis (DEA), Wang Ya[1] made an empirical study on the financial statements and related indicators of listed steel companies in China. Through the research of listed enterprises in China's steel industry, Zhang Aiyuan[2] made a comprehensive score on the investment value of domestic listed steel enterprises and gave an evaluation. Cheng Min[3] takes 29 steel enterprises listed before 2007 as the research target and uses DEA method to quantitatively analyze the fund-raising efficiency of domestic listed iron and steel industry enterprises. Based on the relevant theories of financial performance evaluation of listed companies, Pei Huihui[4] established a four-dimensional financial performance evaluation index system, took 28 listed steel companies as the analysis target, and analyzed successively the debt paying ability, profitability, operation ability and growth ability of listed steel companies through factor analysis method.

The main work of this paper is to analyze the investment value of listed steel companies based on the above steps of principal component analysis, and to analyze the results. The first chapter mainly introduces the development of China's iron and steel industry, the previous research results and the research framework of this paper. The second chapter mainly introduces the establishment of index system and the process of principal component analysis. The third chapter selects 16 financial indicators based on the financial statements of Baosteel in recent ten years. According to the principle of principal component analysis, the selected 16 variables are extracted by SPSS software, and then the comprehensive scores of each principal component are calculated. Based on the data, the paper makes a comprehensive study of the investment value of Baosteel shares.

2. Establish index system

Although the financial data of listed steel companies can be used to calculate the comprehensive operation situation of listed steel companies, it can reflect the investment value of listed steel companies to a certain extent. However, the financial data indicators that reflect the investment value of listed companies are complex and diverse. The research on the investment value of listed steel enterprises should not only include the analysis of the global economic development and the research on the development status of the listed steel enterprises, but also include the research on the internal environment and structure of listed steel enterprises. For example, asset management ability, and equity structure are all variables that can affect the investment value of listed steel companies. However, because the information required for economic situation analysis is very large and complex, it is difficult to realize real-time tracking in terms of technology, and because the research on the industry situation where enterprises live is usually relatively stable in the long term. The index system selected in this paper does not study these two aspects, but only selects the internal financial data of the listed steel company, and selects the financial statement data of the company in a certain period to study the investment value of the listed company. These data can not only show relatively accurate financial situation of listed steel companies in a certain period of time, but also can be linked with each other to form a close system, fully and accurately reflect the internal value of listed steel companies. Therefore, this paper divides the main variables related to the investment value of the steel industry into four aspects: growth ability, profitability, debt paying ability and asset operation ability.

3. Principal component analysis model

Select Baosteel Co., LTD for investment value evaluation. All data are from baosteel's annual financial reports for each year from 2007 to 2016. SPSS statistical software was used for statistical calculation of data, and each principal component[5][6] was extracted within the specified range of cumulative variance contribution rate. Using variables including baosteel sales gross profit margins $X_1$, earnings per share $X_2$, return on net assets $X_3$, net assets per share $X_4$, asset-liability ratio $X_5$, net value of fixed assets rate $X_6$, long-term debt ratio $X_7$, total assets turnover ratio $X_8$, accounts receivable turnover $X_9$, 

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inventory turnover $X_{10}$, current asset turnover $X_{11}$, main business revenue growth rate $X_{12}$, growth rate of net profit growth rate $X_{13}$, growth rate of total assets $X_{14}$, current ratio $X_{15}$, net assets $X_{16}$.

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\begin{align*}
y_1 &= t_{11}X_1 + t_{12}X_2 + \cdots + t_{1p}X_p = T_1X \\
y_2 &= t_{21}X_1 + t_{22}X_2 + \cdots + t_{2p}X_p = T_2X \\
&\quad \vdots \\
y_p &= t_{p1}X_1 + t_{p2}X_2 + \cdots + t_{pp}X_p = T_pX
\end{align*}
\] (1)

By standardizing the data, the eigenvalue, contribution rate and cumulative contribution rate of the correlation matrix $R$ are obtained, and the number of principal variables is obtained. According to the obtained eigenvalue, the eigenvector corresponding to the eigenvalue is calculated to determine the coefficient of the principal component formula, and then the value of the principal component is substituted into the formula to obtain the value of the principal component, and finally the comprehensive evaluation value is calculated to evaluate the financial status of Baosteel shares. Table 1 shows the contribution rate of characteristic roots and variance, representing the total variance of the original variables explained by each principal component. It can be seen from the table that three principal components are selected this time to extract 100% of the information of the original data. In addition, this value can also be obtained by taking the mean of the values extracted from the common factor variance table.

| component | Summation | Initial eigenvalue | Accumulated% |
|-----------|-----------|-------------------|--------------|
| 1         | 10.231    | 63.831            | 63.831       |
| 2         | 3.909     | 24.433            | 88.264       |
| 3         | 1.878     | 11.736            | 100.000      |

The results show that the difference of eigenvalues between factor 1 and factor 2, factor 2 and factor 3, and factor 3 and factor 4 is large, while the difference of other eigenvalues is 0, so the system retains three principal components to cover all the information.

| variable | Component | 1    | 2    | 3     |
|----------|-----------|------|------|-------|
| X4       | 0.999     | 0.017| -0.052|
| X5       | 0.980     | -0.02| -0.198|
| X10      | 0.967     | -0.242| 0.13 |
| X2       | 0.959     | 0.196| 0.206 |
| X11      | -0.901    | -0.156| 0.405|
| X1       | 0.890     | 0.450| -0.075|
| X16      | 0.870     | 0.399| 0.291 |
| X3       | -0.857    | 0.386| 0.340 |
| X7       | 0.853     | 0.247| 0.460 |
| X8       | 0.830     | -0.293| -0.475|
Table 2 shows the component matrix. You can see that the load on the first principal component is very large. The first principal component relatively represents the total economic aggregate, and the second principal component has a higher load and a higher correlation.

Table 3. Principal component coefficient matrix

| variable | Component | Component | Component |
|----------|-----------|-----------|-----------|
| X9       | 0.827     | -0.542    | -0.201    |
| X13      | 0.768     | 0.084     | 0.635     |
| X6       | -0.331    | 0.918     | 0.218     |
| X14      | 0.337     | 0.845     | -0.416    |
| X12      | 0.573     | -0.613    | 0.544     |

The column vector of the ith divisor in the Table 3 is divided by the square root of the corresponding characteristic root to obtain the variable coefficient matrix of the principal component. Write the principal component expressions based on Table 3. The expression of principal component is $F_1 = z_1X_1^* + z_2X_2^* + \cdots + z_{16}X_{16}^*$, where $X_i^*$ is the variable value after standardization, and $z_{11}, z_{21}, \cdots, z_{111}$ is the variable coefficient of the first principal component.

\[
F_1 = 0.087X_1^* + 0.094X_2^* + \cdots + 0.085X_{16}^*
\]  

\[
F_2 = 0.115X_1^* + 0.050X_2^* + \cdots + 0.102X_{16}^*
\]
\[ F_3 = -0.040X_1^* + 0.110X_2^* + \cdots + 0.155X_{16}^* \]  

The principal component score is the corresponding factor score times the arithmetic square root of the corresponding variance. The results are shown in Table 4.

### Table 4. Characteristic roots and variance contribution

| component | Initial eigenvalue | Summation | Variance\% | Accumulated\% |
|-----------|-------------------|-----------|------------|---------------|
| 1         | 10.231            | 63.831    | 63.831     |
| 2         | 3.909             | 24.433    | 88.264     |
| 3         | 1.878             | 11.736    | 100.000    |

The principal component score is the corresponding factor score times the arithmetic square root of the corresponding variance. The results are shown in Table 5.

### Table 5. Baosteel shares each year the principal component score

| Year   | F1       | F2         | F3        |
|--------|----------|------------|-----------|
| 2007   | 106.1067 | 0.58340    | -3.8855   |
| 2010   | 68.9187  | -6.57786   | 4.500     |
| 2013   | -113.1389 | -14.87566  | -1.2504   |
| 2016   | -61.88646| 20.870266  | 0.6357    |

Then, combined with the cumulative variance rate of the principal component, the weighted average of the principal component score was carried out, the comprehensive score of the principal component was calculated.

### 4. Conclusion

We can analyze the investment value of Baosteel shares by using the comprehensive score of three principal components and the single score of Baosteel shares on each principal component. In this case, a series of standardized treatments were used for indicator variables when principal component analysis was conducted by SPSS software, so the average score and composite score of each principal component were all 0. Therefore, we can take 0 as the reference standard. If the score is higher than 0, we can think that the investment value is good, and the higher the value, the better. On the contrary, a score below 0 is considered to be of low investment value, and the higher the value, the lower the investment value.

Therefore, based on various indicators and domestic and foreign economic environment, we can predict that after the national macro-control in recent years and the efforts of iron and steel enterprises in supply-side reform, the utilization rate of production capacity is gradually increasing and the investment value of iron and steel enterprises is gradually increasing. However, the adjustment and development of the steel industry will go through a longer period, process adjustment, survival of the fittest, multiple development, innovation and development process. So in the short term, the steel industry is bound to remain low. In the long run, steel enterprises will be in the upward development trend.

By comparing the theoretical and practical results of this paper, we can draw the conclusion that the result evaluation obtained by using principal component analysis is basically consistent with the objective actual situation. The change of the comprehensive score of each year also fully reflects the change of the performance of Baosteel shares, and the related evaluation index system is also consistent with the value theory of Baosteel shares. We can provide rational investment reference for investors. This method can be used to evaluate the investment value of companies in other industries. However,
there are some problems in using principal component analysis to analyze the investment value of listed iron and steel companies, such as the selection of each component, the analysis of the characteristics and results of steel industry selected by strengthening the index, and the errors caused by the contingency of data. Therefore, the future research needs to be continuously improved and analyzed through more rigorous and systematic knowledge.

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