



# Application of Altman Z-score Model in Credit Risk Assessment of Light Industry in China

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**Abstract.** This article uses the method of empirical analysis to analyze the credit risk of more than 20 light industrial enterprises listed in China, the United Kingdom, and the United States, with the data of their working capital, earnings before interest and tax, retained earnings, the market value of equity, total assets, total liabilities, and sales. The article uses the Altman Z-score model, comparing and analyzing the Z value changes of light industrial enterprises in three countries. This paper also provides some suggestions for the development of Chinese light industrial enterprises, and fills the gap in the combination of the light industrial enterprises and the risk assessment through the Altman Z-score model.

**Keywords:** Altman Z-score model · Light industrial enterprises · Credit Risk

## 1 Introduction

### 1.1 Background and Motivation

From the industrial development history of the developed countries such as the United States and the United Kingdom, it could be seen that the industrialization of a country often starts from the development of the light industry [1]. The light industry could provide not only raw materials and processes, but also the basis for social production management for the development of the heavy industry [2]. Ignoring the development of the light industry and only giving priority to the development of the heavy industry may cause an imbalance in the national industrial system. Taking the Soviet Union as an example, although the country may develop rapidly in a few decades, this kind of imbalance cause a vicious circle and eventually led to the collapse of the entire national industrial system.

The light industry is an integral part of the national economy in China, and the development of the light industry also affects the lives of people in many aspects. Since the reform and opening-up in the 20th century in China, the Chinese government paid much attention to the development of the light industry. After struggling for about 30 years, China became one of the largest exporters of light industrial products, and has an essential influence on the world market. However, because of the COVID-19 and the downward pressure on the economy, some negative factors such as restrictions on international trade may hinder the development of Chinese light industries, and some light industry

enterprises in China are facing difficulties in further development and are even facing the danger of going bankrupt.

There is some existing research on the development of the light industry, and there are also many articles researching enterprise risk with the help of the Altman Z-score model. However, only a few researchers made an analysis of the credit risk of the light industry enterprises through the Altman Z-score model. According to this, this paper will use the Altman Z-score model to analyze the credit risks of Chinese light industry enterprises through their profitability, leverage ratio, liquidity, solvency, and activity. Through the comparison of the Z value of Chinese light industry enterprises and that of enterprises in the United Kingdom and the United States, this paper will provide some suggestions for the development of Chinese light industry enterprises.

## 1.2 Literature Review

Most of the existing research only focuses on the development of light industrial enterprises, and some other researchers only analyze the risk problems of enterprises through Altman Z-Score Model. This means there are only a few researchers making the combination of the risk problems of the light industrial enterprises and the Altman Z-Score Model.

Mysachenko pointed out that heavy industry and light industry should develop in harmony. He thinks the lack of technological innovation may lead to backward production technology, and the national economy may also have negative affection on the lack of light industry development. The high consumption of raw materials and energy is the result of backward light industry technology, and the low level of machinery manufacturing may lead to the lack of competitiveness of light industry enterprises [3]. Hinh believes that the light industry is an important part of the economy of the country. The country should pay attention to the development of light industry enterprises because the practical experience has proved that the development of the light industry is one of the foundations for the stable development of the country in the future [4]. Rothwell states that the development of the light industry should be promoted by stimulating industry innovation [5]. The government could also promote the development of the light industry through tax reduction, attracting high-quality employees by increasing salaries, and enhancing the overall competitiveness of light industry enterprises. Hayes used the Altman Z-Model to predict the future financial performance of companies in various specialty retail industries, proving that almost all bankruptcy could be accurately predicted with the help of the Altman Z-Model [6]. Samarakoon examined the ability of three versions of the Altman Z-Score model to predict corporate distress in the United States, and demonstrated that the Z-Score model seems to work well in evaluating the risk of corporate distress in smaller emerging markets [7]. Through empirical analysis, Christopoulos examines the bankruptcy of listed companies on the Athens Stock Exchange from 2002 to 2008, proving that the Altman Z-Score model performs well in predicting failures. He believes that the Altman Z-Score model should be useful to the company management in oversight agencies, financing decisions, and portfolios [8].

### 1.3 Research Contents and Framework

The rest of the article will be divided into three parts, methodology, results, and conclusion. In the Methodology part, the article will analyze the theoretical mechanism of light industry development, and use the Altman Z-Score model to analyze the credit risk of Chinese light industry enterprises through their profitability, leverage ratio, liquidity, solvency, and activity. A comparison will also be made among the Z-value of the light industry enterprise in China, America, and Britain. In the part on results, the article will analyze the results calculated by the Altman Z-Score model above and analyze the reasons for them. The article will also make some recommendations for Chinese light industrial enterprises in this part. In the conclusion section, in addition to the basic summary of the article, an analysis of the limitations of this article and general directions for future research will also be proposed.

## 2 Methodology

### 2.1 Research on the Theoretical Mechanism of Light Industry Development

The United Kingdom was the first country to start the industrial revolution. During the industrial revolution, many scientific discoveries and inventions were produced, such as steam engines, penicillin, deoxyribonucleic acid (DNA), and so on [9]. The United Kingdom is the sixth-largest economy in the world and is the largest financial center in Europe. The financial markets in London also attract companies from all over the world. As early as 1800, the export value of British cotton fabrics accounted for 25% of the total export value, and in 1828 it reached half. British cotton textile gradually became the backbone of the industry, promoting the occurrence of the Industrial Revolution. Historians believe that cotton textiles are the starting point of the industrial revolution in Britain and in the world.

The United States has a highly developed modern market economy, and its industrial employment once accounted for 20.3% of the total employed population. Manufacturing dominates the industry, which once accounted for about 11% of the total output of the U.S. gross domestic product, and it is also an important foundational pillar of the U.S. economy. American industry is famous for its advanced technology, abundant resources, complete categories, high labor productivity, and strong production strength [10]. After World War II, American industry achieved great development. Its industrial equipment capacity and production scale greatly exceeded that of other countries and became the largest industrial country around the world.

China is the only country that has all the industrial categories listed in the United Nations Industrial Classification. It took China only several decades to go through the process of industrialization that cost developed countries hundreds of years [11]. In 2018, the added value of the Chinese manufacturing industry accounted for more than 28% of the world's share, and the scale of the Chinese digital economy reached 39.2 trillion yuan in 2020, ranking secondly in the world. This means the manufacturing industry in China became an important part of that around the world. China has always been regarded as the world's factory with a developed handicraft industry, and the products in many countries are often made in China. According to incomplete statistics, more than

80% of air conditioners, 90% of personal computers, 70% of mobile phones, and 74% of solar cells around the world came from China.

There are three reasons for the rapid development of the Chinese light industry. Firstly, China became a major manufacturing country in the world because of its abundant labor resources and low labor costs. Secondly, the domestic demand for light industrial products is large, and the demand may drive production. Thirdly, China has a complete industrial production system, and the government attaches great importance to the construction of the light industry by investing sufficient funds.

## 2.2 Empirical Research

NYU Stern Finance Professor Edward Altman developed the Altman Z-score model in 1967. Through the data related to profitability, leverage, liquidity, solvency, and activity of listed companies, a multivariate model was established to analyze the financial status of enterprises. After the continuous re-evaluation of the Z-score by Prof. Altman, the coefficients for each variable for non-manufacturing are determined, the accuracy of the Z-score model has been proved, and the Altman Z-score model is a reliable indicator for calculating credit risk now.

For public manufacturers, the basic expression of the model is as follows.

$$Z = 1.2 X_1 + 1.4 X_2 + 3.3 X_3 + 0.6 X_4 + 1.0 X_5 \quad (1)$$

Where: Z = Altman Z-Score

X1 = working capital/total assets

X2 = retained earnings/total asset.

X3 = earnings before interest and tax/total asset.

X4 = market value of equity/total liabilities

X5 = sales/total assets.

In this model, the companies with a Z below 1.8 are likely to face bankruptcy, while companies with a Z above 3 are financially healthy and investors could consider investing in these companies. When the Z is in the gray area,  $1.8 < Z < 3$ , investors should buy or sell stocks according to the changes in the Z of the company. The article will use the data of listed companies in China, the United Kingdom, and the United States, and use the Altman Z-score model to test the credit risk of light industrial enterprises in these three countries.

This article selects some listed companies from different industries, different regions, and different scales. Through the WIND database, the article finally obtained the relevant data of 8 listed light industrial enterprises from China, 11 from the United States, and 6 from the United Kingdom, which have completed representative data from 2017 to 2021. The form below shows the result of the Z values of these companies (Table 1).

The results of the calculation show that the overall average Z value of Chinese enterprises is 6.520, while that of American enterprises is 4.098, and that of British enterprises is 2.149. Although the Z value of Chinese enterprises seems much higher than that of American and British enterprises, this does not mean that the credit risk of Chinese light industrial enterprises is lower than that of American and British enterprises

**Table 1.** Z-values of listed light industrial companies in China, the United State and the United Kingdom

Company Name	2017	2018	2019	2020	2021	Average
China						
Kweichow Moutai	16.435	13.486	24.781	36.067	29.501	24.054
Chenming Paper	0.728	0.5194	0.601	0.563	0.647	0.612
Haixin Foods	6.688	4.980	4.798	6.799	3.782	5.409
Haier Smart Home	2.057	2.031	2.101	2.576	2.728	2.299
M&G	12.029	10.555	11.510	14.248	10.309	11.730
Sinopharm	2.718	2.379	2.420	2.208	2.298	2.405
Gree Electric	2.647	2.645	3.055	3.004	2.015	2.673
Midea	3.054	2.686	3.084	3.303	2.777	2.981
Average (after adjustment)	2.982	2.542	2.677	3.075	2.375	2.730
United State						
WALMART	4.667	4.269	4.224	4.472	4.729	4.472
STARBUCKS	8.588	4.057	4.033	2.650	3.438	4.553
PROCTER & GAMBLE	4.167	4.173	4.80	4.915	5.521	4.716
COCA COLA	3.557	3.745	3.988	4.026	4.069	3.877
MCDONALD'S	5.803	5.790	4.207	3.840	4.651	4.858
TARGET	3.203	2.975	3.611	3.944	4.318	3.610
JOHNSON & JOHNSON	4.207	4.290	4.357	4.047	4.513	4.283
HP	2.450	2.493	2.468	2.252	2.428	2.418
PFIZER	2.640	3.136	2.618	2.764	3.640	2.960
APPLE	3.767	3.414	4.899	6.910	8.168	5.431
LILLY ELI	3.102	3.850	3.354	3.750	5.419	3.895
average	4.196	3.836	3.869	3.961	4.627	4.098
United Kingdom						
TESCO	1.687	1.725	1.778	1.767	1.910	1.773
UNILEVER	2.797	2.853	2.340	3.430	3.313	2.947
Kompass	4.026	3.638	4.096	3.024	3.437	3.644
GlaxoSmithKline	1.286	1.634	1.616	1.480	1.656	1.534
British American Tobacco	1.352	1.143	1.327	1.371	1.439	1.327
Imperial Tobacco	1.880	1.677	1.453	1.474	1.849	1.667
average	2.171	2.112	2.102	2.091	2.267	2.149

because this high score is mainly caused by the high scores made by two companies, Kweichow Moutai and M&G. The Z values of these two companies are much higher than the average range of Chinese companies and cannot represent the overall situation of the Chinese market, so the two special companies should be excluded in the comparison. The adjusted results show that the Z-score of Chinese companies fell to 2.730, slightly higher than that of British companies but much lower than that of American companies.

### 3 Results

#### 3.1 Results

For manufacturing enterprises, when the Z value is lower than 1.8, the company may have a high risk of bankruptcy, and when the Z value is higher than 3, the risk of bankruptcy is low, and the company may have a stable development prospect. The following chart shows the changes in the average Z value of light industrial enterprises in China, the United States, and the United Kingdom from 2017 to 2021. It can be seen that the Z-value of Chinese light industrial companies is higher than that of British companies and lower than that of American companies (Fig. 1).

The Z-value of UK light industrial companies was the lowest in the five years, with an average of 2.149, which indicates that the risk of UK light industrial companies was high in recent years. Although the Z-value of British light industrial companies will increase slightly in 2021, it is still lower than that of the United States and China. Although the United Kingdom is a country that entered industrialization from the light industry, the development of light industry enterprises was not rapid enough in recent years due to insufficient attention paid to the development of the light industry. It is worth noting that although the Z of British companies is the lowest among that of the three countries, it still remained above the dangerous value of 1.8 in the past five years. This means although the risk of bankruptcy of British light industrial enterprises is relatively high, these companies could still develop continuously.

The companies in the U.S. consistently had the highest Z-scores among the companies in the three countries. American companies performed better, and their average Z

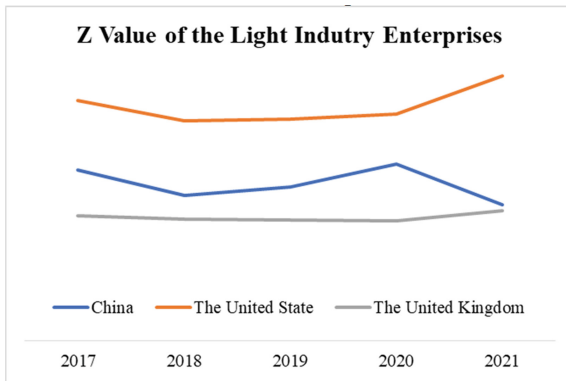


Fig. 1. Z Value of the Light Industry Enterprises

score remained above 3 in the past five years, which means that the light industrial companies in America were less risky and had better investment opportunities. Although the credit rise of the financial and service industries led to the loss of manufacturing talents in the United States, and the industrial relocation of low-end and middle-end manufacturing industries caused the lack of foundation talents, the development of the light industry in the United States is still better than that of other countries. This may be the result of the long-term emphasis on innovation and advanced technology in the United States.

After excluding two companies with a larger degree of dispersion, the Z value of Chinese light industrial enterprises fluctuates between 2 and 3.5. After 2020, the Z-value of Chinese light industrial enterprises dropped significantly, which may be the result of the decrease in international demand caused by the Covid-19 crisis and the pressure from the downturn in the world economy. This result also shows that although Chinese light industrial enterprises are developing rapidly, they do not have sufficient ability to control risks. The Z scores of two companies, Kweichow Moutai and M&G are far above the average, which means that some Chinese enterprises have good risk-controlling capabilities. The reason for this phenomenon may be the particularity of the liquor industry, as well as the outstanding management ability of some special enterprises. The Chinese government attaches great importance to the development of light industrial enterprises, and actively carries out activities including the “Belt and Road” to promote the internationalization of domestic light industrial enterprises, which also provides a good environment for the development of Chinese light industrial enterprises.

### 3.2 Suggestions

According to the analysis above, here are some suggestions for Chinese light industry enterprises. First of all, it is necessary for enterprises to improve innovation capabilities and integrate technology into light industrial products. Innovation is the foundation of the continuous development of an enterprise [12]. In other words, products that lack innovation may face the danger of being eliminated. In the era that intellectual property rights developed rapidly, the enterprises should promote the development of core technologies and products, vigorously carry out innovative activities such as technical cooperation and exchanges, and increase the right to speak in the industry. The Chinese industry enterprises should improve the ability of technological innovation, thus improving their competitiveness in the international market.

Secondly, smart manufacturing and green manufacturing should be promoted, and the integrated application of cloud computing, industrial Internet, and big data should be widely used in the light industry. Home appliance companies such as Haier, Midea, Gree, Hisense, Robam, and Joyoung should built smart factories, which may not only improve the level of automation, but also build a digital system. More than 15% of toys, safety seats, strollers, infant clothing, and children’s beds enterprises have digitized workshops, and more than 40% of them have applied digital R&D design tools. The numerical control rate of key production processes has exceeded 30%, and the production time and the rate of defective products are greatly reduced.

It is necessary to encourage emission reduction and pollution control transformation, and encourage enterprises to use new technologies, new equipment, and new materials to achieve the aim of energy conservation and emission reduction. Enterprises should actively adopt advanced and applicable clean production technology to implement upgrading and transformation. Some industries need to strengthen the terminal treatment of wastewater and waste gas, and implement upgrading and transformation of pollution control facilities. It means the enterprises should actively improve the efficiency of energy utilization, strengthen the comprehensive utilization of water resources, and improve the recycling rate of wastewater and sewage treatment.

In addition, trade frictions should be actively dealt with, and it is better for the Chinese enterprises to make international trading. The export tax rebate rate for light industrial products can be appropriately increased, and the government should also increase the export tax rebate rate for footwear, luggage, leather clothing, fur clothing, finished leather, home appliances, furniture, toys, paper and cardboard, plastic products, musical instruments, stationery, washing products, electronic clocks, umbrella products, hardware, etc. Furthermore, international production capacity cooperation should be carried out. Not only major strategic deployments such as the “One Belt, One Road” initiative should be carried out, but the government should also introduce policies to actively support enterprises in “going out”, and providing these enterprises with various information on the political trends, economic policies and investment environment of the host country.

## **4 Conclusion**

### **4.1 Summary**

This article uses the method of empirical analysis to calculate and analyze the Z score of light industrial enterprises in China, the United States, and the United Kingdom in the past five years through the Altman Z-Score model applicable to the manufacturing industry. The data shows that individual Chinese companies have strong risk control capabilities, but overall, the risk control capabilities of Chinese companies are lower than those of American companies and higher than those of British companies. Through the analysis and comparison of the Z value of light industrial enterprises in three countries, the article provides suggestions for the development of Chinese light industrial enterprises. The Chinese light industrial enterprises should improve their innovation capabilities, increase the application of smart manufacturing and green manufacturing, reduce pollution, and actively resolve trade frictions.

### **4.2 Limitations**

However, there are also some limitations. The upper and lower critical values of the Z model are both too high for Chinese listed companies, because there are many differences in interest expenses and equity market value between Chinese listed companies and those enterprises in the United Kingdom and the United States. This means the Z value of Chinese companies should be lower when evaluating Chinese enterprises in the light industry.



There are two main reasons for this situation. Firstly, there is a big difference in the definition of bankruptcy between the United Kingdom, the United States, and China. For U.S. companies, they may go bankrupt if they are insolvent, but in China, as long as the company is still solvent, creditors cannot file for bankruptcy. Secondly, the Chinese government may intervene in companies. In order to maintain the stable development of the economy and the employment rate of the people, the government may request administrative means to temporarily alleviate the financial crisis of the enterprises with less serious losses but unable to pay through bank loans. This also causes the Z value of Chinese enterprises lower than that in other countries.

### 4.3 Further Development

This paper only selects some representative listed light industrial enterprises in China, the United States, and the United Kingdom as the object of analysis. In the future, the researchers could analyze the risks of unlisted small and medium-sized enterprises, and could also pay attention to the light industry of enterprises in other developing countries and underdeveloped areas. In addition, it is possible to classify specific types of enterprises, conduct classification research on light industrial enterprises of different classifications, and give some targeted suggestions towards them.

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