

**Z-score Model on Financial Crisis Early-Warning of  
Listed Real Estate Companies in China: a Financial Engineering Perspective**

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**Abstract:** Financial engineers developed quantitative models that help firms making financial decisions in the face of risk and uncertainty. Z-score model is one of the most frequently used risk early warning models in financial engineering, but it needs further research to prove whether it is suitable for China's burgeoning real estate enterprises. The financial data of China's 40 listed real estate companies is processed in this article, and statistic analysis is conducted, so as to judge the effectiveness of Z-score model on financial risk early warning of China's listed real estate companies.

*Keywords:* Z-score model; Early-warning; Effectiveness

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## 1. Introduction

The development of real estate industry, which is the pillar industry of China's national economy, has a strong influence on the operation of the entire national economy. In recent years, China's real estate industry has experienced an unprecedented period of rapid development. Considering the immaturity of the real estate market, the government has taken measures to regulate and control the real estate market on many occasions, especially after the second half of 2010, when our country launched a series of strict adjustment and control policies. At the same time, due to tight monetary policies, a large number of real estate enterprises are facing tension and even rupture of the capital chain and are very likely to suffer financial crisis. Listed real estate companies have basically represented the development of this industry in China. Therefore, the research over the financial crisis early warning of listed real estate companies is of great significance for studying the development of China's real estate industry.

Scholars in industrial engineering and management sciences focused on the prediction models using in financial risk. To consider the risk of the entire portfolio, an institution must take into account comparing several models and choosing the proper one. In right time, accurate carrying on pre-warning analysis to enterprise's financial affairs is the objective requirement for the market competition system, it is the essential guarantee of enterprise's survival and development too. The research on financial crisis early warning model has experienced many years of development, from early research on model construction to the research specific to the practical financial crisis early warning model construction of Chinese enterprises [1], and then to explore the financial crisis early warning model that is suitable for the industry.

## 2. Literature Review on Financial Crisis Early-Warning Model

Financial crisis prediction has become an important factor in the healthy development in China's capital market and the problem of financial crisis prediction has become a hot issue. The scholars in financial engineering field generalize, sort and introduce the research progress of financial crisis prediction models. It is necessary to compare, evaluate and analyze the financial crisis prediction models on the basis of financial engineering.

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Since 1932, scholars began to launch on the listed company or private enterprise financial crisis pre-warning model research, from single-variable warning model to the current artificial intelligence and higher discriminating rate pre-alarming model [2]. Although in China, financial crisis early-warning model research began later than abroad, research results can reach the advanced level. Regarding the enterprise, especially the listed company's financial crisis warning research, many experts and scholars from different angles on such questions carried out in depth research. In this paper, it compares the early warning models for enterprises based on the concept of financial engineering cube.

### *2.1 Single-Variable Model*

Single-variable model is a forecast model that uses a financial index as the criterion to judge whether an enterprise is on the edge of bankruptcy. When the financial index involved in the enterprise's financial crisis early warning model deteriorates, it is often a bad signal and a sign of financial crisis.

### *2.2 Multi-Variable Model Analysis*

#### *2.2.1 Z-Score Model*

Z-score Model adopts multi-variable linear function and selects those variables with the biggest difference between the two sample groups and the smallest dispersion within each group through statistical techniques so as to convert multiple variables to categorical variables and obtain equation[3].

#### *2.2.2 Principal Component Analysis*

Principal component analysis is the best comprehensive simplification of multi-variable flat data sheet. To put it another way, after giving up a small quantity of information on the principle of losing as little data information as possible, the principal axis can still be very effective in indicating the variation of the raw data and reduce the dimensions of the high-dimension variable space.

#### *2.2.3 Logistic Regression Analysis*

The objective of logistic model is to seek the conditional probability of observation objects and judge their financial status and business risks on this basis. Logistic model is suitable for the selection model whose dependent variables are of discontinuity and dichotomies [4]. It limits default probability to between 0 and 1 and computes default probability through the logarithmic distribution of functions.

#### *2.2.4 Probit Model*

Similarly, Probit regression model also presumes that the enterprise's bankruptcy probability is P and enterprise samples are normally distributed. With its computing method very similar to that of Logistic model, Probit model also first determines the maximum likelihood function of enterprise samples, then obtains the parameters by looking for the maximum value of the likelihood function and computes the bankruptcy probability of the enterprise.

#### *2.2.5 Artificial Neural Network (ANN) Method*

Neural network model is a complex network system made up of numerous interconnected simple processing units. Consisting of input layer, output layer and hidden layer, it obtains desired output through network study and data correction and then makes prediction on the basis of the judgment rules that are obtained through learning.

In practice, single-variable analysis is almost obsolete due to its defects. ANN modeling is a very complex and time-consuming model that requires continuous artificial adjustment, so its application is very limited [5]. In contrast, multi-variable linear discrimination method and multiple logical regression model has high practicality and predicative accuracy, so these two methods are widely used.

This article uses Z-score Model to construct financial crisis early warning model of listed real estate companies and judges whether Z-score model is suitable for predicting the financial crisis in China's real estate enterprises by testing its accuracy in the financial crisis early warning for real estate enterprises.

### 3. Z-Score Model Early Warning Validity Test

#### 3.1 Z-Score Model

Z-score model theory is the research conclusion published by Altman in 1968. Later, he revised the original model twice and finally established two models: financial failure model for non-listed companies and financial failure model for listed companies [6]. As proved by plenty of empirical studies, these two models have high prediction accuracy in American enterprises. The Z model function of listed non-manufacturing companies is as follows:

$$Z=6.65X_1+3.26X_2+6.72X_3+1.05X_4 \quad (1)$$

$$X_1=(\text{operating asset}/\text{total asset})\times 100\% \quad (2)$$

$$X_2=(\text{retain earnings}/\text{total asset})\times 100\% \quad (3)$$

$$X_3=(\text{profit before interest and tax}/\text{total asset})\times 100\% \quad (4)$$

$$X_4=(\text{owner's equity}/\text{total liability})\times 100\% \quad (5)$$

The judgment criteria for companies' financial status that are based on Z-score model are shown in Table 1.

Table 1. Financial Situation Criterion Based on Z-Score Model

Z-score range	Financial situation
$Z \leq 1.23$	high bankruptcy probability
$1.23 < Z \leq 2.9$	unstable financial status
$2.9 < Z$	Stable financial status

#### 3.2 Sample Selection

Referring to the methods universally recognized by Chinese scholars, this article takes the special treatment (ST) on listed companies that is caused by their unusual financial situation as the symbol of financial crisis. According to the industry division standard released by the China Securities Regulatory Commission, the article selects 40 listed real estate companies on the Shanghai and Shenzhen A-share market. Among them, 10 are crisis samples (companies after ST) and 30 normal samples (companies without ST) are selected according to the principle of similar total asset size.

#### 3.3. Data Processing

This article processes the data with Excel software and substitutes the data of 40 companies during the period of 2008 to 2009 into the formula (crisis samples used financial data 2 years before ST), so as to work out various financial indexes and obtain the company's Z-score as shown in Table 2.

Table 2. Z-Score of 40 List Companies

Stock code	Z-score 1	Z-score 2	Stock code	Z-score 1	Z-score 2
000040	2.78	1.25	600807	6.56	6.69
600247	2.32	2.56	000511	3.88	3.68
000014	1.25	2.01	000667	3.19	3.33
600840	6.25	6.24	600067	2.36	2.45
000546	3.19	3.26	600555	2.05	2.36
000965	1.98	1.87	600576	1.42	1.36
600193	3.14	3.98	600643	1.05	1.22
002016	2.15	1.87	000690	-0.64	0.25
002133	3.05	3.21	600162	0.14	0.25
600079	4.33	4.12	600753	0.51	0.25
600638	3.75	4.56	ST 600515	1.77	1.89
000505	3.35	3.14	*ST 600275	1.16	1.32
000836	1.41	1.56	*ST 000628	1.02	1.58
600064	2.01	1.36	ST 600381	1.25	1.22
000558	1.45	2.57	ST 600743	0.74	1.02
002077	6.21	5.98	ST 000007	1.51	2.14
600082	2.66	3.15	ST600745	1.05	1.46
000632	3.21	3.26	ST600385	0.81	0.92
600648	3.94	4.00	ST 000656	0.34	0.61
600208	3.64	2.15	ST600603	-0.14	-0.89

### 3.4 Test of Predictive Ability of Z-Score Model

According to Table 2, we can find out the predicative ability of Z-score model ST companies. It can be seen that in the previous year before ST, the Z scores of ST companies are all below 1.23, with the prediction accuracy at 80%; two years before ST, the Z scores of 8 out of the 10 companies are below 1.23, with the prediction accuracy at 80%; there is two companies whose Z.score is between 1.23 and 2.90. That is to say, its financial status is in an intermediate state and if there is not any improvement in its operation, it may involve in crisis; two years before ST, the Z scores of only 5 out of the 10 companies are below 1.23, and the Z scores of all of the 10 companies are below 2.90. Generally speaking, the nearer the year is from the ST year, the higher prediction accuracy rate it has.

From the distribution of Z-scores of ST companies in Table 2, we can reach such a conclusion: during the period of one year to two years before ST treatment, Z scores are getting lower and lower. However, its accuracy rates are 80% respectively. It is thus clear that, its accuracy rate is not very high; the earlier the year is before ST, the lower the prediction accuracy rate is; and it is even false, losing thus the significance of prediction.

According to Table 2, in these two years, Z-score model has predicted some non-ST companies as ST ones, with the average ratio of erroneous prediction at 13.3% and the average ratio of correct prediction is 86.7%. The correctly predicted ST companies can be divided into two classes. Firstly, the average ratio of the companies whose Z score is between 1.23 and 2.90 with an intermediate and unstable financial status is 33.3%. Secondly, the average ratio of the companies whose Z score is more than 2.9 with a good financial status is 51.1%.

From Table 2, it can be seen in the two consecutive years of prediction, Z-score Model has a certain degree of reasonability, but its accuracy rate is not high enough and sometimes it even makes erroneous predictions. Specifically speaking, its highest and lowest accuracy rate tested are 80% respectively, while its highest and lowest false rate are 13.3% y.

## 4. Conclusion

The above empirical analysis indicates that in financial engineering field Z-score model is suitable for early warning of China's listed real estate companies to some extent, but the accuracy rate of its prediction is lower than 90%, which is not very high. There are two reasons why its accuracy rate is not high enough. Firstly, due to the difference between China and US securities markets, the model established with the financial data of listed US

companies is not very suitable for the research of financial early warning system of China's listed companies; secondly, Z-score early warning model established by professor Altman fits listed nonmanufacturing companies, but those listed nonmanufacturing companies, which cover many different industries, have not been classified in a detailed way, so this model has very low practicality. Many enterprises have faced crisis after global financial crisis in which many risk models broke down, it should be better to figure out how to create better risk prediction models in the perspective of financial engineering.

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