

Chapter 117

Financial Distress Early Warning Model for Listed Real Estate Companies of China Based on Multiple Discriminant Analysis

Yang Li, Hong Zhang, and Shuo Huang

Abstract This paper uses annual financial statement data of 99 listed real estate companies from A-share market, adopts multiple discriminant analysis to modify a Z-Score baseline model, and establishes a financial distress early warning model applicable to listed real estate companies in China. The findings indicate that the average accuracy of the financial distress early warning model reaches higher than 90 %, which is greatly improved from the previous Z-score baseline model. In the context of deepening adjustments in Chinese real estate industry, this model not only provides a reference indicator for business managers and market investors, but also helps policy makers timely evaluate the potential financial risks in real estate industry.

Keywords Financial distress • Early warning model • Multiple discriminant analysis • Listed real estate company

117.1 Introduction

The term financial distress (or financial failure in some literature) has different meanings, depending on the context. In a broad sense, financial distress can be used to indicate any condition when the business operation and financial circulation of a company fails to proceed normally or stagnates due to internal and external factors. To be specific, the financial distress of a company is a process, typically represented by persistent losses, events of default and insolvency, and finally corporate bankruptcy.

Y. Li (✉) • H. Zhang • S. Huang
Department of Construction Management, Tsinghua University,
Room 426, Building No. 10, 100084 Beijing, China
e-mail: liy-10@mails.tsinghua.edu.cn; zhannie@tsinghua.edu.cn;
hs1986tsinghua@gmail.com

Real estate business, different from the general manufacturing industry, is characterized by large capital investment, long recovery cycle, high debt ratio and etc. In this instance, real estate enterprises in this capital-intensive industry are sometimes confronted with tense capital chain due to slow property sales, and thus leading to the financial distress. In 2008, under the influence of global financial crisis, a lot of property developers suffered from the capital pressure went bankruptcy, leaving the construction in a shutdown state (called as Làn Wěi Lóu in Chinese). The recent example is Top 10 Chinese property developer Greentown China (HKG: 3900). In September 2011, because of the corporate real estate trust business, Greentown triggered the investigation from China Banking Regulatory Commission and then the stock market worried about its tight capital chain. In 1 week from Sep. 22 to Sep. 27, the share price dropped by more than 30 %. The evidences above have preliminarily indicated that the financial distress in the real estate company has its own characteristics. As a consequence, how to establish a financial distress early warning model applicable to listed real estate companies has become the common issue to be solved for both academics and business managers in China.

The research on financial distress early warning model emerged in the 1960s. The application of financial statement analysis in the early warning model at the early stage is univariate models based on the single financial ratio, such as the ratio of cash flow to total debt [1]. Soon after, multivariate models were established with the multiple discriminant analysis (MDA) method, which drove financial distress early warning research into the period of the Z-Score model and its derivative models such as ZETA [2, 3]. Then, other nonlinear statistical techniques are introduced in financial distress prediction, such as Logit [4] and Probit methods [5]. The hybrid model integrated with the MDA and Logit method was also constructed to achieve the longer prediction length [6]. In China, the financial distress analysis and its early warning models developed rapidly along with domestic security market and accounting system. The F-score model (Failure Score Model) was established on the basis of Z-score model by adding the new variable to reflect the variant cash flow [7]. Similarly, with the application of MDA method to modify the Z-score model, another derivative model (referred as Z_0 model hereinafter) was proposed, and its predictive accuracy for financial distress is higher based on 120 listed companies randomly selected from A-share market [8].

Existing literature on financial distress early warning model mostly focuses on all listed companies, so the distinctive business model and the accounting feature in real estate companies is omitted in these models, which could be inapplicable. This paper attempts to make contributions by extending the financial distress research to real estate companies and furthermore with the application of the MDA method, the prediction accuracy for financial distress in real estate companies can be improved.

The remainder of the paper is structured as follows: Sect. 117.2 evaluates the prediction accuracy of two general models based on the financial statement of listed real estate companies from the A-share market, and recognizes the better one as the baseline model. Sect. 117.3 establishes a financial distress early warning model through the modification of the baseline model with the MDA method. Conclusions are presented finally in Sect. 117.4.

117.2 Baseline Model Selection Based on Predictive Accuracy of Financial Distress

Based on the predictive accuracy for financial distress, we can evaluate and compare two different early warning models, including the traditional Z-score model and its derivative Z_0 model applied for Chinese listed companies.

117.2.1 Basic Assumptions

In order to conduct the comparative research, we need distinguish financially distressed companies from listed companies in healthy financial state. Therefore, some basic assumptions need to be made to identify the judging rule and the forecast time limit for financial distress.

1. Take the ST firm¹ designated as the judging rule for financial distress
According to the China Securities Regulatory Commission (CSRC) regulation of the special treatment mechanism, a listed company shall be classified as an ST firm if the audited results of the most recent two fiscal years show that it has suffered a loss. Simply speaking, all the ST firms are in terrible or abnormal financial situation, and thereby the use of special treatment as the judging rule for financial distress is reasonable for listed real estate companies in China which is also supported by previous researchers [7, 8].
2. Set the time limit of the financial distress early warning model as 5 years
The aforementioned literature indicates that, the longest time of the early warning model for financial distress is 5 years. In other words, based on the data of a listed company in the financial year T, the early warning model is just capable to predict its financial situation before the year T+5. When the time limit exceeds 5 years, the forecast accuracy of financial distress sharply drops down as the year increases [6]. In this instance, the time limit of the early warning model is set as 5 years in this paper.

117.2.2 Sample Companies

According to the industry classification standard defined by the CSRC, we select 99 real estate companies listed on A-Share market as the sample. At the end of 2011, 99 listed real estate companies consist of 9 ST firms and 90 non-ST firms. Given that the predictive power is restrained within 5 years for early warning

¹The term “ST”, short for special treatment, is a unique delisting mechanism in China introduced by the China Securities Regulatory Commission (CSRC) in 1998.

Table 117.1 Descriptive statistics (unit: billion yuan)

Variables	Max	Min	Mean	MSE
Total asset	49.920	0.045	3.838	6.087
Total debt	32.466	0.038	2.502	4.171
Cash flow	26.246	-3.644	1.099	2.976
Net profit	2.423	-0.866	0.115	0.315
Retained earnings	5.234	-1.109	0.272	0.815

models according to previous research [2, 8], the basic dataset is sourced from the financial statement of the fiscal year 2006. In order to evaluate the predictive accuracy for listed real estate companies, the 99 companies are divided into two groups as ST and non-ST, containing 9 and 90 companies respectively. The descriptive statistics of the whole sample is provided in Table 117.1.

117.2.3 Baseline Model Selection

In order to assess the predictive accuracy of financial distress early warning model, the discriminant accuracy matrix is constructed, as shown in Table 117.2.

Table 117.2 describes a matrix used to assess the discriminant accuracy. H_1 and H_2 represent the number of correct discriminant samples; M_1 denotes the number of Type I error, which misclassifies ST firms as non-ST firms; M_2 denotes the number of Type II error, which misclassifies non-ST firms as ST firms. The sum of H_1 , H_2 , M_1 and M_2 represents the total sample. The ratio R that the sum of H_1 and H_2 accounts for the total sample can be used to assess the model accuracy of the early warning, as below.

$$R = (H_1 + H_2)/(H_1 + H_2 + M_1 + M_2) \times 100\% \quad (117.1)$$

Following the discriminant analysis standards of Z-score model, the Z scores of ST firms should be less than 1.81, and that of non-ST firms should be larger than or equal to 1.81. In the case of Z_0 model, the value of ST firms should be less than 0.5, and that of non-ST firms should be larger than or equal to 0.5. Therefore, we can calculate the discriminant accuracy for each model based on the sample data of listed real estate companies, and the matrix is listed separately in Tables 117.3 and 117.4.

From Table 117.3, the discriminant accuracy of Z-Score model for listed real estate companies in China is $R_1 = (5 + 48)/(5 + 48 + 4 + 42) = 54\%$.

From Table 117.4, the discriminant accuracy of Z_0 model for listed real estate companies in China is $R_2 = (8 + 60)/(8 + 60 + 1 + 30) = 76\%$. By contrast, the accuracy of early warning for financially distressed real estate companies using Z_0 model is higher than using Z-score model. Accordingly, we use Z_0 model as the baseline model, and modify it with the financial statement of sample companies, and thus establish a financial distress early warning model applicable to listed real estate companies in China.

Table 117.2 Discriminant accuracy matrix

Actual grouping	Predictive grouping	
	ST firm	Non-ST firm
ST firm	H ₁	M ₁
Non-ST firm	M ₂	H ₂

Table 117.3 Discriminant accuracy analysis based on Z-score model

Actual grouping	Predictive grouping	
	ST firm	Non-ST firm
ST firm	5	4
Non-ST firm	42	48

Table 117.4 Discriminant accuracy analysis based on Z₀ model

Actual grouping	Predictive grouping	
	ST firm	Non-ST firm
ST firm	8	1
Non-ST firm	30	60

117.3 Financial Distress Early Warning for Listed Real Estate Companies

117.3.1 Early Warning Setup with the MDA Method

The baseline Z₀ model applies the MDA method in its modeling process, we follow this methodology to modify Z₀ model in line with the financial characteristics of listed real estate companies. The composition of Z₀ model is listed as in Eq. (117.2).

$$Z_0 = 0.517 - 0.460 X_1 - 0.388 X_2 + 9.320 X_3 + 1.158 X_4 \tag{117.2}$$

The definition and the calculation of each independent variable X_i (i = 1, 2, 3, 4) in Eq. (117.2) are described in Table 117.5.

In general sense, higher Z₀ value indicates for healthier financial situation of the company, and further results in lower possibility of having the financial distress. Then, we modify the Z₀ model with the MDA method, in the following steps:

1. Select predictive variables and group variables
 Select X_i (i = 1, 2, 3, 4) contained in Z₀ model as the predictive variables and define the group variable as 1 and 2, respectively for ST firms and non-ST firms. The descriptive statistics of two groups are listed in Table 117.6.

From Table 117.6, we can find that, except the variable of capital/debt ratio (X₁), the average values of the rest predictive variables in non-ST firm group are greater than the ST firm group. Thus, it can be concluded, non-ST real estate companies perform better than ST companies, in terms of long-term, short-term solvency, current and accumulative profitability, and the sample data is to some extent proved to be appropriate.

Table 117.5 Definition and calculation of each variable in Z_0 model

Variable	Definition	Calculation
X_1	The long-term solvency of corporate capital	$X_1 = \text{total debt}/\text{total asset}$
X_2	The short-term solvency of corporate capital	$X_2 = \text{cash flow}/\text{total asset}$
X_3	The current profitability of corporate capital	$X_3 = \text{net profit}/\text{average total asset}$
X_4	Accumulated profitability of corporate capital	$X_2 = \text{retained earnings}/\text{total asset}$

Table 117.6 Descriptive statistics of predictive variables in two groups

Group	Variable	Mean	Standard deviation	Sample size
1	X_1	1.32	1.35	9
	X_2	-0.24	1.15	9
	X_3	-0.13	0.47	9
	X_4	-1.74	2.51	9
2	X_1	0.78	0.17	90
	X_2	-0.14	0.45	90
	X_3	-0.06	0.07	90
	X_4	-0.42	0.55	90

2. Test the significance of the discriminant function

By testing the eigenvalue of the discriminant function and its variance ratio, we can evaluate the explanation power of the discriminant function (see Table 117.7).

Seen from Table 117.7, the number of the function is one and its eigenvalue is 0.585. The variance ratio (to what extent total variance can be explained) reaches 100 %, which reflects the discriminant function has strong explanation power for the sample data. In the MDA method, the significance test is also required, as shown in Table 117.8. Wilks' λ is 0.231, χ^2 statistics is 43.785, demonstrating the overall significance of the discriminant function.

3. Calculate coefficients in MDA function

The coefficients in the MDA function are listed in Table 117.9.

Based on the coefficients listed in Table 117.9, the specific form of financial distress early warning model can be given as in Eq. (117.3).

$$F = 0.236 - 0.178 X_1 + 0.195 X_2 + 0.610 X_3 + 1.139 X_4 \tag{117.3}$$

To clarify, the definitions of predictive variables in Eq. (117.3) are exactly the same as in Eq. (117.2).

4. Determine the discriminant standard

After reaching the early warning model, we need further determine the discriminant standard for financial distress. Based on Fisher's linear discriminant model [2, 9], the mean values of both groups can be calculated as F_1 and F_2 . The mean values of non-ST firm group and ST firm group are 0.254 and -2.260 respectively. According to the symmetry classification rule, the turning point F^* is the average value of F_1 and F_2 , so F^* is computed as $F^* = (F_1 + F_2)/2 = -1.0$.

Table 117.7 Eigenvalue and variance ratio of the MDA function

Function No.	Eigenvalue	Variance ratio	Accumulated ratio	Typical coefficient
1	0.585	100.0	100.000	0.608

Table 117.8 Significance test of the MDA function

Function	Wilks' λ	χ^2 - stats	Dof	Sig.
1	0.231	43.785	5	0.000

Table 117.9 MDA function coefficients

Independent	Predictive coefficient
X_1	-0.178
X_2	0.195
X_3	0.610
X_4	1.139
Constant	0.236

Table 117.10 Predictive accuracy of discriminant analysis model

Actual grouping	Predictive grouping	
	ST firm	Non-ST firm
ST firm	8	1
Non-ST firm	1	90

Following the discriminant standard, we can substitute the financial statement of listed real estate company into the early warning model denoted as Eq. (117.3). If the score F is greater than -1.0 , the company is financially healthy under normal status. On the contrary, if the score F is less than or equal to -1.0 , the company is classified into financially distressed company under poor financial status.

117.3.2 Reverse Test Using Sample Data

By substituting the original sample data into Eq. (117.3) to calculate F values, we can re-group the sample companies based on the discriminate standard (see Table 117.10).

Table 117.10 shows that, the predictive accuracy of financial distress for listed real estate companies reaches $R = (8 + 90)/(8 + 89 + 1 + 1) = 98\%$, and improves by 22% compared with the Z_0 model (76%). The result here indicates that the early warning model modified based on the MDA method can provide more accurate prediction for listed real estate companies than Z_0 model.

The model robustness is very important for financial distress prediction. In sought to test the robustness of our model, we use 2007 financial statement of the

Table 117.11 Robustness test based on predictive accuracy

Actual grouping	Predictive grouping	
	ST firm	Non-ST firm
ST firm	8	1
Non-ST firms	3	87

same 99 listed real estate companies, re-calculate its predictive accuracy, the result as shown in Table 117.11.

Seen from Table 117.11, the predictive accuracy $R = (8 + 87)/(8 + 87 + 1 + 3) = 96\%$. Thus, it can be concluded that, this model keeps its high accuracy for financial distress, and the robustness is testified.

117.4 Conclusions

This paper provides a financial distress early warning model applicable to listed real estate companies in China, by using the multiple discriminant analysis method to modify a baseline Z_0 model. The model established in this paper has provided higher forecast accuracy for financial distress than other models. In the context of deepening adjustments in real estate industry and fast-changing global economy, the model can help business managers and market investors to recognize the potential financial risks in listed real estate companies, so as to take actions at the earlier stage to prevent from running into the bankruptcy or considerable losses.

This paper is mainly focused on the application of financial distress early warning research to analyze the listed real estate companies in China. However, the specific mechanism of the financial distress generating in real estate companies is not completely covered in this paper, the government policy on property sales, for instance. The research in the future can make in-depth explorations into this issue based on the characteristics in real estate business model, financial operation and accounting system, so as to further improve the applicability of the financial distress early warning research in real estate companies.

Acknowledgement We are grateful to the research support from the National Natural Science Foundation of China (No. 71073096).

References

1. Beaver WH (1966) Financial ratios as predictors of failure. *J Account Res* 4:71–111
2. Altman E (1968) Financial ratios, discriminant analysis and the prediction of corporate bankruptcy. *J Financ* 23:589–609
3. Altman E, Haldeman R, Narayanan P (1977) ZETA analysis – a new model to identify bankruptcy risk of corporations. *J Bank Financ* 8:29–54

4. Ohlson J (1980) Financial ratios and the probabilistic prediction of bankruptcy. *J Account Res* 18:109–131
5. Zmijewski M (1984) Methodological issues related to the estimation of financial distress prediction models. *J Account Res* 22:59–82
6. Russ R, Wendy W, Alfred C (2009) The ALTMAN Z-score revisited. *J Int Financ Econ* 9:59–73
7. Zhou S, Yang J, Wang P (1996) Early warning analysis of financial distress – F score model. *J Account Res* 8:8–10 (in Chinese)
8. Zhang L (2000) Financial distress early warning determinant model. *J Quant Tech Econ* 3:49–51 (in Chinese)
9. Fisher RA (1936) The use of multiple measurements in taxonomic problems. *Ann Hum Genet* 7:179–188