



Logistic Model-based Prediction of Financial Distress of Listed Chinese Real Estate Companies

Yueru Chai^{1,†}, Yixin Gan^{2,†} and Yiou Wang^{3,*†}

¹Fudan University, Shanghai, 310000, China

²Shanghai International Studies University, Shanghai, 200000, China

³Southwestern University of Finance and Economics, Chengdu, 610000, China

†These authors contributed equally.

*wyo@smail.swufe.edu.cn

Abstract. With the introduction of restrictive housing price policies in China contemporarily, real estate companies are facing new development challenges. China Evergrande Group's debt crisis has made people emphasize more on the financial status of real estate companies. In this paper, 20 Chinese A-share companies facing financial distress and 20 companies without financial distress are selected as research samples. A total of 16 financial indicators and non-financial indicators are chosen to establish Logistic-based model. Finally, suitable early warning indicators were screened and a financial distress early warning model with high accuracy was derived. The percentage of administrative expenses has the greatest impact on whether a company is in financial distress, and real estate companies should strengthen their operating cost control. By analyzing the model of real estate companies, the company operators can pay attention to the problems that arise in the company's operation in advance and can take corresponding measures to avoid the company from falling into financial distress. Overall, these results shed light on guiding further exploration of enterprise financial distress forecast.

Keywords: Financial Distress Early Warning, Real Estate Companies, Logistic Model.

1 Introduction

Real estate has long occupied an important position in the national economy of various countries. Since China's real estate reform in 1998, China's enterprises in this industry have begun to show vigorous development momentum with the strong support of government policies. However, the international financial crisis in 2008 also brought a great shock to China's real estate industry, during which the sales and sales volume were greatly reduced, and many real estate enterprises also faced difficulties in capital turnover and liquidity shortage. After the financial crisis, the Chinese real estate market has also ushered in a turnaround, but the continuous rise in housing prices has attracted the attention of the government, and the introduction of a series of

© The Author(s) 2024

F. Balli et al. (eds.), *Proceedings of the 2023 2nd International Conference on Economics, Smart Finance and Contemporary Trade (ESFCT 2023)*, Advances in Economics, Business and Management Research 261, https://doi.org/10.2991/978-94-6463-268-2_17

policies to restrict housing prices has also brought new challenges to the development of real estate enterprises. Real estate enterprises are capital-intensive, with large demand for funds and long occupancy time, and slow recovery of funds, resulting in greater risks for enterprises. Although the house can be mortgaged as real estate, which alleviates the problem of funding sources to a certain extent, it also increases the financial risk of the enterprise.

In view of the important position of real estate enterprises in the national economy and the characteristics mentioned above, a suitable early warning model is particularly necessary. After analyzing the financial status of the enterprise through the corresponding financial distress early warning model, the upper management of the company is more aware of the problems in the company's operation, and strives to take corresponding measures to get the enterprise out of financial difficulties. Investors can also decide whether to invest and how much to invest. Therefore, it is of great practical significance to study the early warning model of financial difficulties of listed real estate companies.

Financial distress models can be categorized by the information used by the model and the modeling methods employed. Altman and others use conventional financial metrics, such as debt ratio, current ratio, return on equity, and asset turnover velocity, as variables in predictive models to predict financial distress [1]. Building on Gentry, Newbold, and Whitford's research, Aziz, Emanuel, and Lawson developed a model of cash flow information forecasting financial distress [2]. Beaver, a pioneer in the study of predicting financial distress using stock market yield information, found that in efficient capital markets, stock yields can predict bankruptcy just as well as financial indicators, but with a slight lag [3]. According to the modeling method, it can be roughly divided into statistical method, neural network method and SVM vector machine. For example, the logit model used by Ohlson, Alifiah, et al. [4], and the Probit model used by Cole and Gundher [5] are statistical models; Slavici [6] and Wu [7] adopted the BP neural network model; Mselmi uses the SVM vector machine approach [8].

There is little literature on the prediction of financial distress of domestic real estate enterprises, and Qiong use factor analysis to obtain common factors for indicators, so as to construct a logistic regression model for real estate enterprises [9]. Wang et al. adopted the revised KMV model to measure the credit risk of real estate enterprises and achieved better results [10].

There are many literature studies on early warning of financial difficulties at home and abroad, but many scholars are limited to traditional financial indicators in the selection of early warning variables, and financial indicators have limitations and are easily affected by human operations, and the release of financial statements has a lag, so the relevant financial variable data also lacks a certain timeliness. This paper introduces non-financial information variables (e.g., the company's equity structure, audit opinions and macroeconomic indicators into the early warning research of financial difficulties). It not only broadens the selection ideas of financial early warning variables, but also uses the model to detect whether there are deficiencies in equity structure, management governance and other aspects, guide the relevant departments of the company to effectively prevent from the source, formulate more reasonable and effec-

tive strategies, fundamentally ensure the healthy development of the company, and avoid potential financial distress risks. In addition, investors can also use the financial distress early warning model to conduct financial assessments. Suppliers and customers can also flexibly formulate commercial credit policies according to the early warning model and manage accounts reasonably and effectively.

This paper selects 40 listed real estate companies in China, and takes whether the listed companies are named ST or *ST as the measurement standard for whether they are in financial difficulties. Relevant financial indicators reflecting the solvency, growth ability and operating capacity of enterprises, as well as relevant non-financial indicators, including corporate governance indicators and macroeconomic indicators, were selected as independent variables of the model. For the financial and non-financial research indicators of the research sample during the research period, the Pearson correlation test was first passed to exclude the linear correlation of each index, and then the significance index of the two independent samples of ST and non-ST was obtained through the non-parametric test, and then the financial indicators obtained by the significance test were analyzed to find out the strongest explanatory variables, and the corporate governance and macroeconomic non-financial analysis indicators obtained by the non-parametric significance test were established Logistic financial distress early warning model, and bring test samples into the model, test the model accuracy, and finally draw conclusions. The rest of the paper is organized as follows. The Sec. 2 mainly introduces the empirical analysis of sample selection and variable determination to create a financial distress prediction model for listed real estate companies. In this paper, 20 indicators are preliminarily identified as explanatory variables from three aspects: traditional financial statements, corporate governance information and macroeconomic information, and the indicators are screened by the Mann-Whitney U test in the nonparametric significance test, and then the spearman test is carried out by the indicators that will pass the collinearity test, and the model is constructed with the screened indicators, and the constructed logistic model is tested by using the test sample. The Sec. 3 shows the limitations and prospect. The shortcomings of this paper and the future improvement directions are summarized. The Sec. 4 is the conclusion. The conclusions of this paper are summarized and management recommendations are provided for real estate listed companies.

2 Data & Method

In order to comprehensively evaluate and analyze the financial situation of real estate enterprises, a total of 13 indicators including five aspects of operating capacity, solvency, development capacity, profitability and cash flow capacity were selected as variables in this paper (seen from Table 1). Meanwhile, in order to examine the early warning effect of non-financial information on financial distress, three non-financial indicators, namely, equity concentration, Z-value and management expense ratio, were selected. Through Spearman's correlation test and nonparametric significance test, financial indicators that are both significantly different and helpful to improve

the prediction accuracy of the model are selected, and then the financial early warning model is constructed. Here, Y means whether the financial distress exists or not.

Table 1. Variable selection.

Financial Indicators	X_1 : Earnings per share
	X_2 : Net Asset Margin
	X_3 : Current Ratio
	X_4 : Quick Ratio
	X_5 : Gearing ratio
	X_6 : Cash flow interest coverage multiplier
	X_7 : Equity ratio
	X_8 : Earnings per share growth rate
	X_9 : Operating income growth rate
	X_{10} : Inventory turnover rate
	X_{11} : Accounts Receivable Turnover Ratio
	X_{12} : Ratio of cash from sales of goods and services to operating income
	X_{13} : Cash Ratio
Non-financial indicators	X_{14} : Shareholding Concentration
	X_{15} : Z-value
	X_{16} : Administrative expenses as a percentage

Table 2. Cointegration test of financial indicators.

	B	Std.	Beta	Sig.	VIF
(Constants)	0.142	0.256		0.581	
1.Earnings per share	-0.225	0.069	-0.314	0.002	1.674
2.Net Asset Margin	-0.008	0.007	-0.129	0.211	1.870
3.Current Ratio	-0.012	0.064	-0.031	0.856	5.043
4.Quick Ratio	0.553	0.204	1.412	0.008	48.197
5.Gearing ratio	0.002	0.004	0.071	0.649	4.258
6.Cash flow interest coverage multiplier	0.000	0.000	0.082	0.332	1.262
7.Equity ratio	0.008	0.020	0.053	0.670	2.784
8.Earnings per share growth rate	0.000	0.000	-0.263	0.004	1.422
9.Operating income growth rate	0.000	0.000	0.140	0.094	1.223
10.Inventory turnover rate	0.000	0.007	-0.007	0.947	1.968
11.Accounts Receivable Turnover Ratio	0.000	0.000	-0.018	0.836	1.314
12.Ratio of cash from sales of goods and services to operating income	9.370E-05	0.000	0.120	0.123	1.052
13.Cash Ratio	-0.545	0.192	-1.241	0.006	34.155

Table 3. Non-financial metrics covariance diagnosis.

	B	Std.	Beta	Sig.	VIF
(constants)	0.142	0.256		0.581	
1.Shareholding Concentration	-0.225	0.069	-0.314	0.002	1.674
2.Z-value	-0.008	0.007	-0.129	0.211	1.87
3.Administrative expenses as a percentage	-0.012	0.064	-0.031	0.856	5.043

3 Results & Discussion

For financial indicators, according to the results of Mann-Whitney U test under non-parametric test, X_5 gearing ratio, X_7 equity ratio, X_{10} inventory turnover ratio, and X_{12} ratio of cash to operating income from sales of goods and services with significance level > 0.05 are the same as the dependent variable distribution and should be excluded. Follows a table, figure, equation etc. does not have an indent, either. As shown in Table 2, for financial indicators, according to the test of multicollinearity between independent variables, X_4 quick ratio and X_{13} cash ratio with tolerance < 0.1 and $VIF > 10$ have multicollinearity and should be excluded.

As shown in Table 3, for the non-financial indicators, according to the test of multicollinearity between independent variables, there is no serious multicollinearity and all are retained. For the non-financial indicators, according to the results of Mann-Whitney U test under the non-parametric test, the significance level of shareholding concentration and Z value > 0.05 are the same as the dependent variable distribution and should be excluded. After the nonparametric test to test for covariance, eight early warning indicators, including seven financial indicators and one non-financial indicator, were finally identified. The final indicators are listed in Table. 4.

Table 4. Final warning indicators.

Financial Indicators	X_1 : Earnings per share
	X_2 : Net Asset Margin
	X_3 : Current Ratio
	X_6 : Cash flow interest coverage multiplier
	X_8 : Earnings per share growth rate
	X_9 : Operating income growth rate
	X_{11} : Accounts Receivable Turnover Ratio
Non-financial indicators	X_{16} : Administrative expenses as a percentage

After Spearman's test it can be seen that the indicators are not significantly correlated with each other and can be used to build the model. The functional expression of the logistic model is given by

$$\text{logit}(p) = \beta_0 + \beta_1 X_1 + \dots + \beta_n X_n \tag{1}$$

According to the above expression, it is obtained that

$$P = \frac{e^{\beta_0 + \beta_1 X_1 + \dots + \beta_n X_n}}{1 + e^{\beta_0 + \beta_1 X_1 + \dots + \beta_n X_n}}, 1 - P = \frac{1}{1 + e^{\beta_0 + \beta_1 X_1 + \dots + \beta_n X_n}} \quad (2)$$

Here, P denotes the probability that a listed real estate company is in financial distress, and 1-P denotes the probability that a listed real estate company is not in financial distress. For the critical value of P, we choose a wide range of 0.5. If P>0.5, the company is considered to be in financial distress; if P<0.5, the company is not considered to be in financial distress.

Table 5. Parameter estimation of logistic model.

		B	Std.	Sig.	Exp(B)
Step 1 ^a	X ₁	-.668	.677	.324	.513
	X ₂	-.581	.187	.002	.559
	X ₃	.037	.311	.906	1.037
	X ₆	.001	.002	.414	1.001
	X ₈	.000	.001	.797	1.000
	X ₉	.006	.003	.013	1.006
	X ₁₁	.000	.000	.860	1.000
	X ₁₆	3.179	2.004	.113	24.012
Constants		-.711	.553	.199	.491

a. Variables entered in Step 1: Earnings per Share, Net Asset Margin, Current Ratio, Cash Flow Interest Coverage Multiple, Earnings per Share Growth Rate, Operating Income Growth Rate, Accounts Receivable Turnover Ratio, and Administrative Expense Ratio.

Table 6. Accuracy of Logistic Model.

Actual test			Predictions		
			Is it in financial distress or not		Percent correct
			0	1	
Step 1	Is it in financial distress or not	0	53	7	88.3
		1	12	48	80.0
	Overall percentage				84.2

The logistic regression model can be derived from Table 5 as

$$Y = -0.711 - 0.668X_1 - 0.581X_2 + 0.037X_3 + 0.001X_6 + 0.006X_9 + 3.179X_{16} \quad (3)$$

The logistic regression model shows that X₁ earnings per share and X₂ net asset margin is negatively correlated with the probability of financial distress of the company P, indicating that the higher the earnings per share and the higher the net asset

margin, the less likely the company is to be in financial distress. X_3 current ratio and X_6 cash flow interest coverage multiple have little effect on the prediction model, while X_2 Net Asset Margin, X_9 Operating income growth rate and X_{16} overhead expense ratio significantly affect the prediction model. As shown in Table 6, in order to test the accuracy of the logistic early warning model, this paper substitutes the samples of 20 ST companies and 20 non-ST companies for the previous three years into the model for testing. It can be concluded that the model has a prediction accuracy of 84.2% for real estate listed companies, which is feasible for practical application.

4 Limitations & Prospects

Nevertheless, this study has some shortcomings and drawbacks. Only listed real estate companies were selected as the research sample while ordinary real estate companies were not. This paper fails to construct an early warning system that includes non-listed companies and thus is not applicable to the whole real estate industry. This paper has analyzed empirically on the data of A-share listed companies in the real estate industry and achieved good results, but it has not studied non-listed companies because of the difficulty in obtaining data. Since non-listed companies, especially some small and medium-sized enterprises, exert an important influence on the national economy, it is also necessary to study them. Additionally, it cannot be avoided that managers and boards of directors of enterprises may manipulate financial data as a means to control or adjust the accounting earnings information reported to reach the goal of maximizing their own interests. These possible operations may have some influence on the reliability of the model built. For the subsequent outlook, the number of non-listed companies is equally large in China and their contribution to the economy should not be underestimated. The way to combine the methods proposed in this paper to provide financial risk warning for non-listed real estate companies will be a topic to be considered and in the future study.

5 Conclusion

For China's listed real estate companies, the logistic-based financial distress early warning model constructed in this paper has high applicability and can be a good alarm for A-share real estate companies facing financial anxiety. When it comes to the index system, financial and non-financial indicators are selected in this paper, which reflect the company's situation in a more comprehensive way. From the model, it can be concluded that net asset margin has the greatest influence on whether the real estate listed companies will fall into financial distress, following operating income growth rate and overhead expense ratio. The companies should expand sales, save cost, and rationally allocate investment. In addition, companies can strengthen the operating cost control and improve the management efficiency. Real estate listed companies can prevent financial crisis in the following four aspects. First of all, it is necessary to establish a complete internal control system. The root cause of the company's financial difficulties is its own poor management, and effective internal control

can improve the problems in the internal management of the company. The internal control system needs to include five parts. A sound company system: the job description and responsibilities should be elaborated to oil the work and management process. Organizational control: organizational control should stipulate labors' responsibility and relationships and arouse members' enthusiasm. There are four control methods: simple control, technical control, bureaucratic control, and cultural control. Budget control: it involves three parts, control standard in advance, control process in the matter and control finance after the matter. Risk prevention control: identify enterprise's long-term and short-term risks and establish corresponding risk management systems to avoid the risks. Property preservation control: only authorized personnel can have access to enterprise's property and properties should be counted periodically.

In addition, one needs to strengthen cash flow management control of real estate enterprises. First, strengthen the management of cash flow from operating activities. In terms of cash income management, the sales progress should be accelerated and various measures should be adopted to collect accounts receivable after the products are sold out. Adopt various payment methods for promotion to make the development funds return as expected and abate the financial risks. In terms of cash payment management, companies should postpone the time of down payment for land purchase and reasonably stretch out subsequent payments. Rely on the construction unit to advance funds and get part of the payment only when the construction progress reaches 50% or more. In addition, strengthen the cash flow management of financing activities. In the process of development of real estate enterprises, there is a significant demand for capital, and the funds raised through fund-raising activities are the main source for real estate enterprises. In order to ensure the funds to support company's operation and development, it is necessary to constantly broaden the financing channels. In addition to bank loans, the introduction of investment funds and access to the stock market financing to raise funds are options for companies.

Besides, it is suggested to establish a comprehensive early warning system. The operation process of large-scale enterprises is not comprehensive only through the subjective judgment of the company's management to grasp the various situations of the company. Not to mention the operation of complex real estate listed companies with a high degree of correlation with other enterprises. Therefore, in order to fully grasp the overall situation of the company and avoid falling into financial crisis, it is necessary to establish a comprehensive enterprise early warning system to assist in the company management and help monitor the company's operation. The company's internal control system, financial budget system, financial system and financial early warning model are linked together to establish a comprehensive early warning system for the company, which is used to measure the company's management level, operation, capital, and financial situation on a regular basis. On the one hand, the establishment of a comprehensive early warning system can help managers identify problems in a timely manner to avoid them. On the other hand, it provides information support for managers' decisions to prevent financial difficulties caused by decision-making mistakes.

Moreover, it needs to strengthen the prevention and reaction speed to the changes of external environment. China's real estate industry is greatly affected by changes in the external environment. Various factors, such as economic factors, social and cultural factors, political and legal factors, and natural factors, have different impacts on real estate enterprises' development and operation, and the impact of political factors is particularly prominent in today's Chinese market environment. The adjustment of industrial structure, the change of land policy is bound to affect China's real estate market, which is both an opportunity and a challenge for the real estate industry. This requires real estate companies to establish corresponding linkage mechanisms to strengthen the prediction of changes in the external environment while speeding up the reaction speed to changes in the external environment.

References

1. Altman, E. I., Haldeman, R. G., Narayanan, P.: ZETATM analysis A new model to identify bankruptcy risk of corporations[J]. *Journal of banking & finance*, 1(1), 29-54 (1977).
2. Aziz, A., Emanuel, D. C.: Lawson G H. Bankruptcy prediction-an investigation of cash flow based models. *Journal of Management Studies*, 25(5): 419-437 (1988).
3. Beaver, W. H.: Alternative accounting measures as predictors of failure. *The accounting review*, 43(1), 113-122 (1968).
4. Ohlson, J. A.: Financial Ratios and the Probabilistic Prediction of Bankruptcy. *Journal of Accounting Research* 1, 109-131 (1980).
5. Cole, R. A., Gunther, J. W.: Predicting Bank Failures: A Comparison of On- and Off-Site Monitoring Systems. *Journal of Financial Services Research*, 13(2), 103-117 (1998).
6. Slavici, T., Maris, S., Pirtea, M.: Usage of artificial neural networks for optimal bankruptcy forecasting. Case study: Eastern European small manufacturing enterprises. *Quality & Quantity*, 50, 385-398 (2016).
7. Wang, L., Wu, C.: A combination of models for financial crisis prediction: integrating probabilistic neural network with back-propagation based on adaptive boosting. *International Journal of Computational Intelligence Systems*, 10(1), 507-520 (2017).
8. Mselmi, N., Lahiani, A., Hamza, T.: Financial Distress Prediction:The Case of French Small and Medium-sized Firms. *International Review of Financial Analysis*, 50, 67-80 (2017).
9. Kuang, Q.: Research on Enterprise Financial Warning Based on Logistic Model: Taking Real Estate Enterprises as an Example. *China Business Review*, 29, 112-113 (2016).
10. Wang, H., Zhang, G.: The Application of KMV Model in Credit Risk Measurement of Listed Real Estate Enterprises in China. *Economic Issues*, 463(03), 36-40 (2018).

Open Access This chapter is licensed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (<http://creativecommons.org/licenses/by-nc/4.0/>), which permits any noncommercial use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.

The images or other third party material in this chapter are included in the chapter's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.

