

Does the Financial Status of Company Affect the Bond Credit Rating?

—Empirical Evidence from China's Shanghai and Shenzhen Stock Exchanges

Yuyan Cai

School of Finance, Anhui University of Finance and Economics, Bengbu 233030, Anhui Province, China

Abstract: This article takes the companies that publicly issued corporate bonds on the Shanghai and Shenzhen Stock Exchanges from 2006 to 2018 as the research objects selecting six aspects that comprehensively reflect the 17 financial variables in 6 aspects: profitability, operating ability, bond repayment ability, development ability, cash flow and market value of the company. Principal component analysis method and factor analysis method are used to extract the principal factors of these financial indicator variables. That is how an ordered multi-classification Logistic regression model is constructed to test the impact of the Shanghai and Shenzhen Stock Exchanges' financial status on the corporate bond credit rating. It turns out that the financial status of the Shanghai and Shenzhen Stock Exchanges have an important impact on the credit rating of corporate bonds. The financial status has a greater impact on corporate bonds with credit ratings of A- and AA-, while it has a smaller impact on corporate bonds with credit ratings above AA. The results of this article can help individual and institutional investors prevent risks from investing.

Keywords: Corporate finance; Credit rating; Factor analysis; Ordered multi-classification Logistic model

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***Corresponding author:** Yuyan Cai, 1085262709@qq.com

1 Introduction

As the most promising group in the economic

development of our country, companies on the Shanghai and Shenzhen Stock Exchanges are the cornerstones of the stock market. The bond credit rating results directly reflect the company's financial status which will directly affect the development of the securities market and the interests of investors. However, due to the irregular securities market in our country, the company's financial fraud and damage to the interests of financial institutions and creditors have been keep emerging. It is common for companies to be specially treated due to abnormal financial conditions. For example, Shandong Molong Petroleum Machinery Co., Ltd. (Shandong Molong for short) has "turned losses into profits" in quarterly and semi-annual reports for two consecutive years through deliberately inflated prices and understated costs, with the highest artificially inflated revenue at 100 million yuan, and artificially inflated profits up to 220 million yuan. In September 2017, the China Securities Regulatory Commission imposed administrative penalties on it.

How to evaluate, measure and supervise the credit risk of corporate bonds is an important mission of the Chinese Securities Regulatory Commission, which is also an issue that concerns many investors. Early bond credit rating research methods mainly include factor analysis method, multivariate discriminant model method, multiple regression method and analytic hierarchy process. The bond credit rating methods widely used in modern times include weighted halving method, fuzzy evaluation method and two-dimensional judgment analysis method for multivariate credit risk. There is a certain

correspondence between credit rating and default rate (Altman, 2000)^[6], which means that there is a certain correlation between credit rating and credit risk. Credit risk analysis methods have shifted from subjective judgment analysis and traditional financial ratio scoring methods to dynamic measurement analysis methods of multivariate and scientific software combined with theories (Zhang Ling et al., 2000)^[6]. The magnitude of credit risk mainly depends on the financial status and risk status of the counterparty (Wang Chunfeng, 2001)^[6]. For example, some scholars use a risk discriminant model of multivariate credit to select 5 financial ratios with the most predictive power from 22 financial ratios constituting the Z-value model (Altman, 1968)^[5]. However, the revised Zeta model is widely used commercially. The company's financial status is affected by various factors from external and internal environments, which has a great impact on bond credit. If the bond rating methods improves, our country's corporate bond rating industry will have a brighter future. And the rigorous and accurate rating results can truly embody the financial risks of bond issuers (Duan Anqi, 2016)^[3]. We can objectively understand the company's financial status by credit rating on corporate bonds, protecting the interests of investors, providing a reference for the government and banks to formulate policies. Some scholars have found that the Logistic regression does not have many assumed conditions and is more realistic. It gains popularity among scholars (Ohlson, 1980)^[7]. In addition, the Logistic model has little assumed conditions about the distribution of variables, which is more suitable for Chinese current situation. It can better predict the rating results (Li Jian, 2013)^[4]. This article introduces and applies the multiple ordered variable Logistic model to test the influence of the financial ratio reflecting the company's financial status on the bond credit rating. We hope to provide a reference for the supervisors, creditors and investors of the Securities Regulatory Commission and exchanges. This article is divided into four parts. The second part introduces the Logistic regression model and variable selection in this article; the third part is test of real evidence and result analysis; the fourth part is the conclusion.

2 Introduction of the multiple ordered variable Logistic model

Since the credit rating of the dependent variable selected in this article is a multi-classification variable, the Logistic model is a generalized linear model that the dependent variable is a categorical variable. It does not have as many assumed conditions as multiple linear regression, needless to require the variables to meet normal distribution or equal variance with low requirements for data and strong versatility. So, this article uses the Logistic regression model:

$$P(y = j | x) = \frac{1}{1 + e^{-(\alpha + \beta X)}}$$

Explanations: X_i represents the i indicator, while y represents the probability that the company's credit belongs to a certain level. Each level of is assigned a value starting from 1, (where the credit level A is represented by 1, and the credit level AA- is represented by 2. By analogy, 5 means that the credit rating is AAA).

A cumulative logistic model is established:

$$\text{Logit}(P) = \text{Ln} \left[\frac{P(y \leq j)}{P(y \geq i+1)} \right] = \alpha_j + \beta X$$

Explanations: $P_j = P(y = j)$, $j = 1, 2, \dots, 7$; $(X_1, X_2, \dots, X_7)^T$ represents a set of independent variables; β is a set of regression coefficients α_j intercept corresponding to X . After obtaining the parameter estimation of α_j and β , the probability of occurrence of a certain situation (for example: $y=j$) can be obtained by the following equation:

$$P(y \leq j | x) = \frac{e^{-(\alpha_j + \beta X_i)}}{1 + e^{-(\alpha_j + \beta X)}}$$

3 Analysis of real example

3.1 Selection of samples and variables

This article selects companies on the Shanghai and Shenzhen Stock Exchanges that issued public bonds and rated bonds from 2006 to 2018 as the samples. Financial indicators and corporate information are from the databases of Fung Huashun and Guo Taian. The bond credit rating uses the bond rating announcements issued by the companies, according to AAA=5, AA+=4, AA=3, AA-=2, A-=1 assignment.

This article refers to the profitability, operating ability, loan repayment ability, and development ability indicators adopted by domestic research institutes. It adds cash flow and market value indicators thereafter. The financial variables selected in this article are 17 which are divided into 6 groups. The financial data is selected from the annual report of last year because the financial data before the credit rating can better reflect the impact of financial data on the bond credit rating. The annual data is more representative, deleting samples with missing data. The explanatory variables selected in this paper are shown in Table 1, with descriptive statistics shown in Table 2.

Profitability index: return on net assets = net profit/average net assets \times 100%. The higher the value, the higher the company's investment income ability. Main business ratio = main business profit/total profit \times 100%. The higher the value, the more stable the corporate revenue.

Operational capability indicators: total asset turnover ratio = total sales revenue/ total average assets \times 100%. The higher the value, the stronger the company's ability to operate. Inventory turnover rate = operating cost/average inventory \times 100%. The higher the index, the stronger the company's operating capabilities. Turnover rate of total assets = sales revenue / average accounts receivable \times 100%. The higher the value, the stronger the company's operating capabilities.

Loan repayment capacity indicator: Asset-liability ratio = total liabilities/total assets \times 100%. The lower

the value, the stronger the solvency of the company. Earned interest multiple = total profit before interest and tax / interest expense or = (net profit + interest expense + income tax expense) / interest expense. The higher the value, the stronger the long-term solvency of the company. Current ratio = total current assets/total current liabilities \times 100%. The higher the value, the stronger the company's short-term debt repayment ability. Quick ratio = quick assets/current liabilities \times 100%.

Development ability indicator: growth rate of total assets = total liabilities / total assets \times 100%. Operating profit growth rate = this year's operating profit growth amount / last year's total operating profit \times 100%. The higher the value, the stronger the company's future development capabilities.

Cash flow indicator: percentage of net cash flow from operating activities = subtotal of cash inflows from operating activities - subtotal of cash outflows from operating activities. Cash ratio = (monetary fund + valuable securities) \div current liabilities \times 100%. The higher the value, the stronger the liquidity. Cash flow ratio = net cash flow from operating activities/ current liabilities at the end of the period.

Trading value indicator: earnings per share = profit after tax/total share capital \times 100%. Net cash flow per share = net cash flow from operating activities/total common stock at the end of the year. Current ratio = net cash flow from operating activities/total equity \times 100%.

Table 1. Financial indicator system of corporate bond credit rating of Shanghai and Shenzhen Stock Exchange

First-grade indicator	Second-grade indicator
Profitability indicator	Net assets returns ratio X_1
	Primary business ratio X_2
	Turnover of total assets X_3
Operational capacity indicator	Turnover of inventory stock X_4
	Turnover of receivable accounts X_5
	Assets liabilities ratio X_6
Loan repayment ability indicator	Times interest earned ratio X_7
	Liquid ratio X_8
	Quick ratio X_9
Development capacity indicator	Total assets increase ratio X_{10}
	Business profit increase ratio X_{11}
	Percentage of net cash flow from operating activities X_{12}
Cash flow indicator	Cash ratio X_{13}
	Cash flow ratio X_{14}
	Revenue per share X_{15}
Marketable value indicator	Net cash flow per share X_{16}
	Net cash flow per share from operating activity X_{17}

Table 2. Statistical description of dominant variables

Variable	Obs	Mean	Std. Dev.	Min	Max
Y	2147	3.946	0.874	1	5
X1	2,147	10.014	9.435	-124.346	68.029
X2	2,147	73.913	129.571	-3307.876	1764.765
X3	2,147	0.506	0.496	0.000	4.845
X4	2,147	46.113	1098.635	0.008	49866.040
X5	2,147	139.667	1043.174	0.396	21401.960
X6	2,147	61.952	16.231	3.633	95.173
X7	2,147	49.928	369.831	-15.614	5299.594
X8	2,147	1.507	1.193	0.146	23.0006
X9	2,147	0.788	0.874	0.0639	22.452
X10	2,147	35.277	239.523	-37.010	7455.708
X11	2,147	33.069	304.351	-4668.066	5132.314
X12	2,138	-12057.650	230599.200	-4355200	249605.800
X13	2,147	42.038	60.500	1.672	1642.475
X14	2,147	0.091	0.281	-3.016	2.173
X15	2,147	0.525	0.370	-0.802	6.510
X16	2,147	0.333	0.847	-4.369	7.921
X17	2,147	0.294	0.853	-6.680	8.152

3.2 Results and analysis of model

3.2.1 Results and analysis of factors and principal component

First of all, this article uses factor analysis to reduce the dimensionality of the indicators, replacing all indicator variables with a few factors for multivariate ordered logistic regression, which can reduce the

workload and ensure the low correlation between the variables used for regression. The sample was analyzed using the factor analysis method in the STATA statistical software package. Table 3 shows that the KMO statistic is 0.675, greater than 0.5, and $P < 0.05$, which is suitable for factor analysis.

Table 3. KMO detection

Chi-square	9001.824
Degrees of freedom	136
p-value	0.000
Kaiser-Meyer-Olkin Measure of Sampling Adequacy	
KMO	0.675

Secondly, factor analysis was performed on all variables. When the characteristic root is greater than 1, we extracted a total of 6 principal component factors to replace the original 17 financial ratio indicators. These 6 principal component factors

contain 57.33% of the original indicator information. The accumulated contribution rate is 57.33%, that is, the ability to explain the original financial information is 57.33%. The results are shown in Table 4:

Table 4. Explanation of total variance

Component	Primary characteristic value			Extracted loading sum of square			Rotated loading sum of square		
	Sum	Variance percentage	Accumulation %	Sum	Variance percentage	Accumulation %	Sum	Variance percentage	Accumulation %
X1	2.928	17.225	17.225	2.928	17.225	17.225	2.918	17.163	17.163
X2	2.017	11.863	29.088	2.017	11.863	29.088	1.907	11.216	28.378
X3	1.559	9.169	38.257	1.559	9.169	38.257	1.523	8.956	37.335
X4	1.214	7.141	45.398	1.214	7.141	45.398	1.342	7.894	45.228
X5	1.021	6.004	51.402	1.021	6.004	51.402	1.032	6.072	51.300
X6	1.008	5.929	57.331	1.008	5.929	57.331	1.025	6.031	57.331
X7	.986	5.797	63.128						
X8	.979	5.758	68.887						
X9	.968	5.692	74.579						
X10	.913	5.370	79.949						
X11	.866	5.096	85.045						
X12	.717	4.219	89.264						
X13	.584	3.434	92.698						
X14	.539	3.169	95.867						
X15	.412	2.421	98.288						
X16	.197	1.157	99.445						
X17	.094	.555	100.000						

According to the factor loading matrix (Table 5), it can be concluded that the current ratio and quick ratio in principal component 1 representing the loan repayment ability of the enterprise play a leading role, indicating that principal component 1 mainly represents the debt-paying capacity of the enterprise. The most representative indicator is X9 (quick ratio). The return on equity and main business ratio in principal component 2 represents the profitability of the company, whose financial indicators play a leading role. It refers that principal component 2 mainly represents the profitability of the company, with X1 as the most representative indicator (return on equity rate). The financial indicators of earnings per share, net cash flow per share, and net cash flow generated by operating activities per share in the main component 3 represents the value of corporate in the market, and they play a leading role. It indicates that the main component 3 mainly represents the market value of the company, in which the representative indicator is X17 (net cash flow from operating activities per share). The financial indicators in principal component 4 of total asset growth rate and operating profit growth rate representing the company's development capability play a leading

role, indicating that principal component 4 mainly represents the company's development capability, and the representative indicator is X11 (operating profit growth rate). In the principal component 5, the financial indicators of the net cash flow ratio, cash ratio and cash flow ratio from operating activities that represent the company's cash flow play a leading role. It indicates that the principal component 5 mainly represents the company's debt-paying capacity, with X12 as the most representative index (proportion of net cash flow from operating activities). In the principal component 6, the financial indicators of total asset turnover, inventory turnover and accounts receivable turnover, which represent the company's operating capabilities, play a leading role. It means that principal component 6 mainly embodies the company's operating capabilities, among which X4 (stock turnover rate) is the representative indicator.

Therefore, the representative explanatory variables that finally enter the model are return on net assets X1, inventory turnover rate X4, quick ratio X9, operating profit growth rate X11, percentage of net cash flow generated by operating activities X12, and net cash flow generated by operating activities per share X17.

Table 5. Factors loading matrix

Rotated component matrix	component					
	1	2	3	4	5	6
X1	-0.021	0.322	0.065	0.356	0.057	0.028
X2	-0.012	0.078	0.085	0.405	0.037	-0.174
X3	-0.028	0.031	0.246	0.255	0.052	-0.098
X4	0.024	0.019	0.079	0.021	0.115	0.727
X5	-0.007	0.015	-0.001	0.099	0.595	-0.462
X6	-0.205	0.041	-0.254	-0.065	0.038	0.027
X7	-0.005	0.363	-0.091	-0.296	-0.08	-0.051
X8	0.301	0.036	-0.151	0.018	0.043	-0.071
X9	0.324	0.033	-0.005	-0.007	-0.006	0.002
X10	0.002	0.024	-0.064	0.193	-0.584	-0.132
X11	0.008	0.065	-0.002	0.375	-0.341	0.08
X12	0.007	0.032	-0.178	0.162	0.309	0.391
X13	0.315	0.04	0.015	-0.029	0.013	-0.005
X14	0.012	0.04	0.508	-0.102	0.002	0.047
X15	-0.026	0.332	0.012	0.123	0.172	0.111
X16	-0.017	0.344	-0.137	-0.254	-0.1	-0.091
X17	-0.024	0.107	0.394	-0.266	-0.049	-0.014

3.2.2 Results and analysis of multivariate ordered Logistic model

It can be seen from Table 6 that X4, X9, X11, X12 are negatively correlated with credit ratings, among which X9 and X12 are significantly negatively correlated with credit ratings; X1 and X17 are significantly positively correlated with credit ratings. It means that X1, X9, X12 and X17 have a significant impact on the credit rating of a company,

which shows that the company's financial status has an important impact on the bond credit rating. Among them, the company's development capability, market value are positively correlated with credit rating. As the company's development capability and market value increase, bond credit ratings tend to be higher. This is consistent with the rating results of domestic credit rating companies. This illustrates the effectiveness of the model to a certain extent.

Table 6. Results of multiple ordered logistic regression model

	Assumption	Standardized mistakes	Ward	Degree of freedom	Significance	95% confidence interval		
						Lower limit	Upper limit	
Threshold	Credit rating=1	-8.161	0.932	76.656	1	0.000	-9.988	-6.334
	Credit rating=2	-4.999	0.231	466.507	1	0.000	-5.453	-4.545
	Credit rating=3	-0.795	0.078	103.942	1	0.000	-0.948	-0.642
	Credit rating=4	0.349	0.077	20.508	1	0.000	0.198	0.501
Position	X1	-0.010	0.004	5.257	1	0.022	-0.019	-0.001
	X4	-4.10E-05	4.67E-05	0.771	1	0.38	0.000	5.05E-05
	X9	-4.07E-01	0.055	55.175	1	0.000	-0.515	-0.300
	X11	-3.63E-06	0.00E+00	0.001	1	0.978	0.00E+00	0.00E+00
	X12	-1.24E-05	6.05E-06	4.219	1	0.040	-2.43E-05	-5.69E-07
	X17	0.344	0.055	38.588	1	0.000	0.236	0.453

4 Conclusion

The article takes the companies that publicly issued corporate bonds on the Shanghai and Shenzhen Stock Exchanges from 2006 to 2018 as the research object, selecting the corporate bond credit rating and the corresponding company's important financial ratios. We use principal component analysis and factor analysis methods to extract main factors from financial indicator variables. An ordered

multi-classification Logistic regression model was constructed to test the impact of the financial status of Shanghai and Shenzhen Stock Exchange on the corporate bond credit rating. The results from real examples show that the financial status of the corporates in Shanghai and Shenzhen Stock Exchange has a significant impact on the credit rating of corporate bonds. It has a great impact on the credit ratings of corporate bonds below AA,

while it has little influence credit ratings of corporate bonds above AA. In the process of establishing and applying model, it can be completed with the help of significantly operatable STATA statistical software; The model has no specific requirements for sample variables. Most of the company's financial data does not confine to the multivariate normal distribution and the homoscedasticity, so the model has a wide range of applications with a promising prospect.

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