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The Empirical Analysis of Optimal Capital Structure of the Equipment Manufacturing Industry Listed Companies

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Abstract

In view of the bias of panel data model set can lead to misjudgment to the relationship between enterprise value and the capital structure, this article uses nonparametric method to study the relationship between them, adjusts variables in the model. The article evaluates the optimal capital structure of listed companies of the equipment manufacturing industry in our country Based on financial data from 2006 to 2013, analyzes from the Angle of enterprise value and agency cost respectively,. The results show that, The relationship between enterprise value and capital structure is inverted u-shaped, there exists a maximum asset-liability ratio in enterprise value. And the relationship between agency cost and capital structure present u-shaped roughly, there is a minimum asset-liability ratio in agency costs, there is a reasonable capital structure interval when asset-liability ratio is in range (32.87%, 58.21%).

Keywords: *equipment manufacturing industry, enterprise value, capital structure, panel data model*

1. Introduction

Scholars confirmed the existence of the optimal capital structure from different angles after American economist, Durand Davi, put forward the theory of capital structure since 1952, and studied the influence factors of enterprise capital structure. These factors include: enterprise characteristic, corporate governance, industry factor, institutional factor and macroeconomic factors. But thus capital structure research for the equipment manufacturing industry specifically is not much, and the research methods are limited to simple multivariate linear regression model. Such as: Jie Liang(2010) analyzed the influence factors of the capital structure of the equipment manufacturing industry in Liaoning province [1], Yangpeng Jiang (2013) analyzed the capital structure influencing factor of the equipment manufacturing industry of listed companies using the multivariate regression model [2]. They also study the relationship between capital structure and enterprise value from the perspectives of enterprise value or enterprise performance individually on the choice of the optimal capital structure decision-making method [3]. It is difficult to analysis the advantages and disadvantages of a single method. Due to the capital structure not only affects enterprise value, but also have a large impact on the agency cost, so we deem that enterprises with the optimal capital structure should be able to realize the enterprise value maximum and agency cost lowest [4]. Therefore, in order to make up the lack of a single research method, the enterprise value is the main research angles and the agency cost is as risk threshold judgment.

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2. Variable Selection and Data Sources

2.1 The Selection of Variable

Enterprise value gets to maximum when the enterprise achieved to the optimal capital structure in the perspective of the enterprise value. So we put the enterprise value y_1 as explained variable, capital structure x_1 as the main explanation variable, add control variables which have important influence on enterprise value indicators: enterprise scale x_2, enterprise growth x_3, and operating level x_4. Agency cost gets to minimum when the enterprise achieved to the optimal capital structure in the perspective of the agency cost. So we put the agency cost y_2 as explained variable, capital structure x_1 as the main explanation variable, add control variables as follows: enterprise scale x_2, enterprise growth x_3, and ownership concentration x_5.The variables are summarized as follows according to the above two research perspectives:

Table 1. The Specific Variable Selection

	From the perspective of enterprise value	From the perspective of agency cost
The explained variable	the rate of return on equity	Mfee
the main explanation variable	asset-liability ratio	asset-liability ratio
control variables	Natural logarithm of enterprise size	Natural logarithm of enterprise size
	MBGR	MBGR
	total assets turnover	proportion of shareholding of large shareholder's in the top ten

2.2 Sources of Data

According to the variable selection, the sample data on the equipment manufacturing industry of listed companies are derived from the WIND financial database and the public financial statements of listed companies. Considering the data of listed companies of early year is lack, and balanced panel data model is used, therefore we select persistent equipment manufacturing enterprises (2006-2013) as the object of study, and select by the following principles: (1) reject the company of poor financial condition with ST、ST*.(2) Weed out the company asset-liability ratio is beyond normal range (0-1) between 2006 and 2013. (3) To ensure the data integrity of each section in 2006-2013, excluding listed companies with incomplete data. In the end, we select 73 companies of the equipment manufacturing industry listed as samples for research.

3. The Empirical Test and Analysis Results

3.1 The Optimal Capital Structure of Equipment Manufacturing Industry Listed Companies in the Perspective of the Enterprise Value

1. Judgment of the relationship between enterprise value and capital structure

Considering the data type is panel data, we select nonparametric fixed effect panel data model to explore the initial relationship between enterprise value and capital structure based on local linear estimation [5]. The model is shown below:

$$y_{1,it} = \alpha_i + m\left(x_{1,it}\right) + u_{it} \quad i = 1,2,\ldots,173; t = 1,2,\ldots,8$$

Among them, $y_{1,it}$ is net assets profit. As the representation of the enterprise value indicators, $x_{1,it}$ is asset-liability ratio for the company, on behalf of the company's capital structure [6]. When we estimate the asset-liability ratio's border effect $\square_{FE\cup} x_{1\cap}$, on the net assets profit, considering the influence of window width on the result of nonparametric estimation, give estimates of border effect when a=0.1，a=0.15，a=0.2.

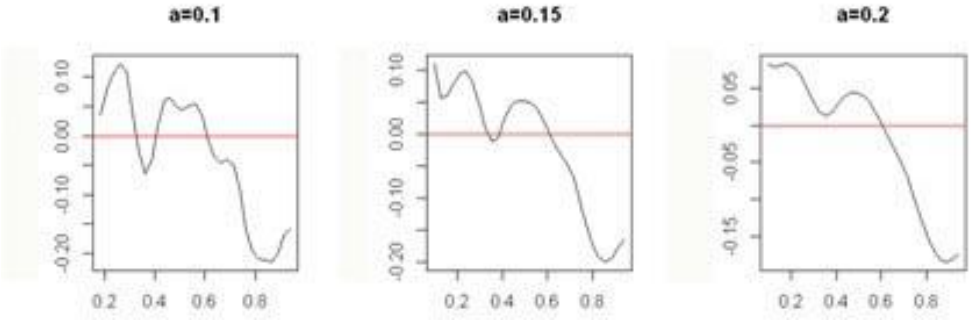

Figure 1. The Marginal Effects of Asset-Liability Ratio on Net Assets Profit

Figure 1 is a estimates point by point under the different window width to $\square_{FE\cup} x_{1\cap}$ Specific to the equipment manufacturing industry all the asset-liability ratio of listed companies, partition 30 equal interval between minimum and maximum, estimate each such point as $\square_{FE\cup} x_{1\cap}$ connect it with a smooth curve. As you can see from the picture, we can divide $\square_{FE\cup} x_{1\cap}$ into two paragraph on the basis of whether it greater than 0. When x_1 is smaller, $\square_{FE\cup} x_{1\cap} \triangleright 0$ is existing. When x_1 is bigger $\square_{FE\cup} x_{1\cap} \triangleleft 0$. Therefore, the relationship between net asset-liability ratio and asset-liability ratio of equipment manufacturing industry of listed companies assume inverted u-shaped curve roughly.

2. The traditional construction of panel data model

Based on the preliminary analysis to the relationship between net assets profit and capit al structure, the following will join the squared of asset-liability ratio when modeling in p anel data model to depict the relationship that there may be inverted u-shaped curve. At th e same time add the control variables, such as enterprise scalex_2, enterprise growth x_3, ope ration level in dexes x_4, to format panel data model:

$$y_{1,it} = \alpha_i + \beta_{1,i} x_{1,it} + \beta_{2,i} x_{1,it}^2 + \beta_{3,i} x_{2,it} + \beta_{4,i} x_{3,it} + \beta_{5,i} x_{4,it} + u_{it}$$

$$i = 1,2,\ldots,173; t = 1,2,\ldots,8$$

Residual sum of squares of hybrid model is obtained by calculation, S1=15.72. Residual sum of squares in the form of variable intercept model S2= 9.36. Residual sum of squares in the form of variable coefficient model S3=3.25.So, obtain two F statistic.

Table 2. Model Choose Statistics under the Perspective of Enterprise Value

	statistics	Critical value（a=0.05）
F_2	1.2869	1.1591
F_1	0.7567	1.1629

The Table 2 shows that statistic F_2 is greater than the critical value fewer than 5% significance level, reject the null hypothesis H_0^2. Statistic F_1 is less than the critical value

fewer than 5% significance level, can't refuse the original hypothesis H_0^1. So choose variable intercept model are as follows:

$$y_{1,it} = \alpha_i + \beta_1 x_{1,it} + \beta_2 x_{1,it}^2 + \beta_3 x_{2,it} + \beta_4 x_{3,it} + \beta_5 x_{4,it} + u_{it}$$
$$i = 1,2,\ldots,173; t = 1,2,\ldots,8$$

Hausman test results show that (Table 3), it has rejected the null hypothesis under the significance level of 5%, so fixed effects model should be adopted by the intercept of variable intercept model above.

Table 3. Hausman Test Results under Enterprise Value Perspective

Correlated Random Effects - Hausman Test Test cross-section random effects			
Test Summary	Chi-Sq. Statistic	Chi -Sq. d.f.	Prob.
Cross-section random	70 .009664	5	0 .0000

3. Model estimation results

According to the established variable intercept fixed effect model, it use the Eviews6.0 software and LSDV to obtain estimation results (Table 4).

Table 4. The Estimated Result of Panel Data Model under Enterprise Value Perspective

Dependent Variable: Y1 Method: Pooled Least Squares				
Variable	Coefficient	St d. Error	t- Statistic	Prob.
C	-1. 131245	0 .121233	-9 .331180	0 .0000
X1	0.356357	0.134090	2.657607	0.0080
X1square	-0.542034	0.129331	-4.191063	0.0000
X2	0.048176	0.005761	8.362842	0.0000
X3	0.024086	0.007294	3.301981	0.0010
X4	0.154970	0.011894	13.02909	0.0000
R-squared	0. 564895	Mean dependent var		0.0 78347
Adjusted R-squared	0.501037	S.D. dependent var		0.124737
S.E. of regression	0.088111	Akaike info criterion		-1.900891
Sum squared resid	9.362752	Schwarz criterion		-1.227895
Log likelihood	1493.417	Hannan-Quinn criter.		-1.649166
F-statistic	8.846026	Durbin-Watson stat		1.897601
Prob(F-statistic)	0.000000			

The P value for each variable coefficient shows that the coefficient of asset-liability ratio x_1, asset-liability ratio squared x_1^2, company scale x_2, operating income growth x_3 and the company's total asset turnover x_4 are significant under 5% level. F statistics also show that mode is significantly in the 5% significance level. But goodness of fit is 0.56, which is not perfect. Possible reason is that the selection of independent variable is not comprehensive.

Because of the coefficient of square of asset-liability ratio is negative, it indicates that the relationship between asset-liability ratio and return on equity is inverted u-shaped. So there is the rate of assets and liabilities which makes return on equity maximum [7]. Seeking extreme to quadratic curve, we get asset-liability ratio 32.87% of the maximized net assets yield under the estimated results of the model. Therefore, the net assets yield presents the increasing trend as the asset-liability ratio increase, when the rate of assets and liabilities of the equipment manufacturing industry of listed companies is less than

32.87%, and when the asset-liability ratio is more than 32.87%, the return on equity of listed companies begin to decline with the increase of the asset-liability ratio. In addition, the coefficient of company scale x_2 is positive from the angle of control variables. That suggests the greater the size of the equipment manufacturing industry of listed companies, the higher return on net assets relatively. From the angle of company growth index x_3, its coefficient is positive; it also conforms to the actual situation. The equipment manufacturing industry in the growth of listed companies is higher, its return on net assets will also be higher accordingly. The coefficient of total asset turnover x_4 also is positive. From the angle of financial indicators, the faster the turnover of funds of listed companies of the equipment manufacturing industry, the higher the efficient utilization of assets, this also reflected in a higher return on equity.

3.2 The Optimal Capital Structure of Equipment Manufacturing Industry Listed Companies in the Perspective of the Agency Costs

1. Judgment of the relationship between agent cost and capital structure

We also select nonparametric fixed effect panel data model to explore the relationship between agent cost and capital structure based on local linear estimation [8]. The model is shown below:

$$y_{2,it} = \alpha_i + m\left(x_{1,it}\right) + u_{it} \quad i = 1,2,\ldots,173; t = 1,2,\ldots,8$$

Among them, $y_{2,it}$ is the rate of overhead expenses as a characteristic index, $x_{1,it}$ is the asset-liability ratio of listed company, which represents the company's capital structure. Considering the influence of the bandwidth on the result of nonparametric estimation, we give estimated value when a= 0.05, a = 0.05 and a = 0.15 respectively, look at the marginal effects of asset-liability ratio on agency costs with the change of asset-liability ratio under different bandwidths, when estimating the marginal effects $\square_{FE\cup} x_{1\cap}$ of asset-liability ratio on the rate of overhead expenses.

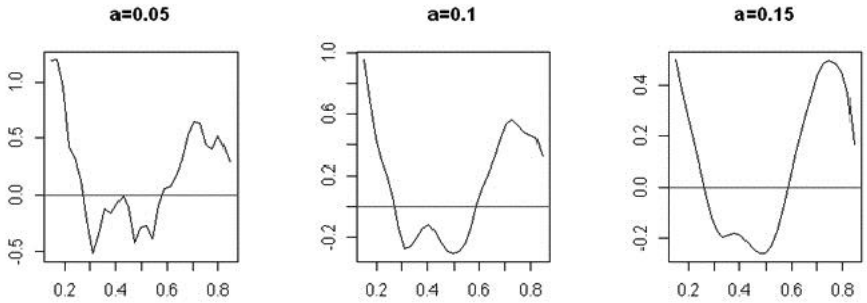

Figure 2. The Marginal Effects of Asset-Liability Ratio on the Rate of Overhead Expenses

Figure 2 divided the range of minimum and maximum of the whole industry asset-liability ratio into 30 equal parts, estimated $\square_{FE\cup} x_{1\cap}$ for each equal diversion point, connect it with a smooth curve. $\square_{FE\cup} x_{1\cap}$ can be roughly divided into three parts according to whether greater than zero in all range of asset-liability ratio in the chart: both ends $\square_{FE\cup} x_{1\cap} \rhd 0$, the middle $\square_{FE\cup} x_{1\cap} \lhd 0$. Therefore, the relationship between the rate of overhead expenses and asset-liability ratio of equipment manufacturing industry of listed companies assumes inverted u-shaped curve roughly first, then assumes u-shaped curve with the increase of asset-liability ratio.

2. The ordinary construction of panel data model

Based on the initial analysis of the relationship between agency cost and capital structure, we investigate whether there is a u-shaped relationship by adding asset-liability ratio square in the ordinary panel data model.

If asset-liability ratio squared coefficient is positive and significant, that indicates the u-shaped relationship between capital structure and agency costs was established to some extent and can get the agency cost which take with minimize capital structure[9]. Considering other factors influencing enterprise agency cost, we form a panel data model by adding control variable such as the enterprise scale x_2, the enterprise growth x_3, and the enterprise centralized scheduling x_5.

$$y_{2,it} = \alpha_i + \beta_{1,i}x_{1,it} + \beta_{2,i}x_{1,it}^2 + \beta_{3,i}x_{2,it} + \beta_{4,i}x_{3,it} + \beta_{5,i}x_{5,it} + u_{it}$$
$$i = 1,2,\ldots,173; t = 1,2,\ldots,8$$

According to the selection of panel data model, we calculated residual sum of squares S_1=2.90 in the hybrid model, residual sum of squares S_2=1.18 in the variable intercept model, residual sum of squares S_3=0.52 in the variable coefficient model. So, we can get two F statistic:

Table 5. The Statistics of Model Selection in the Perspective of Agency Costs

	statistics	Critical value（a=0.05）
F_2	1.5494	1.1591
F_1	0.5154	1.1629

The Table 5 shows that statistic F_2 is greater than the critical value fewer than 5% significance level, reject the original hypothesis H_0^2. Statistic F_1 is less than the critical value under 5% significance level, cannot reject the original hypothesis H_0^1.So choose variable intercept model as follows:

$$y_{2,it} = \alpha_i + \beta_1 x_{1,it} + \beta_2 x_{1,it}^2 + \beta_3 x_{2,it} + \beta_4 x_{3,it} + \beta_5 x_{5,it} + u_{it}$$
$$i = 1,2,\ldots,173; t = 1,2,\ldots,8$$

Hausman test rejected the original hypothesis under the significance level of 5%, so the fixed effects model should be adopted by the intercept of variable intercept model above.

3. Model estimation results

According to the established variable intercept fixed effect model, we get the estimation results by using LSDV with Eviews6.0 software (Table 6).

Table 6. The Estimation Results of Panel Data Model in the Perspective of Agency Costs

Dependent Variable: Y2 Method: Pooled Least Squares				
Variable	Coefficient	St d. Error	t- Statistic	Prob.
C	0. 248589	0 .045693	5 .440353	0 .0000
X1	-0.169049	0.047745	-3.540685	0.0004
X1square	0.145204	0.046091	3.150391	0.0017
X2	-0.006995	0.002090	-3.346644	0.0008
X3	-0.015210	0.002479	-6.136616	0.0000
X5	0.054725	0.012310	4.445456	0.0000
R-squared	0. 658304	Mean dependent var		0.0 79899

Adjusted R-squared	0.608154	S.D. dependent var	0.049908
S.E. of regression	0.031241	Akaike info criterion	-3.974589
Sum squared resid	1.177085	Schwarz criterion	-3.301593
Log likelihood	2928.416	Hannan-Quinn criter.	-3.722864
F-statistic	13.12684	Durbin-Watson stat	1.956132
Prob(F-statistic)	0.000000		

According variation coefficient P, the coefficient of asset-liability ratio x_1, the square of asset-liability ratio x_1^2, scale of company x_2, growth rate of company operating income x_3 and the summation of proportion of shareholding of large shareholder's in the top ten x_5 are all significant under 5% level. F statistics also show that model is significant fewer than 5% level. But the goodness-of-fit is 0.66.

The coefficient of asset-liability ratio square is positive, this indicates that the relationship between asset-liability ratio and management fee present a u-shaped, and there is a certain asset-liability ratio which make management fee to minimum. We get the optimal asset-liability ratio 58.21%which make minimize overhead expenses rate by seeking extreme. According to agent cost theory of Jensen and Meckling, the relationship between agency costs and debt ratios present u-shaped in theory, the test results are consistent with the theory. Therefore, when the asset-liability ratio of listed companies of the equipment manufacturing industry is less than 58.21%, the overhead expenses rate showed a trend of decline with the increase of asset-liability ratio. When asset-liability ratio is more than 58.21%, the overhead expenses rate of listed company will be increased as the asset-liability ratio increasing. In addition, the coefficient of company scale x_2 is negative, this shows that the listed companies of equipment manufacturing industry is bigger, and the overhead expenses rate is smaller. And the coefficient x_3 of company growth is negative, which agree with the point of view of variable selection mentioned. The growth of the equipment manufacturing industry listed companies is higher, the overhead expenses rate is small. The index x_5 of COCEN is positive. That does not agree with the description of the variable selection. So we believe that the equity is more concentrated, the overhead expenses rate is bigger in the equipment manufacturing industry of listed companies.

4. Conclusion

1. Based on the research to the listed company's assets structure of equipment manufacturing industry from different perspective, the results show that, the relationship between enterprise value and capital structure is inverted u-shaped in perspective of enterprise value, and the enterprise value is maximum when the asset-liability ratio is 32.87%. But agency cost and capital structure is a u-shaped relationship in the perspective of agency costs. The agency costs to a minimum when the asset-liability ratio is 58.21%.

2. Synthesize two perspectives of enterprise value and agency cost, we divide the asset-liability ratio of the equipment manufacturing industry listed companies into three regions according to the comprehensive effects of the enterprise value and agency cost from asset-liability ratio: (0,32.87%] as "efficiency gains interval", [58.21%,100%) as "benefits decline interval", and (32.87%, 58.21%) for a "reasonable capital structure interval".

3. For those listed companies of equipment manufacturing industry with lower and decreasing debt ratio, they should maintain their own good benefits by increasing the debt ratio. At the same time, equipment manufacturing enterprises should attach importance to the effects of the company size, growth of service level and such factor which can influence the enterprise benefit. In addition, the enterprise should arrangement the ratio of current liabilities and non-current liabilities of corporate debt reasonably.

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