Optimization of Capital Structure by Combined Methods of TOPSIS and Entropy Method

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Abstract: The purpose of this paper is to contribute to the methodology of quantified optimization of capital structure. The decision of capital structure is influenced by a variety of factors, including the integrated capital cost, the risk factor and the capital value added rate. After set-up of evaluation indicator model, two methods are applied and the results are consistent with each other. Therefore the suggestion of how to optimize the capital structure is given and the empirical result of the company is also proved.

1. Introduction

The capital structure of listed companies in China is not reasonable, characterized by the pheromones as capital debt ratio is too low, the proportion of internal financing is too low and external financing is too heavily relied on, equity financing preference exists. And it is well-known that Chinese listed companies strongly prefer to equity financing.

These problems are hindering the further development of China's capital market and affecting the healthy and rapid development of economy. Therefore, it is of great significance to study the optimization of capital structure of Chinese companies. In addition, the study of capital structure is the premise of analyzing financial risk, determining financing strategy and utilizing financial leverage.

The research of foreign capital structure theory shows that for enterprises, bond financing is better than stock financing. While in China, the situation is exactly in contrast to the theory. The priority of financing is equity financing first, followed by short-term debt financing, and long-term debt financing, and internal financing is the least preferred.

Researches to evaluate capital structure have been conducted for more than hundreds of years and many opinions are controversial and diverse from each other. For example: Titman and Wessels (1988) use six indicators as capital structure measures: long-term, short-term and convertible debt divided by owner's equity and three market values and three book values are generated respectively.

Rajan and Zingales (1995) use five leverage ratios to describe the capital structure: non-equity liabilities to total assets ratio, loan to total assets ratio, loan to net assets ratio, loan to capital ratio, interest coverage.

As to the methodology, in China, Xu Jianzhong, Ma Ruixian (2007) use the analytic hierarchy process and fuzzy analysis hierarchy process (AHP) to reflect the development factor. Yumin (2011) uses the hierarchical index system, to establish target index system first, then the secondary level index. Pang Qinghua and Wang Censu adopt AHP and entropy method to determine the weight. The evaluation system is set up including 37 indicators in all. This method combines AHP, entropy method, fuzzy comprehensive method, Delphy method, eliminating the shortcomings of one single method, and prevailing with great flexibility, which makes the evaluation results with high accuracy and credibility.
2. Methodology

2.1 TOPSIS

The Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) is a multi-criteria decision analysis method, which was originally developed by Hwang and Yoon in 1981. It is a method of compensatory aggregation that compares a set of alternatives by identifying weights for each criterion, normalizing scores for each criterion and calculating the geometric distance between each alternative and the ideal alternative, which is the best score in each criterion. An assumption of TOPSIS is that the criteria are monotonically increasing or decreasing. Normalisation is usually required as the parameters or criteria are often of incongruous dimensions in multi-criteria problems.

Vector normalization was incorporated with the original development of the TOPSIS method, and is calculated using the following formula:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}}, i = 1, 2, \ldots, m, j = 1, 2, \ldots, n$$

2.2 Entropy (statistical thermodynamics)

In classical statistical mechanics, the entropy function earlier introduced by Rudolf Clausius is interpreted as statistical entropy using probability theory. The method originated from the field of rare event simulation, where very small probabilities need to be accurately estimated, for example in network reliability analysis, queuing models, or performance analysis of telecommunication systems.

For a classical system (i.e., a collection of classical particles) with a discrete set of microstates, if $E_i$ (display style $E(i)$) is the energy of microstate $i$, and $p_i$ (display style $p_{(i)}$) is the probability that it occurs during the system's fluctuations, then the entropy of the system is

$$S = -k_B \sum_i p_i \ln p_i$$

In information theory, entropy is a measure of uncertainty. The more information, the less uncertainty, the less entropy; the less information, the more uncertainty, the more entropy. According to the characteristics of entropy, we can judge by calculating the randomness and the disorder of an event, you can also use entropy to determine the discrete degree of an index, the greater the degree of discrete and the greater the influence of the index of comprehensive evaluation.

3. Model construction

An overarching framework of factors is set up to evaluate the capital structure and help to determine the best capital structure for the company. This indicator system has taken into consideration two groups of influential factors. And the first group includes 10 indicators which are the most widely used and adopted in recent researches in the field of capital structure. The other group of factors follow the concept of financing strategy of Hawawini and Vieri, who in the monograph of enterprise value creation distinct value creation (return on invested capital rate ROIC-capital cost rate WACC) and cash deficiency (sales growth rate G sale-sustainable growth rate (SGR)) respectively as vertical and horizontal axis of a matrix, the matrix is called financial strategy matrix.
4. Empirical results

a) Establishment of r matrix. \( r = \{ r_1, r_2, \ldots, r_i, \ldots, r_m \} \) and \( I = \{ 1, 2, \ldots, m \} \); M represents different periods. In all, 4 years’ fiscal statement can be traced back to.

b) The normalization of the r matrix

Since each indicator has different dimensions and different types, it is difficult to be directly compared and calculated. Therefore, these indicators must be normalized to a certain dimensionless
interval before the evaluation. Generally, according to the actual value range of the index, the dimensional data is normalized to the range of [0, 1]. However, the impact of individual abnormal data cannot be excluded. Therefore, the intermediate variable is introduced on the basis of the mean value, and after the data of different dimensions is unified in [0, 1], the exponential function is used to transform it into (0, 1] interval, which can avoid the individual abnormal data’s impact on evaluation.

Table 4 The Eigenvalue matrix Rij.

<table>
<thead>
<tr>
<th>0.475</th>
<th>0.499</th>
<th>0.398</th>
<th>0.368</th>
<th>0.368</th>
<th>0.368</th>
<th>0.487</th>
<th>0.368</th>
<th>0.902</th>
<th>0.368</th>
<th>0.484</th>
<th>0.368</th>
<th>0.451</th>
<th>0.416</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.368</td>
<td>0.368</td>
<td>1.000</td>
<td>0.627</td>
<td>0.434</td>
<td>0.468</td>
<td>0.602</td>
<td>0.368</td>
<td>1.000</td>
<td>0.368</td>
<td>0.434</td>
<td>0.368</td>
<td>0.641</td>
<td>0.368</td>
</tr>
<tr>
<td>0.513</td>
<td>0.543</td>
<td>0.368</td>
<td>0.809</td>
<td>0.664</td>
<td>0.726</td>
<td>0.784</td>
<td>0.624</td>
<td>0.683</td>
<td>0.509</td>
<td>0.664</td>
<td>1.000</td>
<td>1.000</td>
<td>0.561</td>
</tr>
<tr>
<td>1.000</td>
<td>1.000</td>
<td>0.407</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td>0.804</td>
<td>0.541</td>
<td>1.000</td>
<td>1.000</td>
</tr>
</tbody>
</table>

c) Determination of indicator weight

Table 5. Weight matrix.

| 0.052 | 0.048 | 0.069 | 0.039 | 0.051 | 0.048 | 0.039 | 0.046 | 0.057 | 0.050 | 0.104 | 0.098 | 0.086 | 0.104 |

Table 6. Evaluation Result.

<table>
<thead>
<tr>
<th>Evaluation Result</th>
<th>TOPSIS</th>
<th>Entropy Method</th>
<th>Asset-liability Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>0.1636</td>
<td>0.1756</td>
<td>0.66</td>
</tr>
<tr>
<td>2014</td>
<td>0.3036</td>
<td>0.2050</td>
<td>0.65</td>
</tr>
<tr>
<td>2015</td>
<td>0.5094</td>
<td>0.2730</td>
<td>0.59</td>
</tr>
<tr>
<td>2016</td>
<td>0.6773</td>
<td>0.3463</td>
<td>0.54</td>
</tr>
</tbody>
</table>

5. Conclusion

There are two methods used to evaluate how to optimize the corporate capital structure, that is the best asset-liability value. These two methods are Topsis and Entropy method. The value may vary from each other for different measure, while the result is exactly consistent with each other as shown in the Table 6 above: the lower of asset-liability ratio, the better evaluation result of the company’s capital structure. Thus we get the conclusion that the best company capital structure is close to the value of 0.54 asset-liability ratio, and in order to further optimize the company capital structure, it should take actions to reduce liabilities when its asset volume remains as the same level.

References


