

Research on Financial Status and Later Growth of the Enterprise Based on Financial Accounting Data under EWM-TOPSIS Model

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Abstract: Given the research on the future development and current financial situation of the enterprise, this paper selects 13 indexes in total according to the solvency, profitability, operation capability, and growth ability, establishes a comprehensive evaluation model combining the entropy weight method (EWM) and the technique for the order of preference by similarity to ideal solution (TOPSIS) and analyzes the situation of BY-HEALTH Company in the past 12 years. It is found that the two types of comprehensive scores fluctuate greatly before and after 2010, which corresponds to the actual situation of the company's operation. This proves the rationality of the model in this paper, which can correctly reflect the actual situation of enterprise operation and development, providing a new analytical perspective for enterprise evaluation and a basis for investors to make decisions.

1. Introduction

The financial statement of an enterprise is an important way to obtain the basic financial status and growth ability of an enterprise. By analyzing the financial accounting data, the internal relationship of enterprise economic activities can be effectively explored. Enterprise operations and growth issues have always focused on academic attention, and listed companies with stronger financing abilities and sustainable development ability get more and more academic attention.

Yingchun, Z [1] studied the financial situation and development prospects of enterprises based on financial statements and relevant financial data. She analyzed the company's condition for each specific index and gave relevant analysis and suggestions. Mengze, T et al. [2] used regression analysis to explore the correlation between corporate growth and financial performance from the SMEs level, and revealed the sustainable development of enterprises. Bo, S et al. [3] used EWM-TOPSIS to rank the advantages and disadvantages of China's listed tourism companies and evaluate the performance of the companies. The objective weighting method replaces the subjective one, which has a stronger accuracy. J. Clixans-Tenas et al. [4] proposed for the first time to use component data (CODA) in the partial least squares structural equation model (PLS-SEM) to predict financial statements from nonfinancial variables, reducing the asymmetry, redundancy, and outliers of the predictions.

By analyzing the operation status of BY-HEALTH company, this article explores two aspects of the corporate financial position and growth ability. The EWM-TOPSIS model is adopted to objectively give a comprehensive score of financial status and growth ability, describing the phenomenon of data fluctuations in combination with the weight of financial data and the change of specific indicators, providing a new idea for business analysis through analyzing the causes of fluctuations in connection with the actual background.

2. Index introduction

Referring to the General Principles of Corporate Finance [5] and other relevant provisions of the financial accounting system, the following financial indicators are selected to construct a comprehensive evaluation index system. The financial status is constructed by the index of solvency,

profitability, and operation capability, and the comprehensive evaluation system of growth ability is constructed by the growth index.

2.1 Comprehensive index system of financial status

- Solvency index: reflects the ability of the enterprise to repay maturing debts

The asset-liability ratio reflects the ratio of capital provided by creditors to total assets, which is the long-term solvency ratio. Current ratio, quick ratio, and cash to current ratio are short-term solvency ratios. The larger the index value is, the stronger the company's solvency is, and the company's financial risk is relatively small.

- Profitability index: reflects the profitability of an enterprise within a certain time.

The net profit rate reflects the income level of sales revenue. The gross income ratio is the percentage of gross profit on net sales, where gross profit is the difference between net sales revenue and the cost of the product. The rate of return to assets is used to measure the level of income earned by all enterprise assets.

- Operating capability index: reflects the ability and efficiency of enterprise asset management.

The higher the inventory turning rate is, the better the inventory liquidity and management efficiency are. ART rate is the ratio of net sales revenue to the average balance of accounts receivable in a certain period. It reflects the turnover speed of accounts receivable.

2.2 Comprehensive index system of growth ability

- Growth ability index: reflects the future development and sustainable ability of the enterprise.

The total asset growth rate reflects the growth of the enterprise's current asset scale. The asset growth reflects the expansion speed of enterprise capital scale and is an important index to measure the change and growth of enterprise total scale. The net profit growth rate index reflects the growth of the profitability of the enterprise. The main operating income growth index reflects the expansion of the company's main operating income scale.

2.3 Summary of index system

In the overall financial comprehensive evaluation index system, an asset-liability ratio of 40% to 60% is preferable. However, since the enterprise's asset-liability ratio has always been below 50%, it is directly treated as a positive indicator to simplify the calculation. In addition, except that the current ratio, quick ratio, and cash to current ratio are moderate indicators, the other secondary indicators are positive.

Table.1. Index Introduction

Main Index		Sub-index		Abbreviation	Index types	Unit
B1	Solvency Index	C1	Debt Assets Ratio	Dbassrt	Positive	%
		C2	Current Ratio	Currtr	Optimal: 1	\
		C3	Quick Ratio	Qckrt	Optimal: 2	\
		C4	Cash to Current Ratio	Cascrrt	Optimal: 20	%
B2	Profitability Index	C5	Net Profit Ratio	Netprfrt	Positive	%
		C6	Gross Income Ratio	Gincmrt	Positive	%
		C7	Return To Assets	ROA	Positive	%
B3	Operation Capability	C8	Inventory Turning Rate	Invtrrrat	Positive	\
		C9	ART Rate	ARTrat	Positive	\
B4	Growth Ability	C10	Total Assets Growth Rate	TAGR	Positive	%
		C11	Asset Growth	AG	Positive	%
		C12	Net Profit Growth Rate	NPGR	Positive	%
		C13	Main Operating Income Growth	MOIG	Positive	%

3. EWM - TOPSIS formula

As a multiobjective decision-making method, EWM-TOPSIS overcomes the subjectivity of AHP and is widely used in enterprise management decision-making and enterprise risk analysis. [6]

3.1 EWM assignment method

As an objective weighting method, the entropy weight method reflects the amount of information by evaluating the variation degree of each index value. The greater the variation degree of a certain index, the smaller the entropy value, The greater the degree of variation of an index, the smaller the entropy value, so the more information the index contains, the greater the role it plays in the comprehensive evaluation, and the greater the weight it gives, and vice versa. The specific steps are as follows:

a) The dimensionless treatment of the value of the evaluation index:

Due to the inconsistent dimensions of each index, it is necessary to standardize them before calculation. As the positive index, negative index and moderate index represent different meanings (The positive index value should be higher, the negative index value to be lower, and the moderate index value to be closer to a certain number). Therefore, different algorithms are needed for dimensionless data processing.

If n samples and m indicators are selected, x_{ij} will be the corresponding value of the j indicator of the i sample. ($i = 1, 2, \dots, n; j = 1, 2, \dots, m$);

Positive indicators:

$$X_{ij} = (x_{ij} - \min\{x_j\}) / (\max\{x_j\} - \min\{x_j\}) \quad (1)$$

Negative indicators:

$$X_{ij} = (\max\{x_j\} - x_{ij}) / (\max\{x_j\} - \min\{x_j\}) \quad (2)$$

Moderation indicators:

$$X_{ij} = (\max\{x_j\} - x_{ij}) / (\max\{x_j\} - x_0), \quad x_0 \leq x_{ij} \quad (3)$$

$$X_{ij} = (x_{ij} - \min\{x_j\}) / (x_0 - \min\{x_j\}), \quad x_0 > x_{ij}$$

b) Calculate the proportion of the i evaluated object in the j index:

$$p_{ij} = \frac{X_{ij}}{\sum_{i=1}^n X_{ij}} \quad (i = 1, 2, \dots, n; j = 1, 2, \dots, m) \quad (4)$$

c) Calculation of index entropy value:

$$e_j = -k \sum_{i=1}^m (p_{ij} \times \ln p_{ij}) \quad j = 1, 2, \dots, m; \quad e_j > 0 \quad (5)$$

$$k = \frac{1}{\ln m} \quad (6)$$

d) Calculate the information utility value:

$$h_j = 1 - e_j, \quad j = 1, 2, \dots, m \quad (7)$$

e) Calculate the weights of each indicator:

$$w_j = \frac{h_j}{\sum_{i=1}^m h_j}, \quad j = 1, 2, \dots, m \quad (8)$$

After determining the weight of each evaluation index of an enterprise, it is necessary to choose the evaluation method of financial status and growth ability. The quantitative evaluation method is less affected by human factors and more objective than the qualitative evaluation method. This paper chooses the TOPSIS multi-attribute decision-making method.

3.2 TOPSIS multi-attribute decision-making method

TOPSIS is a method that can sort the degree of proximity between a limited number of evaluation objects and ideal points. The model construction steps are as follows:

a) Construct evaluation matrix A of sample data and standardize $A = (x_{ij})_{n \times m}$:

$$\mathbf{A} = \begin{bmatrix} X_{11} & X_{12} & \cdots & X_{1m} \\ X_{21} & X_{22} & \cdots & X_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ X_{n1} & X_{n2} & \cdots & X_{nm} \end{bmatrix} = [X_1 \ X_2 \ \cdots \ X_m] \quad (9)$$

The above decision matrix \mathbf{A} refers to n evaluated objects and m attribute indexes, and x_{ij} refers to the value of the j indicator of the i sample. Then Normalize the matrix \mathbf{A} to eliminate dimensional effects.

$$Z_{ij} = \frac{X_{ij}}{\sqrt{\sum_{i=1}^n (X_{ij})^2}} \quad (10)$$

b) Multiply the weight matrix $\mathbf{W} = \text{diag}(\omega_1, \omega_2, \dots, \omega_m)$ obtained by the entropy method to the right of the evaluation matrix \mathbf{A} to obtain the value matrix \mathbf{V} .

$$\mathbf{V} = \mathbf{A} \times \mathbf{W} = \begin{bmatrix} V_{11} & V_{12} & \cdots & V_{1m} \\ V_{21} & V_{22} & \cdots & V_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ V_{n1} & V_{n2} & \cdots & V_{nm} \end{bmatrix} = [V_1 \ V_2 \ \cdots \ V_m] \quad (11)$$

c) Determine the positive and negative ideal solutions. The positive ideal solutions \mathbf{S}^+ are the maximum value of the positive indicators and the minimum value of the negative indicators, and the negative ideal solutions \mathbf{S}^- are the maximum value of the negative indicators and the minimum value of the positive indicators.

$$\begin{aligned} \mathbf{S}^+ &= \{s_1^+, s_2^+, \dots, s_n^+\} \\ \mathbf{S}^- &= \{s_1^-, s_2^-, \dots, s_n^-\} \end{aligned} \quad (12)$$

Positive indicators:

$$\begin{aligned} s_j^+ &= \max \{v_{ij} \mid 1 \leq i \leq n\} \\ s_j^- &= \min \{v_{ij} \mid 1 \leq i \leq n\} \end{aligned} \quad (13)$$

Negative indicators:

$$\begin{aligned} s_j^+ &= \min \{v_{ij} \mid 1 \leq i \leq n\} \\ s_j^- &= \max \{v_{ij} \mid 1 \leq i \leq n\} \end{aligned} \quad (14)$$

Moderate indicators have been converted into positive indicators for easy calculation.

d) Calculate the Euclidean distance between each scheme and the positive and negative ideal solution separately:

$$d_i^+ = \sqrt{\sum_{j=1}^m (v_{ij} - s_j^+)^2} \quad (15)$$

$$d_i^- = \sqrt{\sum_{j=1}^m (v_{ij} - s_j^-)^2} \quad (16)$$

e) Calculate the relative closeness of each scheme to the ideal solutions:

$$c_i = \frac{d_i^-}{d_i^+ + d_i^-}, \quad i = 1, 2, \dots, n \quad (17)$$

f) Rank each scheme according to the value of c_i . The larger c_i is, the better the evaluated object is, and obviously $c_i \in [0, 1]$.

4. The study of enterprise operation and growth ability under EWM-TOPSIS model based on China BY-HEALTH Company

4.1 Collection and analysis

This article selects the typical Chinese famous health products company BY-HEALTH as the research object. Based on the analysis of the current financial and accounting data, this article studies the impact of the particularity of the financial situation and future growth control ability on different

enterprises. Here takes this company as an example to analyze the volatility of data over the past 12 years. Among them, the sample index data are from Sina Finance.

4.2 Calculation

EWM-TOPSIS model contains a large number of matrix operations. This article uses MATLAB to assist in modeling and achieve the algorithm. The basic data unit of MATLAB is the matrix, which has a variety of functions such as row matrix operation, drawing functions, and realizing algorithms. It is widely used in numerical analysis, scientific calculation, and other aspects, which provides convenience for realizing data analysis.

4.2.1 The Financial

- Entropy weight assignment

The weight and information entropy of each financial index is determined by the objective assignment of the entropy weight method:

Table.2. EWM Result of Financial

Main index		Sub-index		weight	entropy
B1	Solvency	C1	Dbassrt	0.280055	0.760984
		C2	Currt	0.098413	0.916009
		C3	Qckrt	0.082047	0.929976
		C4	Cascrrt	0.077909	0.933508
B2	Profitability	C5	Netprfrt	0.038628	0.967032
		C6	Gincmrt	0.054449	0.95353
		C7	ROA	0.085759	0.926808
B3	Operational Capability	C8	Invtrrrat	0.176802	0.849106
		C9	ARTrat	0.105939	0.909585

The financial situation of By-Health is mainly affected by two first-level indicators, solvency index, and operating ability. From the specific entropy value in Table 2 and Figure 1, it can be intuitively seen that the fluctuations of asset-liability ratio and inventory turnover, have a great impact on the overall financial situation of the company, which accounts for more than 45% of the weight.

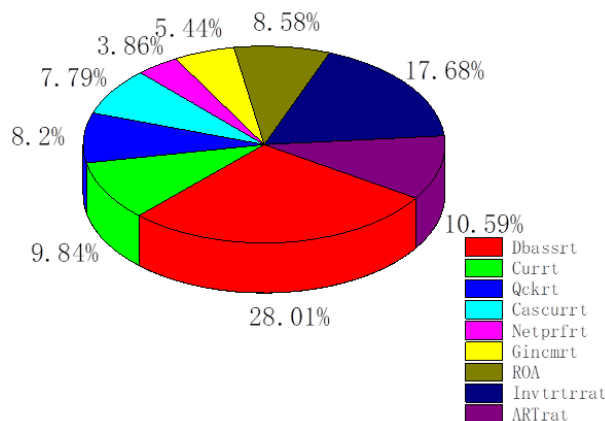


Figure 1. Financial Status Indicator Weight Chart

- TOPSIS comprehensive score

- Standardize the original data according to Formula 10 to obtain the standardized matrix.
- Standardize the data by Equation 11 to get the value matrix and then determine the positive and negative ideal solutions by Equations 12-14. The results are shown in Table 3.
- According to Equation 15-16, calculate the Euclidean distance between each scheme and positive and negative ideal solutions, respectively, and then calculate the relative closeness of each scheme to the ideal solutions according to Equation 17 to get the final comprehensive score.

Table.3. The Positive And Negative Ideal Solutions

	Dbassrt	Curr	Qckrt	Cascurr	Netprfrt	Gincmrt	ROA	Invtrrrat	ARTrat
S^+	0.16169	0.04024	0.03126	0.02956	0.01284	0.01579	0.04434	0.06391	0.03885
S^-	0.02561	0.00041	0.00032	0.00030	-0.00344	0.01407	0.00001	0.04296	0.01891

4.2.2 Growth ability

- Entropy weight assignment

Table.4. EWM Result of Growth Ability

Main index		Sub-index		weight	entropy
B4	Growth ability	C10	TAGR	0.40688	0.54065
		C11	AG	0.46747	0.47224
		C12	NPGR	0.03424	0.96134
		C13	MOIG	0.0914	0.89681

In the comprehensive evaluation system of growth capacity, total asset growth rate and asset growth account for more than 87% of the total. It reflects that the values of these two indicators fluctuate sharply. Figure 2 shows the weight distribution of each index. Net profit growth rate and main operating income growth fluctuate gently and occupy a small weight.

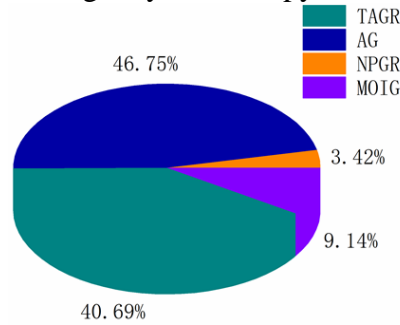


Figure 2. Growth Ability Index Weight Chart

- TOPSIS comprehensive score

According to the calculation steps of financial status, the comprehensive score of growth ability is obtained in the same way.

4.3 Comprehensive score analysis

4.3.1 Descriptive analysis of rating fluctuations

The comprehensive scores of BY-HEALTH's financial status and growth ability are shown in Figure 3:

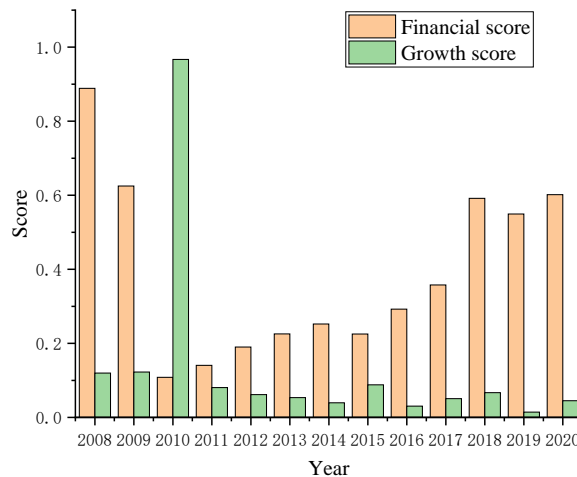


Figure 3. Comprehensive Score Chart

In terms of financial condition, BY-HEALTH had a good financial condition in 2008 and 2009, and the comprehensive score was over 0.6, which was at a high level. In the following years, the situation changed sharply. Although the financial condition showed a recovery trend in the following eight years, it was relatively slow and at a poor level. It was only after 2018 that the score breakthrough 0.5, and gradually returned to a better situation and kept stable.

To further reflect the overall fluctuations, this paper selects the three indexes with the highest weight and tries to explore the causes of the fluctuations. The debt assets ratio accounts for 28.01% of the total weight, the inventory turning rate accounts for 17.68%, the ART rate accounts for 10.59%. The fluctuation of these three indicators explains the overall degree of more than 50%. According to the principle of weight given by the entropy weight method, it can be known that these three indicators fluctuate more than others, which is conducive and reasonable to our exploration of the cause of overall fluctuation.

The time sequence diagram is shown in Figure 4:

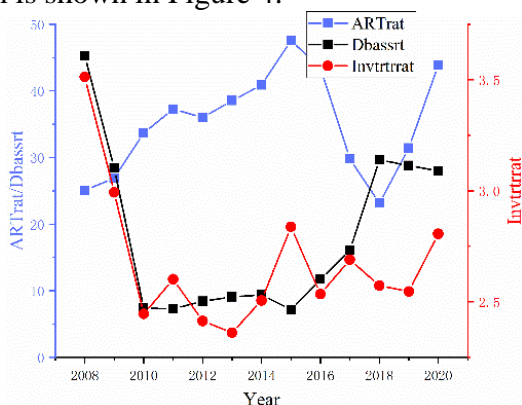


Figure 4. Large-Weighted Index Fluctuation of Financial Status

In this case, the Dbassrt and Invtrtrat, as positive indicators, were at a high level in 2008 but plummeted to less than 10% in 2010, which directly led to the substantial deterioration of the company's financial condition. The Invtrtrat fluctuated around a certain value during 2010-2015. The ARtrats and the Dbassrt fluctuated slightly, and the improvement of the financial situation in the following years was mainly influenced by the asset-liability ratio.

In terms of growth ability, BY-HEALTH's growth ability reached a peak value in 2010, which was much higher than the combined score of other years. After 2011, the growth ability of the enterprise generally declined and remained to fluctuate at a low level.

Similarly, as shown in Figure 5, by selecting two highly weighted indicators for time sequence diagram analysis, it can be observed that the fluctuation trends of TAGR and AG were nearly the same, and both had a significant increase in 2010, thus making the score of the company's growth ability reach the peak. For the next ten years, the ability to grow could not be maintained and dropped to a low level of gentle fluctuations.

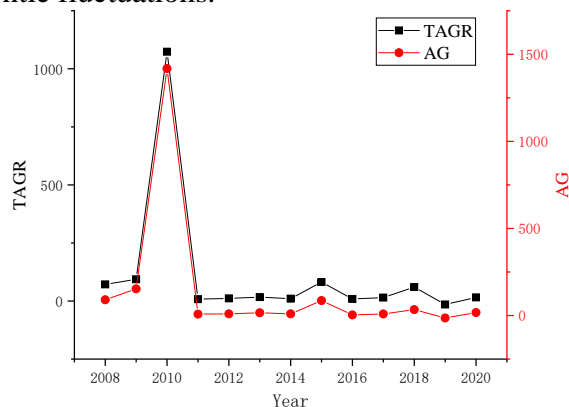


Figure 5. Large-Weighted Index Fluctuation of Growth Ability

4.3.2 Causes of fluctuation analysis and suggestions

(1) In terms of finance, data [7] shows that in 2010, BY-HEALTH issued an initial public offering and achieved a very high IPO price-to-earnings ratio, which directly led to a sharp increase in the company's assets and a sharp decline in the company's Dbasrt. From the second year, the company implemented the "2011-2015 Business Planning Outline", focusing on brand building and scale expansion. Its financial situation began to recover. However, due to the blind expansion of using over funds, BY-HEALTH faced low investment efficiency and a negative rate of return, leading to a small decline in its financial situation. After 2015, the company used debt financing to expand the company scale. Under the condition of the fundamental guarantee of short-term solvency, the financial leverage has been actively increased, and the company's financial situation has improved again. A modest decline in 2019 is likely to be affected by the sudden outbreak of the new champions league and the impact of the new e-commerce law.

(2) In terms of growth capacity, although BY-HEALTH had a substantial increase in assets after its listing in 2010 to raise funds, in the next five-year plan, excessive funds were invested in brand building and expansion without increasing the proportion of fixed assets. Therefore, TAGR cannot be maintained at a high level, which resulted in a substantial decline in the company's growth ability since 2011.

(3) Suggestions: At present, the listing period of BY-HEALTH is still short, the corporate system is not sound enough, and the unreasonable decisions of the management are easy to constrain the growth ability of the enterprise. In the first year of its listing, BY-HEALTH was blind in putting forward the plan of focusing on scale expansion and channel expansion. The experience and inspiration are that the enterprise should make reasonable plans, combine the company's actual situation, make efficient use of over raised funds, and avoid the substantial risks caused by unstable foundations and blind expansion.

5. Conclusion

This paper studies the overall situation of BY-HEALTH in the past 12 years and comprehensively analyzes the current financial situation and future growth ability by selecting nine financial indicators and four growth indicators. Based on the MATLAB data analysis tool, firstly, the entropy weight method was used to assign objective weights to 13 indicators to avoid the influence of subjective factors on the weight of indicators. The TOPSIS multiattribute decision-making algorithm was combined to sort the data of each year according to the proximity to the ideal solutions. Then, by drawing some important charts of indicators, the data fluctuation can be shown more intuitively, and the causes of each turning point and its impact on the company can be analyzed, which provides a feasible method for the analysis and evaluation of enterprise operation, and further provides a reference for other industries and enterprises to judge the operation situation and adjust the decision

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