

Financial performance evaluation of listed companies in a-share pharmaceutical industry—A model based on entropy method-coefficient of variation method

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Abstract: With the increasing of Chinese aging, but also with the rapid development of pharmaceutical enterprises, the country for pharmaceutical enterprise control is more strict, in this case, this text need to pay attention to the development of pharmaceutical enterprises, especially from the aspects of pharmaceutical enterprise financial performance data analysis, to better development of pharmaceutical enterprises. With the continuous development and progress of the society, residents' ability to pay has increased, their health awareness has been continuously strengthened, and the country's control over the pharmaceutical industry has become more strict. The influence of various factors makes the demand of the pharmaceutical industry only increase but not decrease. The pharmaceutical industry has gradually become a vigorously supported industry in China, and is closely related to the people, and is one of the important industry pillars in China.

1. Introduction

With the expansion of the pharmaceutical industry, the market share of the pharmaceutical industry has increased year by year, and the pharmaceutical industry has become more specialized and refined. Under such circumstances, to promote the development of the pharmaceutical industry towards a more orderly or even better place, we should pay attention to standardize the securities market to attract investment, improve the efficiency of resource utilization, and guide the standardized investment in the market.

In the past research, many scholars have made some achievements in the research on the financial performance of listed companies in various industries. In the analysis of financial performance of the pharmaceutical industry, scholars mainly focus on the four aspects of financial analysis: profitability analysis, operation ability analysis, debt solvency analysis and growth ability analysis. At present, scholars mainly use factors analysis, clustering analysis, hierarchical analysis or principal component analysis in the financial performance analysis and evaluation. Zhu Liping et al [1-2](2015) from the profitability, solvency, operation ability and development ability four aspects selected 10 indicators, using hierarchical analysis of pharmaceutical manufacturing listed company financial performance analysis, and concluded that profitability index is the most important pharmaceutical industry development, enterprise managers should pay attention to the

profitability of the pharmaceutical enterprise yield per share and the asset-liability ratio. Li Zhifeng [3](2014) analyzed the financial performance of listed manufacturing companies in Shenzhen and Shanghai by using principal component analysis. According to 11 indicators such as profitability, operating ability, solvency, growth ability and growth ability, to improve the accuracy and reliability of financial performance evaluation of listed manufacturing companies, the evaluation of financial performance can provide decision-making basis for investors and related groups. Zou Jieru [4](2022) Factor analysis was used to analyze 20 listed pharmaceutical companies, and important indicators were selected to build financial performance from four aspects of profitability, solvency, operation ability and development ability. Li Wei [5](2012) Using factor analysis, correlation analysis and regression analysis methods, analyze the data of 49 listed companies in China's transportation industry, study the relationship between corporate social responsibility and its financial performance, and draw the conclusion of positive correlation between corporate financial performance and corporate social responsibility after considering the growing indicators. Miao Yujun and Zhu Dan [6](2017) using descriptive statistical analysis, independence inspection and correlation analysis, through the 2012-2014 information transmission, software and information technology services in Shenzhen a-share listed company internal control and social responsibility and the relationship between the financial performance, found in terms of improving the enterprise's financial performance, internal control plays an important role in which.

In the past studies, some achievements have been made in the financial performance of pharmaceutical enterprises of listed companies, but due to the different number of samples selected, different indicators selected, and single research methods, there are still certain deficiencies in the literature. Therefore, this paper collected 15 indicators from four aspects to construct the evaluation system for the development of pharmaceutical enterprises. Combined with the data, we innovatively adopted the method of coefficient of variation method and entropy method, and adopted the Lagrange multiplier method for coupling, and selected 42 listed pharmaceutical enterprises as examples for research and analysis.

2. Construction of the index system

1) Debt solvency indicator.①The current ratio(X_1)refers to the ratio of current assets to current liabilities. In general, the higher the ratio, the stronger the solvency of the company, and vice versa. ②Quick ratio(X_2)refers to the ratio of quick assets to current liabilities. Generally speaking, the higher the ratio, the stronger the solvency of the enterprise; the opposite is weak.③Asset-liability ratio(X_3)refers to the ratio of the total liabilities to the total assets of the enterprise. It reflects how much of the overall assets of the enterprise is raised by borrowing. The higher the ratio, the weaker the solvency of the enterprise, and the stronger vice versa.

2) Profitability indicator.①Gross profit margin of sales(X_4)is the percentage of sales revenue, where gross profit is the difference between sales revenue and cost of sales. The larger the ratio, the higher the profitability, the gross sales margin and profitability is positively correlated.②The net interest rate on sales(X_5)is the percentage of net profit and sales revenue, and the net profit is the difference between total sales and income tax expenses. The higher the ratio, the higher the profitability, and vice versa. Net profit margin on sales reflects the ability of a company to earn a profit from net sales revenue. The higher the net margin on sales, the higher the company earns from sales and the more net profit.③The return on total assets(X_6)is the net profit divided by the total average assets, of which the average assets at the beginning and the sum of 2. Return on total assets is positively correlated with profitability. The higher the return on total assets of the enterprise, the lower the debt ratio of the enterprise, which directly leads to the improvement of the

enterprise's ability to resist risks, and the profitability also increases, while the opposite is low.^④ The cost profit margin (X_7) is the percentage of the total profit over the total cost, which is positively correlated with the profitability. The higher the cost profit margin, the better the enterprise will control the cost and operating loss, the higher the profitability, and the lower vice versa.

3) Operating ability index.^①Accounts receivable turnover rate(X_8) is the ratio of operating income to the average balance of accounts receivable, in which the operating income is the difference between the sales income of the current period and the sales income of the current period, and the average accounts receivable balance is the average of the accounts receivable balance at the beginning and the end of the period. The turnover rate of accounts receivable and operating ability is a moderate relationship, which presents a positive correlation to a certain extent. To a certain extent, the higher the turnover rate of accounts receivable, the lower the operating risk of the enterprise, and the higher the operating ability, which exceeds a certain limit. The too high accounts receivable turnover rate may be due to the too few accounts receivable of the enterprise, which cannot correctly reflect the operating ability of the enterprise.^②Inventory turnover(X_9) is the ratio of operating cost to the average balance of inventory. Inventory turnover is positively correlated with operating capacity. The higher the inventory turnover, the higher the operating capacity, and the lower and vice versa.^③The total asset turnover ratio(X_{10}) is the ratio of the operating income to the average total assets. The total asset turnover ratio is positively correlated with the operating ability. The higher the total asset turnover ratio, the higher the operating ability of the enterprise, and the lower and vice versa.

4) Development capacity indicators.^①The growth rate of operating income(X_{11}) is the ratio of the growth rate of the enterprise's operating income this year to the total operating income of the previous year. The growth rate of operating income is greater than zero, indicating that the operating income of the enterprise has increased this year, the higher the ratio, the higher the growth rate of operating income, the higher the development ability of the enterprise, and the opposite is low.^②Technology investment rate(X_{12}) is the ratio of research and development spending and operating income, technology research and development investment can make the enterprise products and services with the potential of sustainable development and sustainable development of power, technology investment ratio is positively associated with enterprise development ability, the greater the ratio, technology investment ratio, the higher the higher of the enterprise development ability, otherwise low.^③Capital value rate(X_{13}) is the ratio of the end of the owners' equity and early owners' equity, when the ratio of 100%, the enterprise no value, when the ratio of more than 100%, the enterprise value, the enterprise owner's equity, the higher the capital the value, the higher the ability of the development of the enterprise, the capital value appreciation rate is positively correlated with development ability.^④The capital accumulation rate(X_{14}) is the ratio of the growth rate of the owners' equity in this year to the owner's equity at the beginning of the period. This index reflects the change level of the owners' equity of the enterprise. The capital accumulation rate is positively correlated with the development ability. The more the owner's equity of the enterprise is accumulated, the stronger the capital retention of the enterprise, the stronger the development ability of the enterprise, and the opposite is weaker.

To sum up, this paper mainly selects 14 second-level indicators from four first-level indicators to establish the financial performance evaluation index system of pharmaceutical enterprises in China, as shown in Table 1

Table 1: Evaluation index system

Level indicators	1one-level code	Secondary indicators	Secondary code	Indicator type	Computational tools
debt paying ability	Y1	current ratio	X1	forward direction	(Current assets / current liabilities) 100%
		quick ratio	X2	forward direction	(Quick assets / current liabilities) 100%
		asset-liability ratio	X3	negative direction	(Total liabilities / total assets) 100%
profitability	Y2	gross profit margin	X4	forward direction	[(Sales revenue-cost of sales) / sales revenue] 100%
		Net interest rate on sales	X5	forward direction	[(Total profit-income tax expense) / sales revenue] 100%
		all capital earnings rate	X6	forward direction	{(Net profit + income tax) / [(total assets at the beginning + total assets at the end) / 2]} 100%
		Cost and expense profit margin	X7	forward direction	(Total profit / total cost and expense) 100%
capax negotii	Y3	average accounts receivable turnover ratio	X8	negative direction	(Current sales revenue-current sales revenue and current sales income) / [(initial accounts receivable balance + ending accounts receivable balance) / 2]
		inventory turnover ratio	X9	forward direction	Operating cost / average inventory balance
		turnover of total capital	X10	forward direction	Net operating income / average total assets
Development ability	Y4	increase rate of business revenue	X11	forward direction	[(Current operating income-operating income of the same period of last year) / operating income of the same period of last year] 100%
		Technology input rate	X12	forward direction	(R & D expenditure / operating income) 100%
		Capital value preservation and appreciation rate	X13	forward direction	(End of term owner's equity / beginning owner's equity) 100%
		rate of capital accumulation	X14	forward direction	(Increase in owner's equity in this year / owners' equity at the beginning of the year) 100%

3. Model construction

3.1 Data standardization processing

Due to the different magnitude and magnitude of each index, the direct use of original data may result in the data analysis of pharmaceutical enterprises to highlight or reduce the role of an index in the data analysis, which will seriously affect the subsequent data analysis. In order to eliminate this effect and make the expression ability of the data in different dimensions is the same, the data is treated with positive and negative data indicators:

3.1.1 Treatment of positive indicators

For the forward indicator processing:

$$x_{ij} = \frac{X_{ij} - \min(X_{1j}, X_{2j}, \dots, X_{nj})}{\max(X_{1j}, X_{2j}, \dots, X_{nj}) - \min(X_{1j}, X_{2j}, \dots, X_{nj})} \quad (1)$$

3.1.2 Treatment of inactive indicators

For the negative indicator processing:

$$x_{ij} = \frac{\max(X_{1j}, X_{2j}, \dots, X_{nj}) - X_{ij}}{\max(X_{1j}, X_{2j}, \dots, X_{nj}) - \min(X_{1j}, X_{2j}, \dots, X_{nj})} \quad (2)$$

3.2 Entropy value method

Entropy value judges the entropy value of the index according to the entropy information of the index. The greater the dispersion degree of the entropy information of the index, the greater the dispersion degree of the index, the comprehensive evaluation (weight). If the value of an index is equal, the index does not play a role in the framework of the overall evaluation. Therefore, the information entropy tool can be used to calculate the weight of each index as the basis for the overall evaluation of multiple indicators. Therefore, because the entropy method is easy to determine and calculate the valuation weight [7], this paper chooses the entropy method as one of the weight determination methods for the financial performance analysis of pharmaceutical enterprises. The specific methods are as follows:

Step 1: Organize the data processed by the positive and negative indicators, with i samples and j indicators, and calculate the entropy value of item j index:

$$e_j = -k \sum_{i=1}^n p_{ij} \ln(p_{ij}), j = 1, \dots, m \quad (3)$$

Among them, meet; $k = \frac{1}{\ln(n)} > 0$ $e_j \geq 0$

Step 2: Calculate the information entropy redundancy (difference):

$$d_j = 1 - e_j, j = 1, 2, \dots, m \quad (4)$$

Step 3: Calculate the weight of each index:

$$w_j = \frac{d_j}{\sum_{j=1}^m d_j}, j = 1, 2, \dots, m \quad (5)$$

Step 4: Calculate the comprehensive score of each sample:

$$s_i = \sum_{j=1}^m w_j x_{ij}, i = 1, 2, \dots, m \quad (6)$$

3.3 Coefficient of variation method

The coefficient of variation method is an objective empowerment method. The index can be strengthened according to the change degree of the current value and the target value of each evaluation index. When there is a large gap between the existing value of each index and the target

value, it is difficult to reach the target value, and a large weight should be given; otherwise, a small weight should be given [8].

Step 1: First, standardize the data, adopt the positive and negative index processing method to transform the positive index, convert the negative index into positive index, so that the results fall within the [0,1] interval:

$$\text{Positive indicator processing: } \frac{(X - \min)}{(\max - \min)} \quad (7)$$

$$\text{Negative indicator processing: } \frac{(\max - X)}{(\max - \min)} \quad (8)$$

Step 2: Then, the weighted average method is used to determine the comprehensive score. The calculation formula of the coefficient of variation of each index is as follows: the coefficient of variation of the i index; the standard deviation of the i index; and the arithmetic mean of the i index:

V_i, σ_i, X_i

$$V_i = \frac{\sigma_i}{X_i} \quad (9)$$

Step 3: The calculation formula for the weight of each variable is as follows:

$$W_i = \frac{V_i}{\sum_{i=1}^n V_i} \quad (10)$$

3.4 Lagrange multiplier method

In the evaluation of the financial performance of the pharmaceutical industry, this paper uses the entropy method and the coefficient method of variation to analyze the weight. In the comprehensive evaluation, this paper selects the Lagrange multiplier method to analyze the weight. In order to make the final weight as close to the original subjective and objective weight as possible, according to the optimization of the Lagrange multiplier method, the final weight is obtained through the principle of minimum relative information entropy. The specific method is as follows:

$$w_{3i} = \frac{(w_{1i} w_{2i})^{0.5}}{\sum_{i=1}^n (w_{1i} w_{2i})^{0.5}} \quad (11)$$

Where, w_{1i}, w_{2i}, w_{3i} Where, n is the selected n indicators, the weight of the entropy method, the coefficient of variation method, and the combined weight of the Lagrangian multiplier method.

4. Results

4.1 Data collection and processing

This paper index data from Oriental wealth network, select a-share medical services 42 listed company data, selected data released on December 31, 2022, covering December 31,2021 to December 31,2022 during the company financial data, from the solvency, profitability, management ability and development ability of four aspects of 14 secondary indicators to establish evaluation

system.

4.2 Determination of the index weight

After calculating and sorting out the indicators, the data were analyzed and sorted out by SPSSRO1.1.15 software according to the above method, and the weight of entropy method and coefficient of variation method was obtained, and the combined weight was obtained by using the calculation formula of Lagrange multiplier method, as shown in Table 2:

Table 2: Index weights

name of index	W1i weight (%)	W2i weight (%)	Wi weight
current ratio	12.755	5.928	0.099
quick ratio	13.433	6.21	0.104
asset-liability ratio (%)	2.005	3.403	0.030
gross profit margin (%)	2.27	2.542	0.027
Net rate on sales (%)	1.61	10.938	0.048
Return on total assets (weighted)(%)	1.169	9.604	0.038
Cost and expense profit margin of (%)	1.857	8.521	0.045
Accounts receivable turnover rate (times)	2.102	5.747	0.040
Inventory turnover rate (times)	17.509	7.851	0.134
Total assets turnover rate (secondary)	7.747	3.298	0.058
Operating revenue growth rate of (%)	2.802	12.785	0.068
Technology input rate is (%)	18.755	8.007	0.140
Capital value preservation and appreciation rate is (%)	7.999	3.144	0.057
rate of capital accumulation (%)	7.985	12.022	0.112

As can be seen from the chart, the technology investment rate accounts for the largest proportion, and the sales gross profit rate is the smallest. This paper uses Lagrange multiplier method to find the combination weight, which can better realize the combination of entropy method and coefficient of variation method, and better establish the financial performance evaluation system of pharmaceutical enterprises.

4.3 Calculation of the scoring results

According to the financial performance evaluation system of pharmaceutical enterprises constructed in this paper, combined with the weight of entropy method, coefficient of variation method and Lagrange multiplier method, the calculation formula of the development index of pharmaceutical enterprises is as follows:

$$y_1 = 0.099x_1 + 0.104x_2 + 0.03x_3$$

$$y_2 = 0.027x_4 + 0.048x_5 + 0.038x_6 + 0.045x_7$$

$$y_3 = 0.04x_8 + 0.134x_9 + 0.058x_{10}$$

$$y_4 = 0.068x_{11} + 0.14x_{12} + 0.057x_{13} + 0.112x_{14}$$

$$L = y_1 + y_2 + y_3 + y_4$$

Among them, L is the final score, and the score is ranked;

Calculated by the formula, the scores and rankings of 42 A-share listed companies are obtained. Due to the limited space of the article, only the top five and the bottom five companies in the score are listed here, as shown in Table 3 and Table 4:

Table 3: Top five scores and rankings

name	Y1	ranking	Y2	ranking	Y3	ranking	Y4	rankings	score	ranking
Chengda Pharmaceutical Company 301201	0.2331		0.10613		0.04332		0.2031		0.5851	
Chengdu Pilot 688222	0.2192		0.08525		0.04528		0.1209		0.4692	
Northanger 301333	0.1056		0.09917		0.04726		0.1892		0.4403	
Baicheng Pharma 301096	0.0939		0.1194		0.03935		0.1475		0.3984	

Table 4: Shows the bottom five scores and rankings

name	Y1	ranking	Y2	ranking	Y3	ranking	Y4	ranking	score	ranking
International Medicine 000516	0.015	38	0.025	41	0.102	5	0.032	39	0.174	38
Aoyang Health 002172	0.005	42	0.068	37	0.074	9	0.008	42	0.155	39
Yingkang Life 300143	0.033	31	0.010	42	0.068	14	0.038	38	0.149	40
Photoactive ophthalmology department 002524	0.005	41	0.061	39	0.056	24	0.025	40	0.147	41
Great East 600327	0.024	35	0.077	32	0.014	42	0.016	41	0.131	42

5. Conclusion and suggestion

5.1. Research conclusions

Due to the problems existing in the previous research on the financial performance of listed pharmaceutical companies, this paper optimizes the financial performance evaluation method of pharmaceutical enterprises, and selects the financial performance analysis indicators more suitable for pharmaceutical enterprises to establish the evaluation system. This paper selected 42 a-share listed pharmaceutical companies as the research object, selected 4 aspects of 14 indicators, using the entropy method-coefficient of variation method, using the Lagrange multiplier method coupling mathematical modeling and empowerment score, finally 42 listed pharmaceutical companies in solvency, profitability, management ability and development ability of the four dimensions of score and comprehensive score, through the empowerment score chengda pharmaceutical score first, the lowest.

5.2. Research suggestions

According to the above analysis and conclusions, this paper puts forward the following suggestions: First, improve the guarantee of the capital safety of pharmaceutical enterprises and the flow ratio of capital, grasp the capital safety of listed pharmaceutical enterprises firmly in their own hands, and increase the capital turnover rate of pharmaceutical enterprises, to attract more investment for development. The second is to improve the technology investment rate of pharmaceutical enterprises, that is, the innovation ability of pharmaceutical enterprises. General Secretary once pointed out: "We must adhere to independent innovation." As a pharmaceutical enterprise, only by adhering to the reform and innovation, scientific and technological innovation can we develop and produce better medical products, make better medical services, and truly protect the health and future of the people. And mastering the core technology can make the pharmaceutical enterprises improve the production efficiency, optimize the enterprise structure, optimize the allocation of enterprise resources, and other issues, and create more development space. Pharmaceutical enterprises should reform, innovate and optimize their enterprise structure by improving their own solvency and development ability, and face the challenge of further enhancing the market competitiveness of China's aging population and its innovation ability.

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