Financial Evaluation of Publicly Listed Companies in the Feed Industry Based on Cross-section Data

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Abstract　The feed industry serves as a critical intermediary between agriculture and animal husbandry，providing essential support for the modern breeding industry. Utilizing the annual financial report data from 19 publicly listed companies within the feed industry in 2023，a comprehensive evaluation index system was developed to assess the financial performance of these companies from four dimensions：debt paying ability，operational ability，profitability，and development ability. Factor analysis and hierarchical cluster analysis were employed to assess the financial performance of publicly listed companies within the feed industry. By comparing the mean classifications and comprehensive scores，this study analyzed the strengths and weaknesses of these listed feed companies. Ultimately，it offered recommendations for improvement in areas such as product optimization and enhancement，reasonable liability management，and the advancement of company governance practices.

Key words　Feed industry，Factor analysis，Cluster analysis，Financial evaluation

0　Introduction

The expansion of the global population，coupled with the rising demand for animal feed，has led to the growing significance of the feed industry within the national economy. As the largest producer and consumer of industrial feed worldwide，China possesses a substantial and expanding market for feed，which has emerged as a crucial driver in advancing agricultural modernization and facilitating the transformation and upgrading of the livestock industry. According to the *2023 National Feed Industry Development Overview* published by the China Feed Industry Association Network，the total output value of the feed industry in China in 2023 reached 1401.83 billion yuan，reflecting a growth of 6.5% compared to the previous year. Additionally，the total operating income amounted to 1330.44 billion yuan，representing an increase of 5.4%. Furthermore，the total output of industrial feed in China was recorded at 321.627 million t，which signifies a rise of 6.6% in comparison to the prior year. The data indicates that in 2023，the total output value of the feed industry experienced continued growth，with the total output of industrial feed reaching a new peak. This trend suggests a positive trajectory for the development of China's feed industry，as well as a relatively stable business environment for enterprises within this industry.

With the ongoing advancement of China's feed industry，there has been a notable increase in research focused on publicly listed feed companies. Meng Lihui[1] emphasized that the high-quality development of the feed industry represents a crucial pathway for expediting the establishment of a robust agricultural nation and realizing the modernization of agriculture and rural areas. The digital economy has the potential to enhance the internal management efficiency of feed enterprises significantly. Additionally，it can contribute to the establishment of a positive corporate brand image and facilitate the transformation of traditional marketing channels，thereby promoting the high-quality development of the feed industry. Liu Huizi[2] posited that within the contemporary framework of the digital economy，it is imperative to conduct a thorough analysis of the developmental challenges facing the feed industry. Furthermore，leveraging the advantages and functionalities of the digital economy is essential for actively facilitating the transformation and upgrading of the feed industry，thereby fostering its healthy and sustainable development. Song Yingchun *et al.*[3] developed an evaluation index system and a coupled coordination degree model to assess the high-quality development of the digital economy and feed industry. Based on their research findings，they proposed policy recommendations aimed at fostering the synergistic development of the two. According to Shi Zhuzi[4]，pioneering enterprises in the feed industry should prioritize research and development of new technologies，expedite digital transformation，investigate green and sustainable development models，and actively engage in the establishment of an industry-university-research platform. These initiatives are essential for enhancing the quality and efficiency of the entire feed industry chain and facilitating its green transformation. In the context of evaluating financial performance，a variety of analytical methods have been employed by numerous scholars to assess the financial performance of publicly listed feed companies. For instance，Hao Yanhua[5] employed the AHP model to identify effectiveness indicators and utilized the DEA model to assess the financial performance of publicly listed feed companies. Xia Juzi[6] employed the entropy weight multi-layer TOPSIS method to assess the financial performance of publicly listed feed companies in China. This evaluation was conducted through various dimensions，including asset operational ability，profitability，developmental ability，debt paying ability，and non-financial indicators. Furthermore，Xia proposed essential strategies aimed at improving the financial performance of these companies，particu-

larly by fostering the development of innovative business models and leveraging financial instruments effectively. Yang Lei[7] employed factor analysis to identify publicly listed companies within the feed industry for the purpose of evaluating their financial performance. The study further examined the differences in financial performance among these companies and explored the underlying factors that contributed to these variations.

This study developed a comprehensive evaluation index system for assessing the financial performance of 19 publicly listed companies in the feed industry, based on the annual financial report data from 2023. The evaluation framework was structured around four key dimensions: debt paying ability, operational ability, profitability, and development ability. This study employed factor analysis and hierarchical cluster analysis to assess the financial performance of publicly listed companies within the feed industry. Based on the findings, relevant policy recommendations were proposed to serve as decision-making references for operators, consumers, and investors.

1 Data sources

1.1 Selection of samples This study selected 19 publicly listed companies within the feed industry from the Shenzhen and Shanghai stock exchanges. To ensure the credibility and representativeness of the sample, all selected companies were those that had not been designated as ST or *ST. The samples comprised 11 livestock and poultry feed companies, which included Zhenghong Science and Technology (000702), New Hope (000876), Boen Group (001366), Tecon Biology (002100), Dabeinong (002385), Kingsino (002548), Tangrenshen (002567), Star Lake Bioscience (600866), Teamgene Technology (603151), Wellhope Foods (603609), and Road Biology Environmental Protection Technology (688156). Additionally, there were four aquatic feed companies: Yuehai Feeds (001313), Haid Group (002311), Baiyang Investment (002696), and Tianma Science and Technology (603668). Furthermore, the sample included four pet feed companies: China Pet Foods (002891), Petpal Pet Nutrition Technology (300673), Gambol Pet (301498), and Luscious Pet Food (832419).

The data utilized in this study were obtained from the annual financial reports published by publicly listed feed companies in 2023. This information was sourced from the Shenwan Hongyuan Financial Terminal and further supplemented by the CSMAR database.

1.2 Selection of indicators This paper constructed a financial performance evaluation system for publicly listed companies in the feed industry by selecting 12 financial indicators across four dimensions: debt paying ability, operational ability, profitability, and development ability. This selection was based on analyses of financial performance conducted by relevant scholars both domestically and internationally, as illustrated in Table 1.

Table 1   Financial evaluation system of publicly listed companies in the feed industry

Type of indicators	Name of indicators	Interpretation of indicators
Debt paying ability	Current ratio	Current assets/Current liabilities
	Quick ratio	Quick assets/Current liabilities
	Asset-liability ratio	Total liabilities/Total assets × 100%
Operational ability	Accounts receivable turnover	Operating income/Average accounts receivable balance
	Inventory turnover	Operating costs/Average inventory balance
	Total asset turnover ratio	Operating income/Average total assets
Profitability	Operating profit ratio	Operating profit/Operating income × 100%
	Return on total assets (ROA)	Total earnings before interest and tax/Average total assets × 100%
	Return on equity (ROE)	Net profit/Average net assets
Development ability	Operating income growth rate	Increase in operating income for the current year/Total operating income for the previous year × 100%
	Total asset growth rate	Growth in total assets for the year/Total assets at the beginning of the year × 100%
	Operating profit growth rate	Increase in operating profit for the current year/Total operating profit for the previous year × 100%

2 Factor analysis

Factor analysis is a multivariate statistical method that elucidates the relationships among multiple variables by extracting a limited number of factors. These extracted factors are subsequently named to provide a comprehensive explanation of the variables involved.

2.1 Factor analysis fitness test Prior to conducting the factor analysis, the data were standardized to mitigate the impact of varying scales among different variables. The formula used for standardization was as follows: $Z_{ij} = \dfrac{x_{ij} - \bar{x}_j}{S_j}$, $i = 1, 2, \cdots, n$; $j = 1, 2, \cdots, p$.

Consequently, the standardized matrix Z was derived[8], after which all standardized data were analyzed using the KMO test and Bartlett's test of sphericity, employing SPSS 27. The results of these tests are presented in Table 2.

As presented in Table 2, the result of the KMO test was 0.612, exceeding the threshold of 0.5. Additionally, the outcome of Bartlett's test of sphericity yielded a value of 238.961, with a significance level (P value) approaching 0. These findings suggested a strong correlation among the 12 evaluation indicators. Consequently, both the KMO and Bartlett tests indicated that the data were appropriate for factor analysis.

Table 2   KMO and Bartlett's test

Goodness of fit test		Calculated value
KMO measure of sampling adequacy		0.612
Bartlett's test of sphericity	Approximate *Chi*-squared value	238.961
	Degree of freedom	66
	Significance	0.000

2.2   Eigenvalues and variance contribution rate   In the process of selecting the extracted common factors, the criteria employed were based on eigenvalues exceeding 1. In this instance,

only three common factors out of the 12 evaluation indicators exhibited eigenvalues greater than 1. Consequently, a total of three public factors were identified (Table 3). The eigenvalues of these selected common factors were 5.788, 2.141, and 1.372, with corresponding variance contribution rates of 48.237%, 17.844%, and 11.431%, respectively[9]. The cumulative contribution rate of these three factors amounted to 77.513%. Consequently, it can be concluded that the three extracted common factors accounted for a total of 77.513% of the variance in the original variables. This indicates that the original indicators can be effectively represented by the common factors.

Table 3   Total variance for factor analysis

Component	Initial eigenvalue			Sum of squared rotating loads		
	Total	Percentage of variance	Cumulative contribution rate//%	Total	Percentage of variance	Cumulative contribution rate//%
1	5.788	48.237	48.237	3.543	29.529	29.529
2	2.141	17.844	66.081	3.530	29.416	58.944
3	1.372	11.431	77.513	2.228	18.568	77.513
4	0.971	8.093	85.606			
5	0.577	4.805	90.411			
6	0.549	4.574	94.985			
7	0.282	2.346	97.331			
8	0.198	1.646	98.977			
9	0.082	0.684	99.661			
10	0.026	0.217	99.879			
11	0.013	0.108	99.986			
12	0.002	0.014	100.000			

2.3   Factor loading matrix   In this study, the initial loading matrix was subjected to rotation utilizing the maximum variance method. Subsequently, a rotated loading matrix was derived, from which common factors with distinct economic significance can be identified. As illustrated in Table 4, the factor loadings for the current ratio, quick ratio, asset-liability ratio, and total asset turnover ratio in the first principal component were notably high. This primarily indicated the company's debt paying ability, leading to the designation of the first factor as the debt paying ability factor. In the second principal component, the factor loadings for operating profit margin, return on total assets, return on equity, operating income growth rate, and operating profit growth rate were notably substantial. This primarily indicated the company's profitability, leading to the designation of the second factor as the profitability factor. In the third principal component, the factor loadings for accounts receivable turnover, inventory turnover, and total asset turnover were notably substantial, primarily indicating the company's operational efficiency. Consequently, this third factor may be designated as the operational efficiency factor.

2.4   Factor score and ranking   Regression analysis was employed to estimate the factor score coefficient matrix for publicly listed feed companies (Table 5). The three selected common factors were represented as linear combinations of the respective variables. The score functions for the three common factors are as follows:

$$F_1 = 0.366x_1 - 0.379x_2 - 0.250x_3 + 0.021x_4 + 0.087x_5 + 0.044x_6 - 0.050x_7 - 0.035x_8 - 0.048x_9 - 0.297x_{10} +$$

$$0.095x_{11} + 0.017x_{12}$$

$$F_2 = -0.157x_1 - 0.175x_2 + 0.008x_3 - 0.074x_4 - 0.022x_5 + 0.081x_6 + 0.272x_7 + 0.255x_8 + 0.251x_9 + 0.348x_{10} + 0.090x_{11} + 0.172x_{12}$$

$$F_3 = 0.040x_1 + 0.033x_2 - 0.075x_3 + 0.265x_4 + 0.444x_5 + 0.437x_6 - 0.030x_7 - 0.014x_8 - 0.026x_9 - 0.015x_{10} - 0.049x_{11} + 0.126x_{12}$$

Table 4   Component matrix after rotation by the maximum variance method

	Component		
	1	2	3
Current ratio	0.943	0.184	−0.135
Quick ratio	0.957	0.150	−0.154
Asset-liability ratio	−0.812	−0.458	0.025
Accounts receivable turnover	−0.286	−0.322	0.603
Inventory turnover	−0.084	−0.072	0.930
Total asset turnover ratio	−0.018	0.206	0.906
Operating profit ratio	0.406	0.868	−0.135
Return on total assets	0.413	0.835	−0.105
Return on equity	0.367	0.798	−0.119
Operating income growth rate	−0.325	0.623	0.062
Total asset growth rate	0.560	0.532	−0.219
Operating profit growth rate	0.317	0.594	0.199

A comprehensive evaluation model was developed for the financial indicators of 19 publicly listed feed companies in 2023, utilizing three common factors identified through factor analysis:

$$F = 0.381F_1 + 0.380F_2 + 0.240F_3$$

where F denotes the composite score derived from the financial indicators of the publicly listed feed companies. This score was calculated by first determining the three factor scores for each of the 19 publicly listed feed companies in 2023. Subsequently, the composite scores were computed using a comprehensive evaluation model. The companies were then ranked based on these composite scores, with the results presented in Table 6.

Table 5   Factor score coefficient matrix

|	Component		
	1	2	3
Current ratio	0.366	−0.157	0.040
Quick ratio	0.379	−0.175	0.033
Asset-liability ratio∥%	−0.250	0.008	−0.075
Accounts receivable turnover	0.021	−0.074	0.265
Inventory turnover	0.087	−0.022	0.444
Total asset turnover ratio	0.044	0.081	0.437
Operating profit ratio	−0.050	0.272	−0.030
Return on total assets	−0.035	0.255	−0.014
Return on equity	−0.048	0.251	−0.026
Operating income growth rate	−0.297	0.348	−0.015
Total asset growth rate	0.095	0.090	−0.049
Operating profit growth rate	0.017	0.172	0.126

Table 6   Financial composite score and ranking of 19 publicly listed feed companies

Rank	Company	F
1	Goodbaby Pets	1.05
2	Boen Group	0.88
3	Haid Group	0.61
4	Teamgene Technology	0.58
5	Luscious Pet Food	0.53
6	Wellhope Foods	0.41
7	Yuehai Feeds	0.20
8	China Pet Foods	0.10
9	Petpal Pet Nutrition Technology	0.01
10	Star Lake Bioscience	−0.05
11	New Hope	−0.09
12	Baiyang Investment	−0.23
13	Road Biology Environmental Protection Technology	−0.23
14	Tangrenshen	−0.28
15	Zhenghong Science and Technology	−0.35
16	Dabeinong	−0.59
17	Tecon Biology	−0.61
18	Tianma Science and Technology	−0.62
19	Kingsino	−1.33

3   Cluster analysis

Cluster analysis refers to the process of categorizing objects into groups based on the characteristics inherent in the data. In this study, the three identified common factors F_1, F_2, F_3 were subjected to systematic clustering analysis. The intergroup distances were computed utilizing the sum of squared deviations method. The resulting clustering dendrogram is presented in Fig. 1,

which indicates that publicly listed companies within the feed industry can be categorized into four distinct groups, as detailed in Table 7.
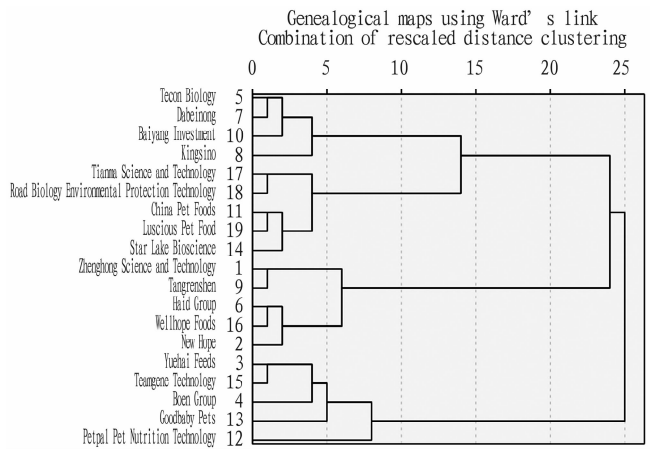
Fig. 1   Clustering dendrogram

Table 7   Category of each publicly listed company in the feed industry

Category	Number	Company
First	5	Yuehai Feeds, Boen Group, Petpal Pet Nutrition Technology, Goodbaby Pets, Teamgene Technology
Second	5	Zhenghong Science and Technology, New Hope, Haid Group, Tangrenshen, Wellhope Foods
Third	5	China Pet Foods, Star Lake Bioscience, Tianma Science and Technology, Road Biology Environmental Protection Technology, Luscious Pet Food
Fourth	4	Tecon Biology, Dabeinong, Kingsino, Baiyang Investment

Based on the findings from the hierarchical cluster analysis, which involved a comparison of the means of the three common factors alongside the composite factor scores (Table 8)[10], the classification characteristics associated with each category were delineated as follows.

Table 8   Comparison of mean classifications

Category	Debt paying ability	Profitability	Operational ability	Composite score
First	1.431 686	−0.011 200 0	0.011 584 0	0.544
Second	−0.495 490	−0.156 518 0	1.280 802 0	0.060
Third	−0.483 696	0.887 310 0	−0.857 068 0	−0.054
Fourth	−0.565 625	−0.899 487 5	−0.544 152 5	−0.690

The initial category of sample companies comprised five publicly listed entities within the feed industry: Yuehai Feeds, Boen Group, Petpal Pet Nutrition Technology, Goodbaby Pets, and Teamgene Technology. The mean value of the composite factor score for these companies was 0.544, positioning it as the highest among the sample companies. Specifically, Petpal Pet Nutrition Technology achieved the top rank in composite score, followed by Boen Group in second place, and Teamgene Technology in fourth place. In the analysis of single factors, it was observed that both debt paying ability and operating ability were greater than zero,

with debt paying ability exceeding the average value of the composite score. This suggested that companies within this category placed significant emphasis on debt paying ability, indicating favorable operating conditions in the short term. Conversely, profitability was found to be less than zero and below the average value of the composite factor score, highlighting a deficiency in profitability among these companies. To enhance profitability, it is recommended that these companies should focus on improving their profitability through strategies such as product optimization and innovation, as well as effective cost control and management practices.

The second category of sample companies comprised five publicly listed entities within the feed industry: Zhenghong Science and Technology, New Hope, Haid Group, Tangrenshen, and Wellhope Foods. The mean value of the composite factor score for this group was 0.06, positioning it in the second place among the sample companies, with the composite score ranking falling within the middle to upper range. Notably, certain companies in this category achieved relatively high rankings in the composite score; for instance, Haid Group was ranked third, while Wellhope Foods secured the sixth position. Among the individual factors analyzed, only the mean value of the operational ability factor score exceeded zero and was greater than the mean value of the composite score. This finding suggested that this category of companies placed a greater emphasis on operational ability. However, it also indicated that these companies exhibited deficiencies in profitability and debt paying ability, despite possessing a distinct advantage in operational ability. Similar to the first category of companies, certain companies must enhance their focus on profitability. Furthermore, these companies should maintain a requisite level of attention to debt paying ability, necessitating that the category of publicly listed companies within the feed industry improve their financial management capabilities. In light of the specific circumstances of each enterprise, it is essential to rationally control the scale of debt and adjust the debt structure to optimize the company's debt paying ability.

The third category of sample companies comprised five publicly listed entities within the feed industry, specifically China Pet Foods, Star Lake Bioscience, Tianma Science and Technology, and Road Biology Environmental Protection Technology. The mean value of the composite factor score for this group was −0.054, positioning it in third place among the sample companies. This ranking indicated that the composite score fell within the middle to lower range of the overall assessment. In the analysis of single factors, it was observed that the mean value of the profitability factor score exceeded zero and was greater than the mean value of the composite score. This finding suggested that this category of companies placed a higher emphasis on profitability. Conversely, the mean values for debt paying ability and operational ability were negative and lower than the mean value of the composite score. This indicated that while these companies demonstrated relatively strong prof-

itability and an effective ability to generate profits, their debt paying ability and operational ability were comparatively weak. This category of publicly listed companies within the feed industry should not only enhance and refine their financial management capabilities, but also implement reasonable controls over the scale of liabilities and adjust the structure of liabilities in accordance with the specific circumstances of the comapny, to optimize the company's debt paying ability. Additionally, it is essential to improve asset management and internal operations to enhance the overall operational capacity of the company.

The fourth category of sample companies comprised four publicly listed entities within the feed industry: Tecon Biology, Dabeinong, Kingsino, and Baiyang Investment. The mean value of the composite factor score for this group was −0.69, positioning it at the lower end among the sample companies analyzed. Consequently, the ranking of the composite score was classified as low. The scores for the debt paying ability factor, profitability factor, and operational ability factor in the single-factor analysis were all below zero; however, only the profitability factor was lower than the average of the composite scores. This finding suggested that the debt paying ability and operational ability of this category of companies were relatively strong, while profitability was comparatively weak. Consequently, these companies should consider adjusting their profitability strategies and formulating long-term development plans.

4   Conclusions and suggestions

This study focused on 19 publicly listed companies within the feed industry in 2023 as the research subjects. Utilizing analytical methods such as factor analysis and hierarchical cluster, this paper aimed to develop a comprehensive evaluation system for assessing the financial status of these companies. The evaluation was conducted across four dimensions: debt paying ability, operational ability, profitability, and developmental ability. Furthermore, the financial status of 19 publicly listed companies in the feed industry was ranked and evaluated. By comparing the mean classifications and mean comprehensive scores, this analysis identified and examined the strengths and weaknesses of the publicly listed companies in the feed industry. Based on the findings, several recommendations are proposed.

(ⅰ) Product optimization and upgrading. Publicly listed companies within the feed industry can attain a more comprehensive understanding of market dynamics and consumer requirements. This knowledge enables them to refine their feed formulations and production processes, as well as to develop a diverse range of feed products tailored to various animal growth stages and breeding environments. Such strategic initiatives are essential for enhancing their competitive edge, effectively managing costs, and ultimately improving profitability.

chemical factor of fish growth limiting in the experimental group, the feed utilization rate of crucian carp was relatively improved. The yield of crucian carp in the experimental group increased by 21.54% and the feed conversion ratio decreased by 4.73%.

According to the comprehensive test results, integrated agro-aquaculture can not only effectively control the eutrophication of aquaculture water bodies, increase the yield per unit area and reduce the feed consumption rate, but also expand the rice planting area and increase the grain yield, showing significant economic and ecological benefits.

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(ii) Rational planning of liabilities. For publicly listed companies within the feed industry, it is imperative to strategically manage their liabilities and enhance their debt paying ability. Enterprises should assess their specific circumstances to effectively regulate the scale of their liabilities and adjust their debt structures, to optimize their overall debt paying ability.

(iii) Improving company governance. Companies can enhance asset management by improving the management of accounts receivable and implementing regular collection practices. Furthermore, it is essential to strengthen internal management to bolster the operational ability of the company. This can be achieved through the optimization of the governance structure and the enhancement of employee training, aimed at improving the overall operational ability of the company.

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