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The research on growth evaluation of Chinese bio-pharmaceutical listed companies based on factor analysis and entropy method

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ABSTRACT

With the development of China's economy and the evolution of medical insurance system, bio-pharmaceutical has become an industry experiencing rapid development. In this situation, it is of great importance to evaluate the growth ability of bio-pharmaceutical listed companies in order to boost its stable growth. The concepts of factor analysis and entropy method are first defined in the first part. Then, this paper explores the key factors that affect the growth capacity of Chinese bio-pharmaceutical listed companies most by using factor analysis and entropy method. As a result, these influential elements can be summed up as growth equality factor; risk factor; growth efficiency factor and innovation factor. Finally, some reasonable suggestions are presented to escort the sustainable development of Chinese bio-pharmaceutical listed companies .

Keywords: bio-pharmaceutical listed companies; growth evaluation; factor analysis; entropy method

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INTRODUCTION

With the development of China's economy, the tendency of population aging and the evolution of medical insurance system, bio-pharmaceutical has become a sunrise industry with strategic importance, experiencing rapid development. In this situation, it is of great importance to evaluate the growth ability of bio-pharmaceutical listed companies in order to boost its stable growth.

EXPERIMENTAL SECTION

1 Introduction of factor analysis and entropy method

1.1 Introduction of factor analysis

Factor analysis Model:

$$Z_j = a_{j1}F_1 + a_{j2}F_2 + a_{j3}F_3 \cdots + a_{jm}F_m + U_j \quad (1)$$

Factor analysis is a suitable method which can evaluate the growth ability of Chinese bio-pharmaceutical listed companies because the method eliminates the overlapped information of primitive indexes. It makes the result more rational and reliable. Effective classification for extracting the key factors that affect the growth capacity of bio-pharmaceutical listed companies from numerous factors with complex structure is studied in this paper blow based on factor analysis.

1.2 Introduction of entropy method

Entropy Method Formula:

$$P_{ij} = \frac{F_{ij}}{\sum_{i=1}^{n} F_{ij}} \quad (2)$$

$$S_j = -\frac{1}{\ln n}\sum_{i=1}^{n} P_{ij} Ln\, P_{ij} \quad (3)$$

$$D_j = 1 - S_j \quad (4)$$

$$W_j = \frac{D_j}{\sum_{j=1}^{m} D_j} \quad (5)$$

Entropy can measure the disorder degree of a system. We can evaluate the growth capacity of bio-pharmaceutical listed companies by analyzing the comprehensive scores based on entropy method.

By choosing factor analysis combined with entropy method, we can remove both repeatability and application correlations between indexes. At the same time, these two methods both reflect the effect of variation of each index to comprehensive evaluation.

2 Sample selection and data sources

This paper selected 76 bio-pharmaceutical listed companies from Shanghai Stock Exchange and Shenzhen Stock Exchange, excluding those with incomplete data, changing core business or having a record of ST or *ST. All these 76 bio-pharmaceutical listed companies' financial data from 2010 to 2012 are used to evaluate their growth capacity comprehensively.

3 Variable descriptions

A company's growth ability can be divided into two parts: one is using existing resources to maximize enterprise value, another is the room for further development and progress.

This paper evaluates the growth ability of Chinese bio-pharmaceutical listed companies comprehensively from five dimensions, including innovation, risk, growth speed, growth efficiency and growth equality. 9 financial indexes are used to describe company's growth capacity specially. (Table 1)

Table 1 variable description of growth indicators

Variable type	Symbol	Variable name
Innovation	X_1	Intangible Assets/ Total Assets
Risk	X_2	Equity ratio
	X_3	Cash Ratio
Growth speed	X_4	Net Profit Growth Rate
Growth efficiency	X_5	Ratio of Profits to Cost
	X_6	Accounts Receivable Turnover
	X_7	Inventory Turnover
Growth equality	X_8	Total Assets Payment Growth Rate
	X_9	Net Assets Profit Growth Rate

3 Factor analyses

3.1 Descriptive statistics

Table 2 Descriptive Statistics

	Minimum	Maximum	Mean	Std. Deviation
Intangible Assets/ Total Assets(X1)	0.01	0.24	0.06	0.05
Equity ratio(X2)	0.12	0.98	0.64	0.19
Cash Ratio(X3)	0.30	51.13	3.22	4.56
Net Profit Growth Rate(X4)	0.03	0.84	0.44	0.19
Ratio of Profits to Cost(X5)	-0.75	2.52	0.18	0.25
Accounts Receivable Turnover(X6)	0.95	258.36	12.58	22.36
Inventory Turnover(X7)	0.20	8.95	3.51	1.73
Total Assets Payment Growth Rate(X8)	-0.23	0.32	0.10	0.07
Net Assets Profit Growth Rate(X9)	-0.72	0.40	0.11	0.11

As a whole, Chinese bio-pharmaceutical listed companies have good growth propensity and bright growing prospect.

The average net profit growth rate reached 0.84.

3.2 Feasibility test of factor analysis

Firstly, this paper uses KMO and Bartlett's Test to checkout whether the correlation between indicators are feasible to factor analysis. Table 2 shows the result. The KMO is 0.680, more than the moderate criteria 0.6, while Bartlett sphere test value is 974.831 (the significance level of 0). Therefore, it is possible and reasonable to do factor analysis using spss.

Table 3 KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.680
Bartlett's Test of Sphericity	Approx. Chi-Square	974.831
	Sig.	0.000

3.3 Establish factor variables

According to Table 4, the communalities of all the variables are higher than 60% or even 90%, indicating that factors been extracted have covered most information of initial variables.

Table 4 Communalities

	Initial	Extraction
Intangible Assets/ Total Assets(X_1)	1.000	0.797
Equity ratio(X_2)	1.000	0.787
Cash Ratio(X_3)	1.000	0.725
Net Profit Growth Rate(X_4)	1.000	0.779
Ratio of Profits to Cost(X_5)	1.000	0.691
Accounts Receivable Turnover(X_6)	1.000	0.773
Inventory Turnover(X_7)	1.000	0.814
Total Assets Payment Growth Rate(X_8)	1.000	0.944
Net Assets Profit Growth Rate(X_9)	1.000	0.883

Extraction Method: Principal Component Analysis.

In Table 5, all the 9 variables are merged into 4 kinds of common factors whose Initial Eigen values larger than 1. Their contribution rates to the growth capacity of Chinese bio-pharmaceutical listed companies are 29.12 %, 22.48 %, 15.12 % and 13.20 %. The cumulative variance is almost 80%.

Table 5 Total Variance Explained

	Initial Eigen values			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.358	37.313	37.313	2.621	29.119	29.119
2	1.687	18.749	56.062	2.023	22.478	51.597
3	1.116	12.396	68.457	1.361	15.120	66.716
4	1.031	11.457	79.915	1.188	13.199	79.915
5	0.635	7.055	86.970			
6	0.432	4.798	91.768			
7	0.410	4.556	96.324			
8	0.266	2.953	99.277			
9	0.065	0.723	100.000			

Extraction Method: Principal Component Analysis.

3.4 Factor component matrix

By analyzing the rotated factor component matrix table (Table 6), we can draw the following conclusions (Table 7).

Table 6 Rotated Component Matrixes

	1	2	3	4
Total Assets Payment Growth Rate(X_8)	0.960	0.143	0.041	0.030
Net Assets Profit Growth Rate(X_9)	0.933	0.027	0.108	0.001
Ratio of Profits to Cost(X_5)	0.754	0.248	-0.241	-0.057
Cash Ratio(X_3)	-0.001	0.847	-0.035	-0.080
Equity ratio(X_2)	0.315	0.813	-0.159	-0.039
Net Profit Growth Rate(X_4)	0.385	0.578	-0.536	0.097
Inventory Turnover(X_7)	0.041	-0.131	0.887	0.093
Intangible Assets/ Total Assets(X_1)	-0.085	-0.392	-0.186	0.776
Accounts Receivable Turnover(X_6)	0.071	0.239	0.392	0.746

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 8 iterations.

Table 7 Conclusion

	Load	Name
the first common factor	X8, X9, and X5	growth equality
the second common factor	X3, X2, and X4	risk
the third common factor	X7	growth efficiency
the forth common factor	X8 and X1	innovation

3.5 Scoring of factors

Factor scoring is the ultimate expression of factor analysis. The scores about 4 common factors are cited in Table 8. We can calculate the scores of the 4 common factors for each observation based on the coefficient and initial variables. After factor scoring, we can achieve the effect of dimensionality reduction by replacing initial variables with the scores of factors.

Table 8 Scores of Common Factors

	Component			
	1	2	3	4
Intangible Assets/ Total Assets(X1)	0.010	-0.206	-0.306	0.672
Equity ratio(X2)	-0.017	0.417	0.020	0.030
Cash Ratio(X3)	-0.162	0.518	0.128	-0.005
Net Profit Growth Rate(X4)	0.051	0.200	-0.342	0.172
Ratio of Profits to Cost(X5)	0.288	-0.037	-0.139	-0.031
Accounts Receivable Turnover(X6)	-0.036	0.257	0.279	0.622
Inventory Turnover(X7)	0.049	0.071	0.688	-0.028
Total Assets Payment Growth Rate(X8)	0.401	-0.087	0.064	-0.001
Net Assets Profit Growth Rate(X9)	0.413	-0.145	0.102	-0.041
Extraction Method: Principal Component Analysis. *Rotation Method: Varimax with Kaiser Normalization.* *Component Scores.*				

4 Comprehensive scoring by the entropy method

Finally, taking the year of 2012 as an example, we use the entropy method to determine the weight of evaluating indicators. Then we calculate the composite score that reflects each sample company's growth ability on the basis of the results of factor analysis. Following are the steps.

$$P_{ij} = \frac{F_{ij}}{\sum_{i=1}^{n} F_{ij}} \tag{2}$$

$$S_j = -\frac{1}{\ln n} \sum_{i=1}^{n} P_{ij} Ln\, P_{ij} \tag{3}$$

Following the formulas above, the entropy of 4 common factors (Sj) is (0.173004, 0.345815, 0.36602, 0.398452).

$$D_j = 1 - S_j \tag{4}$$

$$W_j = \frac{D_j}{\sum_{j=1}^{m} D_j} \tag{5}$$

Following the formulas above, the weight of 4 common factors (Wj) is (0.304411, 0.240801, 0.233363, 0.221425).

Last but not least, we can calculate the composite score reflecting each sample company's growth ability following the formula above.

The ranking of the sample companies according to the scores are presented in Table 9.

RESULTS

The final composite score calculated by adopting factor analysis and entropy method implies that JZYY (600750), GLSJ (002275), DEEJ (000423), QJYY (600479), and LRZY (600285) score higher than other companies. However, if we only use entropy method to determine the weight the evaluating indicators, companies with higher scores will be JZYY (600750), QZZY (002287), GLSJ (002275), DEEJ (000423) and YNBY (000538). Ranking results will be

different depending on different evaluating methods. Using factor analysis and entropy method agrees more with the fact because entropy method only neglects the overlapped information of primitive indexes, thus resulting in irrationality in the ranking of growth ability. Contrarily, factor analysis combined with entropy method can remove both repeatability and application correlations between indexes.The result will be more rational and reliable.

Table 9 Composite scores

Entropy method combined with factor analysis		Entropy method only	
Item	Score	Item	Score
JZYY (600750)	1.4025	JZYY (600750)	9.9826
GLSJ (002275)	0.5660	QZZY(002287)	4.0493
DEEJ (000423)	0.5495	GLSJ (002275)	3.8172
QJYY (600479)	0.5216	DEEJ (000423)	3.5853
LRZY (600285)	0.5034	YNBY (000538)	2.7902

CONCLUSION

1 Conclusion

By factor analyzing, we could merge all the 9 variables that affect the growth capacity of a company into 4 kinds of common factors, namely, growth equality, risk, growth efficiency and innovation. Their contribution rates to the growth of Chinese bio-pharmaceutical listed companies are 29.12 %, 22.48 %, 15.12 % and 13.20 %.

The empirical research has shown that, as a whole, Chinese bio-pharmaceutical listed companies have good growth propensity and bright growing prospect. The average net profit growth rate reached 0.84. The final composite score implies that JZYY (600750), GLSJ (002275), DEEJ (000423), QJYY (600479), and LRZY (600285) score higher than other companies.

Using entropy method directly to estimate the growth ability of Chinese bio-pharmaceutical listed companies will neglect the overlapped information of primitive indexes, thus resulting in irrationality in the ranking of growth ability. By using factor analysis combined with entropy method, we can remove both application correlations between indexes and repeatability, at the same time; these two methods both reflect the effect of variation of each index to comprehensive evaluation. The result will be more rational and reliable.

2 Suggestions

(1) Improve the specialization level of cooperation in bio-pharmaceutical industry through asset reorganization
Bio-pharmaceutical industry should strengthen asset restructuring and integrate resources to reduce the cost of competition, increase profits, cut transaction costs and improve anti-risk abilities, facing the growth problems brought by low industry concentration rate and poor resources utilization efficiency, .

(2) Vigorously promote technological progress in bio-pharmaceutical industry
The constraints analysis about the growth ability of bio-pharmaceutical companies shows that bio-pharmaceutical companies widely have the problem of weak R & D efforts and low scientific and technological achievements conversion rate. Vigorously promote scientific and technological progress, will become an essential way to improve the growth ability of bio-pharmaceutical listed companies. On the one hand, improving the scientific research ability of bio-pharmaceutical listed companies needs the support from the government. On the other hand, Chinese bio-pharmaceutical listed companies should strengthen the international technology cooperation to improve their scientific research ability.

(3) Improve the competitiveness of bio-pharmaceutical cooperation comprehensively
The most prominent feature of the listed company's competitiveness is the combination of human resource and advanced products. The strategies used to promote the competitiveness of products and innovations have been discussed before. Four measures promoting the competitiveness of human resource will be proposed below. Firstly, cultivate a unique brand culture. Secondly, focus on the innovation of marketing and service. Thirdly, build the core capability of human resource. Last but not least, build a unique corporate culture.

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