



Research on the Growth Measurement and Characteristics of Chinese ChiNext Listed Companies

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Abstract. The article takes 640 companies listed on the ChiNext board as research samples, selects 16 measurement indicators from both financial and non-financial perspectives, and uses factor analysis to evaluate the growth of Chinese ChiNext board listed companies. The second order clustering method is used to classify companies from six dimensions: solvency factor, profitability factor, R&D ability factor, growth potential factor, operational ability factor, and growth score. Explored the growth characteristics of different enterprises. Research has found that the overall level of growth of enterprises listed on the ChiNext board in China is relatively low and there is a significant gap between different enterprises. At the same time, the clustering results show that enterprises listed on the ChiNext board are divided into four types, namely high-speed growth enterprises, conservative growth enterprises, innovation potential enterprises, and risk decline enterprises. The study revealed the problems of enterprises listed on the ChiNext with different growth characteristics, and proposed corresponding suggestions to improve their growth, providing certain reference and reference for China's ChiNext listed enterprises to achieve sustainable growth.

Keywords: Enterprise growth; Growth Enterprise Market; Factor analysis; cluster analysis.

1 Introduction

The ChiNext market was established in 2009 with the aim of addressing the financing difficulties faced by entrepreneurial and innovative small and medium-sized enterprises. In the process of over a decade of development, the size of the ChiNext market has been continuously expanding. The ChiNext market has become an important component of China's capital market. Although the rapid development of China's ChiNext market has provided financing channels for a large number of entrepreneurial and innovative small and medium-sized enterprises, currently listed companies on the ChiNext market in China are also facing problems such as overvalued stock prices, high P/E ratios, and unstable operations. If the future development of these companies falls short of expectations, it will inevitably bring risks to investors and the

entire ChiNext market. Therefore, studying the growth potential of listed companies on the ChiNext is crucial for the sustainable development of China's ChiNext market.

2 Literature Review

By Domestic and foreign scholars have also conducted extensive research on the measurement and evaluation of corporate growth^[1]. Most scholars evaluate a company's growth by selecting single or multiple financial indicators^[2]. Shan Chunxia believes that enterprises can continuously increase revenue to increase market share and achieve sustainable growth^[3]. Therefore, the growth rate of operating revenue is used as an evaluation indicator to measure the growth of enterprises. Scholars such as Lu Fucui have selected three indicators, namely net profit growth rate, main business revenue growth rate, and total asset growth rate, to represent the explicit characteristics of enterprise growth as the outcome indicators of growth^[4]. By selecting and predicting indicators, they constructed a three in one enterprise growth indicator measurement system that integrates enterprise resources, capabilities, and characteristics^[5]. In addition to financial indicators, some scholars have also included non-financial indicators to evaluate and measure the growth of enterprises. Li Fei, Hu Yi and Zhang Qi selected 15 indicators from both financial and non-financial perspectives to construct a growth evaluation model for listed companies on the Northeast Growth Enterprise Market^[6]. Ghosh evaluated and analyzed the growth potential of 50 small and medium-sized enterprises in Singapore, while taking into account non-financial factors such as executive quality and strategic decision-making^[7].

The above scholars' research on corporate growth provides a theoretical basis for the selection of growth measurement indicators for Chinese ChiNext companies in the future. The growth of a company is a dynamic process with a certain degree of complexity. The growth of a company not only includes the growth of profitability, but also the growth of market and scale. Measuring a company's growth solely through a single indicator is too one-sided. In addition, according to previous research by scholars, there is still little analysis of the growth characteristics of different GEM companies. Therefore, this article will start from both financial and non-financial perspectives, and based on the research of existing scholars, combined with the characteristics of listed companies on the ChiNext board, select multiple measurement indicators. By combining factor analysis and cluster analysis, comprehensively measure the growth characteristics of Chinese GEM listed companies, and analyze the growth characteristics of Chinese GEM listed companies in cities.

3 Research Design

In the past, scholars have used methods such as Analytic Hierarchy Process, Factor Analysis, Coefficient of Variation, and Catastrophe Series to measure the growth of enterprises^[8], all of which have a certain degree of scientificity and focus^[9]. Considering that there are many measurement indicators for the growth of enterprises, and the information contained in different indicators may overlap, factor analysis method

can extract indicators with the same characteristics, use a few factors to describe the relationship between the majority of indicators, and comprehensively measure the growth level of various research objects^[10]. Therefore, this article chooses to use factor analysis method to measure the growth of Chinese ChiNext listed enterprises.

3.1 Source of Sample Data

As of December 30, 2022, there were a total of 1232 companies listed on the ChiNext board in China. After excluding ST and * ST companies, this study selected 640 companies with relatively complete relevant indicator data between 2019 and 2021 as the research objects. The average indicator values of these companies over the past three years were used as the research data to reduce the influence of accidental factors. All data were from Dongfang Fortune Network and Juchao Information Network.

3.2 Selection of Measurement Indicators for Enterprise Growth

This article combines the characteristics of listed companies on the ChiNext board in China, and considers the availability and operability of indicators. From a financial and non-financial perspective, 6 primary indicators and 16 secondary indicators are selected to construct a growth measurement system for listed companies on the ChiNext board in China, as shown in Table 1. The selection of financial measurement indicators for the growth of listed companies on the Growth Enterprise Market in China mainly considers the company's debt paying ability, profitability, operational ability, and growth ability, while the selection of non-financial measurement indicators mainly considers the company's characteristics and research and development ability.

Table 1. Growth measurement indicators for Chinese ChiNext listed companies

Indicator type	Primary indicators	Secondary indicators
Financial index	solvency	Asset liability ratio (X1)
		Current ratio (X2)
		Quick ratio (X3)
	Profitability	Operating gross profit margin (X4)
		Asset return rate (X5)
		Net profit margin on total assets (X6)
	Operational capability	Accounts receivable turnover rate (X7)
		Inventory turnover rate (X8)
		Total asset turnover rate (X9)
	Growth ability	Net profit growth rate (X10)
		Revenue growth rate (X11)
		Total asset growth rate (X12)
Non-financial indicators	Enterprise characteristics	Enterprise scale (X13)
		Top Ten Shareholders Shareholding Ratio (X14)
	R & D capabilities	R&D expense rate (X15)
		R&D personnel rate (X16)

3.3 The Mathematical Model of Principal Component Analysis

Assuming there are n samples, each with a total of p indicators, consider these p indicators as p random variables to form an $n * p$ -order data matrix X , denoted as $X=(x_1, x_2, \dots, x_p)^T$. The matrix is shown in equation (1):

$$X = \begin{bmatrix} x_{11} & \cdots & x_{1p} \\ \vdots & \ddots & \vdots \\ x_{n1} & x_{n2} & x_{np} \end{bmatrix} \quad (1)$$

Due to $x_1, x_2, \dots,$ and x_p being the original variable indicators, a linear transformation of X can generate a new comprehensive indicator, namely principal component, denoted as $Y=(y_1, y_2, \dots, y_p)^T$. The mathematical model of principal component analysis is equation (2):

$$\begin{cases} y_1 = a_1^T X = a_{11}x_1 + a_{21}x_2 + \cdots + a_{p1}x_p \\ y_2 = a_2^T X = a_{12}x_1 + a_{22}x_2 + \cdots + a_{p2}x_p \\ \vdots \\ y_p = a_p^T X = a_{1p}x_1 + a_{2p}x_2 + \cdots + a_{pp}x_p \end{cases} \quad (2)$$

Assuming that both the expected value and covariance matrix of X exist and are known, denote $E(X) = \mu$, $Var(X) = E[(X - \mu)^2]$. From equation (2), it can be concluded that (3) and (4):

$$var(y_j) = a_j^T \sum a_j, j = 1, 2, 3 \cdots, p \quad (3)$$

$$cov(y_j, y_k) = a_j^T \sum a_k, j, k = 1, 2, 3 \cdots, p \quad (4)$$

The principal component is a linear combination of P variables that are uncorrelated, i.e. $cov(y_j, y_k) = 0 (j \neq k)$, while maximizing the variance in equation (3). But there are several combinations that satisfy this condition, so only the coefficient vector with a_j as the unit length is considered, which satisfies $a_j^T a_j = 1$. The eigenvalues of the matrix can be calculated from the covariance matrix or correlation coefficient matrix of the original data λ . Because each characteristic value λ All correspond to the variance of a principal component y , such as λ_1 corresponds to the variance of y_1 , as the eigenvalues decrease sequentially, $\lambda_1 \geq \lambda_2 \geq \cdots \geq \lambda_p$. Therefore, if $var(y_1) \geq var(y_2) \geq \cdots \geq var(y_p)$, the larger the variance contribution rate of the i -th principal component, the more information the i -th principal component integrates with the original variable.

4 Empirical Analysis

4.1 Feasibility Testing of Factor Analysis

Perform KMO and Bartlett tests on the 16 indicator data of the sample using SPSS 24.0 statistical software. According to Table 2, the test value of KMO is 0.671. When

the KMO measure is greater than 0.5, it indicates that factor analysis is suitable. At the same time, the Bartlett sphericity test statistic is 8391.241, with a corresponding significance of 0.000. The null hypothesis is rejected, and there is a significant difference between the correlation coefficient matrix and the identity matrix. Therefore, the samples selected in this article are suitable for factor analysis.

Table 2. KMO and Bartlett's test

KMO sampling suitability quantity		0.671
Bartlett sphericity test	Approximate chi square	8391.241
	Degree of freedom	120
	Significance	0.000

4.2 Extraction of Principal Factors

As shown in Table 3, this article extracted 5 main factors with eigenvalues greater than 1, and the cumulative contribution rate of these 5 main factors reached 68.115%, indicating that these 5 main factors can explain 68.115% of the total variance of the original variable, fully reflecting most of the information in the original data. The effect of factor analysis is relatively ideal. Therefore, this article uses five main factors, namely F1, F2, F3, F4, and F5, as representatives to analyze the original 16 measurement indicators and measure the growth of Chinese ChiNext listed companies.

Table 3. Eigenvalues and contribution rates of principal factors

Principal factor	Eigenvalue	Contribution rate(%)	Accumulated rate(%)
F1	4.315	26.970	26.970
F2	2.734	17.089	44.059
F3	1.544	9.651	53.710
F4	1.277	7.980	61.689
F5	1.028	6.425	68.115

4.3 Rotating Component Matrix and Principal Factor Naming

After extracting 5 principal component factors, the maximum variance method was used to obtain the component matrix through orthogonal rotation, as shown in Table 4, and the principal component factors were explained.

Table 4. Component Matrix after Rotation

indicators	Principal factor				
	F1	F2	F3	F4	F5
Current ratio	0.892	0.179	0.143	0.007	-0.050
Quick ratio	0.879	0.179	0.164	-0.021	-0.029
Asset liability ratio	-0.826	-0.217	-0.162	0.009	0.007
Enterprise scale	-0.565	0.488	-0.016	-0.146	-0.151
Asset return rate	0.266	0.847	-0.060	0.270	0.131
Net profit margin on total assets	0.298	0.837	-0.028	0.271	0.119
Net profit growth rate	0.054	0.514	0.022	0.263	0.156
R&D expense rate	0.208	-0.040	0.862	0.016	-0.056
R&D personnel rate	0.054	-0.043	0.838	0.060	0.046
Operating gross profit margin	0.407	0.424	0.517	-0.046	-0.081
Revenue growth rate	-0.093	0.151	0.099	0.830	-0.024
Total asset growth rate	-0.013	0.406	0.079	0.788	0.043
Top Ten Shareholding Ratio	0.358	0.109	-0.223	0.475	0.091
Inventory turnover rate	-0.067	-0.036	0.110	-0.100	0.749
Total asset turnover rate	-0.150	0.093	-0.309	0.243	0.693
Accounts receivable turnover rate	0.159	0.221	0.016	0.031	0.575

The main factor F1 has a high load on current ratio, quick ratio, asset liability ratio, and enterprise size, mainly reflecting the short-term and long-term solvency of the enterprise. Therefore, the main factor F1 is named solvency factor. The main factor F2 has a significant impact on asset return rate, total asset net profit margin, and net profit growth rate. The return on assets and net profit margin of total assets mainly reflect the current profitability of the enterprise, while the growth rate of net profit reflects the growth status of the enterprise's profitability. Therefore, the main factor F2 is named the profitability factor. The main factor F3 has a significant impact on the proportion of R&D expenses, R&D personnel, and operating gross profit margin. The R&D expenses and R&D personnel reflect the level of R&D investment of the enterprise, while the operating gross profit margin reflects the R&D efficiency of the enterprise. Therefore, the main factor F3 is named as the R&D capability factor. The main factor F4 has a significant impact on the growth rate of operating revenue, total asset growth rate, and the shareholding rate of the top ten shareholders. The growth rate of operating revenue and total assets respectively measure the current level of competitiveness and scale growth of the enterprise, while the shareholding rate of the top ten shareholders indicates the participation of major shareholders and their confidence in achieving sustainable growth of the enterprise, both reflecting the growth potential of the enterprise. The main factor F4 is named the growth potential factor. The main factor F5 has a significant impact on inventory turnover, total asset turnover, and accounts receivable turnover, reflecting the operational capability of the enterprise. Therefore, it is named the combat capability factor.

4.4 The Calculation Formula for the Main Factor

According to the coefficient matrix of component scores, the formula for calculating the growth score is obtained by using the proportion of variance contribution as the weight of the five main factors: $F=(0.2697) \times F1+0.1709 \times F2+0.0965 \times F3+0.0798 \times F4+0.0643 \times$ Based on F5)/0.6812, the growth scores of 640 Chinese ChiNext listed companies were measured.

4.5 Analysis of Growth Scores of Chinese ChiNext Listed Companies

According to the growth score results, the score range of Chinese ChiNext listed companies is between -1.5 and 2.0. Based on the characteristics of growth score F, this article divides the growth score of Chinese ChiNext listed companies into 5 intervals, corresponding to 5 growth levels, as shown in Table 5.

Table 5. Growth Scores of Chinese ChiNext Listed Companies

Growth score range	Number	Percentage	Growth level
>1.0	17	2.66%	Excellent
0.5-1.0	57	8.91%	Good
0-0.5	223	34.84%	Commonly
-0.5-0	263	41.09%	Poor
-0.5<	80	12.50%	extremely poor

From the perspective of growth scores, the overall level of growth of listed companies on the ChiNext board in China is poor and there are significant differences. Among the 640 listed companies on the ChiNext board, more than half of them scored below 0 in terms of growth potential. Among them, 263 companies had poor growth potential, accounting for the largest proportion of the total sample, accounting for 41.09%. They still face certain challenges in the current market environment. In addition, 80 companies have extremely poor growth potential, accounting for 12.50% of the total sample. Their development is far from expected and they are facing significant growth difficulties. Measures need to be taken to improve and enhance the development prospects of the enterprise. Among the companies with a growth score above 0, 17 companies have a growth score exceeding 1.0. These companies have demonstrated excellent comprehensive abilities in their development process, but the number of such companies is rare, accounting for only 2.66% of the total sample. At the same time, only 8.91% of companies have good growth performance. Most companies have average growth levels, with relatively stable growth but still significant room for improvement.

4.6 Cluster Analysis

Due to the fact that the number of clustered enterprises in this article has reached 640 and there is no clear number of cluster groups, this article uses second-order clustering method to classify China's GEM listed enterprises from six dimensions and analyze the growth characteristics of each category of enterprises. This article uses SPSS 24.0 to perform second-order clustering on the sample data, using logarithmic similarity as the distance measurement method and Schwarz Bayes criterion (BIC) as the clustering criterion. The clustering results of the growth characteristics of Chinese ChiNext listed companies are obtained, as shown in Table 6. The optimal number of clusters is 4, and the measured value of cluster profile is 0.3. The quality of this clustering is good.

Table 6. Second-order Cluster Results of Chinese ChiNext Listed Enterprises

Group	num ber	per- centag e	Centroid					Growth
			F1	F2	F3	F4	F5	
1	50	7.8%	-0.1880	0.3292	1.1937	0.6115	1.9440	0.6097
2	160	25.0%	1.3002	0.2047	-0.1414	-0.0302	-0.1144	0.3743
3	290	45.3%	-0.3950	0.2535	0.0124	0.1987	-0.1177	-0.0360
4	140	21.9%	-0.6006	-0.8766	-0.2904	-0.5956	-0.3376	-0.5709

The first type of enterprises are high-speed growth enterprises, with only 50 (7.8%), and an average growth score of 0.6097, making them the best performing enterprises in China's ChiNext market. This type of enterprise is currently in a stage of rapid expansion, with innovation and high growth as its core competitive advantages. The second type of enterprises are conservative growth oriented enterprises, with a total of 160 (25%), and their current financial situation is the most stable. But this type of enterprise performs relatively conservatively in terms of research and development capabilities and operational potential. The third category of enterprises is innovative potential enterprises, with a total of 290 (45.3%), of which manufacturing enterprises account for 94.48%. These enterprises require a large amount of funds to purchase production equipment and improve technology to meet the market demand brought about by technological innovation. Therefore, this type of enterprise has low debt repayment ability but certain profitability and growth potential. At the same time, low debt repayment ability limits the growth performance of this type of enterprise, which limits its research and operation capabilities and prevents it from fully unleashing its growth potential. The fourth type of enterprises is risk declining enterprises, with a total of 140 (21.9%), with an average growth score of only -0.5709 and significantly lagging behind other types of enterprises. The comprehensive ability of enterprises in the growth process is declining. This type of enterprise is a disadvantaged enterprise in the industry, and in the future, it needs to actively implement strategic transformation and business reshaping to achieve sustainable growth.

5 Conclusions

In this paper, 640 GEM listed companies are selected as research samples, 16 measurement indicators are selected from both financial and non-financial aspects, and factor analysis is used to evaluate their growth. At the same time, the second order clustering method is used to classify enterprises from six dimensions and explore the growth characteristics of different enterprises. It is found that the overall growth level of GEM listed enterprises in China is low, and there is a significant gap between different enterprises. The clustering results show that GEM listed enterprises are divided into four types: high-speed growth enterprises, conservative growth enterprises, innovation potential enterprises and risk reduction enterprises. The research reveals the problems existing in enterprises with different growth characteristics, and puts for-

ward corresponding suggestions to improve growth, which provides certain reference for the sustainable growth of listed enterprises in chinext

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