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Growth Evaluation of Technology-based Small and Medium-sized Enterprises based on Catastrophe Series Method

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Abstract

Technology-based SMEs are one of the important groups to promote China's economic development. However, due to the limited scale of technology-based SMEs and the high degree of uncertainty in corporate innovation activities, the market environment of enterprises is changing rapidly. The growth evaluation of technology-based small and medium-sized enterprises can not only enable enterprises to understand the problems in their development process, but also provide effective data support for the future development strategy of the enterprise. Therefore, this article selects 10 listed technology-based SMEs in the information technology industry in Shaanxi Province as the analysis and research object, adopts the catastrophe series method, selects a scientific and reasonable comprehensive index to establish an evaluation model, and carries out the growth of the technology-based SMEs in Shaanxi Province. the study. The evaluation results are highly consistent with the actual situation of the enterprise, and can effectively reflect the growth of technology-based SMEs in Shaanxi Province. The research not only provides a reference for the technology-based SMEs to make adjustments in the course of their development, but also provides a reference for the government's policy-supporting technology-based SMEs.

Keywords

technology-based SMEs, catastrophe series method,growth evaluation.

1. Introduction

There are a large number of high-tech small and medium-sized enterprises in China, all of which are extremely dynamic. It is one of the important components of China's promotion of scientific and technological progress and is a small unit of regional economic development. Its growth determines the growth of the regional economy. Especially in places where there are many technology-based SMEs in Shaanxi Province, however, their insufficient operating funds, single financing channels, low risk resistance, and poor corporate structure stability make it difficult for technology-based SMEs to face changes in the external environment. Make effective responses in a timely manner, making the growth of technology-based SMEs full of dangers and hardships.

Enterprise growth refers to the development potential and trends possessed by an enterprise. It is a prediction of the company's future development capabilities, and it can provide an all-round dynamic prediction of the enterprise, which can provide effective decision-making basis for enterprise executives. The evaluation of the growth of technology-based SMEs can not only clearly understand the development status of technology-based SMEs and their shortcomings in growth, so as to provide targeted strategies, but also to study how to improve the capabilities of enterprises and optimize the structure of enterprises. Provide theoretical and data support to improve the environment for corporate growth. Many scholars in China have studied the growth evaluation of technology-based small and medium-sized enterprises,

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but most studies have combined qualitative indicators with quantitative indicators to establish a growth evaluation index system and use regional data for comparison. However, regional data has Certain limitations do not suffice to explain the growth issues of enterprises. This article will use regional data to compare with national data, and compare and analyze selected samples, providing more data and information support for comparative analysis of samples.

2. Literature References

2.1. Research on Evaluation Index System of Enterprise Growth

Kimberly Frank selected 6164 observation samples from 1981 to 1995 to study the relationship between the growth of the company and the correlation of the value of accounting information. The results show that the growth of the company accurately determines the accounting information and stock price There is a potential impact, and the relationship between corporate growth and accounting information has a negative correlation. Compared with the accounting data of low-growth companies, the accounting data of high-growth companies has lower value [1]. Therefore, accounting information can be used as one of the indicators of enterprise evaluation, but because the degree of value information that companies with different degrees can extract is different, if accounting information is used as a single evaluation index, it has certain limitations. D.J.Storey divides the factors of corporate growth into three aspects: the quality of managers, the intrinsic quality of SMEs and the strategic category of business development [2]. BCGhosh et al. Conducted a factor analysis on the key factors of the company's capabilities and success by studying 66 companies in Singapore's "top 50" in 1995 and 1996. The results of the study revealed five main points of corporate success The company has the ability to accurately position the market and segment the market, and efficient management, including a strong management organization and management execution and a visionary and ambition leadership team, able to obtain extensive support and sustainable development. Resources, government support, and appropriate strategic means. Although qualitative indicators are forward-looking indicators, they can make a certain prediction of the future development of the company, but the lack of an evaluation system of quantitative indicators greatly reduces the degree of conviction, so some researchers are more inclined to use qualitative indicators with financial indicators. Combined composite indicator system [3]. For the small and medium-sized technology-based enterprises, Mca et al. Divided the twenty-seven evaluation criteria into six categories, which are the quality of entrepreneurs, the experience of entrepreneurs, special points of products and services, market characteristics, financial characteristics, and enterprises. Teamwork [4].

At present, China's comprehensive enterprise evaluation index system is divided into four categories, the financial evaluation index system and economic benefit evaluation index system issued by the Ministry of Finance, the comprehensive evaluation index system announced by the State Economic and Trade Commission and the National Bureau of Statistics, and the State-owned Assets Management Bureau. The prescribed index system for capital appreciation and preservation. In 2000, the research group of the former Small and Medium Enterprise Department of the State Economic and Trade Commission put forward a relatively complete and quantitative evaluation index system, including development status, profitability level, economic efficiency, and solvency. However, Zhao Zhongwei and others believe that technology-based enterprises should evaluate the growth of the company from five dimensions of the perspective of dynamic capabilities. These five dimensions are environmental insight, change and innovation, organizational flexibility, organizational learning, and resources. Integration capabilities [5]. Wang Yuzheng and others selected sixteen quantitative and one qualitative indicators to build a growth evaluation system from

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seven aspects: profitability, debt repayment ability, employee quality, research and development ability, growth ability, business strength, etc., and policy support. The method of combining statistical method, analytic hierarchy process and expert consultation method to evaluate the growth of Shanghai Songjiang Science and Technology "Little Giant" [6]. Wu Dan believes that we should comprehensively evaluate the growth of China's high-tech enterprises from four aspects: technological innovation capabilities, economic operation capabilities, organizational management capabilities, and value creation capabilities [7]. Wang Juying and others established a growth index system suitable for science and technology SMEs from three perspectives of resources, strategy, and capabilities, and used ANP analysis to evaluate the growth of science and technology SMEs in Qingdao [8]. Sui Bo et al. Used Monte Carlo simulation to establish an enterprise growth system model to determine that hardware, scientific management systems, knowledge distribution trends, the soundness of financing mechanisms, and resource conditions have a decisive impact on enterprises [9].

Domestic and foreign research results on corporate growth evaluation index systems are very rich, and the industries involved are also diverse. However, there is currently a commonly used growth evaluation index system, and it is specifically targeted at the growth evaluation of technology-based SMEs. The indicator system is also not perfect. For the specific enterprise type of science and technology SMEs, comprehensive evaluation and analysis of various indicators should be used in accordance with their characteristics, so as to provide scientific and effective strategic decision support for science and technology SMEs.

2.2. Research on Evaluation Method of Enterprise Growth

There are various analysis methods for growth evaluation at home and abroad. Jimme. A. Keizer and others used regression methods to analyze small and medium-sized enterprises in the Dutch mechanical and electrical industry, and found that the connection with the technology research center, the government's different policy on innovation, and higher R & D investment have a significant impact on innovation [10]. M. Kakati uses a cluster analysis method] After researching the 38 evaluation criteria adopted by venture investors with high and low-tech experience in success and failure, it is found that entrepreneurial qualities, resource capabilities, and comprehensive competition Strategy is a key factor for a company's vitality and success [11]. Yin Xianan and others proposed the use of VIKOR multi-attribute decision-making method to evaluate and analyze the growth of high-tech enterprises from the perspectives of financial control, innovation ability and risk control [12]. Chen Xiaohong and others used the catastrophe series method to analyze the small and medium-sized listed companies in 2002 from the complete index system composed of five aspects: growth ability, profitability, capital operation ability, market expectations, and enterprise size [13]. Mu Jing et al. Put forward the principal component analysis method, using the three indicators of growth rate, profitability and operating capability as an index system for the evaluation of corporate growth, and analyzed the growth of 18 small and medium-sized enterprises [14]. Chen Xiaohong et al. Based on the analysis method combining gray correlation method and mutation series method, conducted a validity test on small and medium boss companies in 2003 [15]. Zeng Fanfu and others used a factor analysis method to evaluate the growth of our innovative enterprises from five aspects, including the strength of innovation attempts, production and sales capabilities, capital operation capabilities, scientific research innovation and achievement transformation capabilities, and risk resistance capabilities. .

Although the current growth evaluation methods are very rich, there is still no evaluation method that adapts to any environment and conditions. When selecting an evaluation method, it is necessary to combine the selected evaluation index system with the characteristics of the selected enterprise, and choose different evaluation methods according to the specific situation.

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3. Research Design

3.1. Sample Selection and Data Source

This article studies the growth of technology-based SMEs in Shaanxi Province. Due to the large number of technology-based enterprises, it is biased to compare technology-based enterprises in different industries according to the same evaluation index and model. Therefore, this article selects the information technology industry. A typical science and technology industry is selected as a sample category. At the same time, considering the difficulty of obtaining research data, this article selects the information technology industry after referring to the list of Shaanxi science and technology small and medium-sized enterprises disclosed by Shaanxi Provincial Science and Technology Department and the list of listed companies in Shaanxi Province published by the China Securities Regulatory Commission. The 10 listed technology-based SMEs were used as analysis and research objects, and 10 technology-based SMEs from all over the country were selected from the small and medium-sized board information technology industry to calculate the national average level of technology-based SMEs. The data involved in the empirical analysis in this article are basically directly available, mainly from the annual financial reports of listed companies disclosed on the Juchao Advisory Network by the national SME share transfer system.

3.2. Establishment of the Evaluation Index System for the Growth of Technology-based SMEs

Enterprise growth evaluation is an evaluation of the company's future development capabilities. The fundamental factor affecting this ability should be the current operating performance of the company and the relationship between the company and the industry market. Therefore, it is necessary to establish a comprehensive evaluation system. of. In establishing a comprehensive evaluation index system, issues of comparability, comprehensiveness, authenticity, and objectivity must be considered.

In order to establish a comprehensive, objective, and scientific evaluation index system, taking into account that the growth of an enterprise is a continuous process, if you want to comprehensively evaluate the growth of an enterprise, you cannot judge the growth of an enterprise from only one point in time. It is more reasonable to consider the combination of the receivable turnover rate and the operating cash flow per share as its evaluation index. This paper refers to Lei Yong ’s two-dimensional judgment model [17]. Dimension has established a comprehensive index evaluation system. In terms of time, the growth rate and quality of the company over a period of time should be considered as much as possible, and space should correctly reflect the market expectations of the industry in which the company is located and the location of the company in the industry status.

Net profit reflects the income of the company, and its growth rate is a direct indication of the company's operating conditions, and reflects the expansion speed of the company to maximize value. But it is not enough to just use the growth rate of net profit as an indicator to analyze the growth and development of enterprises. Operating income, as a company's main business income, is not only the main source of corporate profits, but also represents the market share of the enterprise. If its growth rate gradually increases, it not only indicates that corporate profits are increasing, but also that the market share of the enterprise is increasing year by year, indicating that the enterprise may be in a period of rapid growth and growth. On the contrary, the enterprise may be in a state of slow growth or even gradual decline. The growth rate of operating income can be used as one of the indicators to measure the development speed of the company's main business and the expansion speed of the company. In addition, corporate assets are an important carrier for an enterprise to obtain income, and at the same time it is a guarantee for the company to repay its liabilities. For companies with

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better development and higher growth, the total assets are generally steadily increasing. The growth rate reflects the speed of the expansion of the asset management scale of the enterprise in a certain period. Therefore, the total asset growth rate can be used as an indicator of the growth rate of the enterprise. one.

The growth of an enterprise is a process. The quality of enterprise growth should be guaranteed while pursuing the growth rate. Closely related to the quality of enterprise development should be the company's cash flow. A company with strong cash flow indicates to a large extent that its operating income is stable, its products are highly competitive in the industry, its credit is high, and it has a considerable future market development. Prospects. For listed companies, operating cash flow per share not only directly reflects the cash flow earned by the company per share, but also reflects the ability of the company to distribute the highest cash dividends to shareholders, which is one of the important indicators of the quality of corporate development. At present, companies often sell by credit sales, and a large amount of accounts receivable will be generated. The speed of collection of accounts receivable greatly affects the company's cash flow. The slower the turnover rate of accounts receivable, the slower the working capital of the enterprise will stagnate on the accounts receivable, which affects the normal capital turnover [18]. On the surface, the enterprise is rich in assets and has a high growth potential, but the actual The company has less cash flow and insufficient driving force for growth. Therefore, the account receivable turnover rate is used as one of the criteria for measuring the quality of corporate growth.

Because this article is based on technology-based SMEs, Tang Yuejun and others have proved that the size of an enterprise has a certain effect on the growth of the enterprise [19]. When considering the size of an enterprise, we generally choose the total assets of the enterprise and the number of employees as indicators. The total assets of the enterprise reflects the assets that the enterprise can use for a period of time. The number of employees in the enterprise indirectly reflects the degree of perfection of the corporate structure.

4. Enterprise Growth Evaluation based on Improved Catastrophe Series

4.1. Basic Principles

The catastrophe series method is a multi-level contradiction decomposition of the evaluation target, and then uses catastrophe theory and fuzzy mathematics to generate catastrophe fuzzy membership functions, and then uses the normalization formula to perform comprehensive quantification operations. Finally, it is normalized to a parameter. A comprehensive evaluation method that gives out the total membership function, so as to sort and analyze the evaluation targets [20].

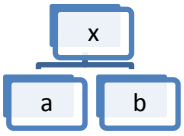
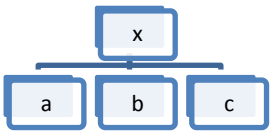
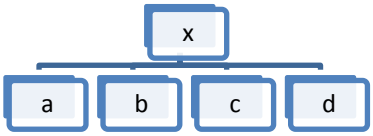
The most important idea in the decision theory of the catastrophe series method is that each attribute in a multi-attribute decision system is a state variable determined by the behavior change of its corresponding underlying attribute. Therefore, when using the catastrophe series method, the most important thing is Scientific decomposition of the target. According to the purpose of evaluation, the evaluation index is divided into primary and secondary levels, and a hierarchical index evaluation system is gradually constructed.

4.2. Types of Mutation-level Systems

There are currently seven types of mutation systems, namely folding mutation system, cusp mutation system, dovetail mutation system, butterfly mutation system, elliptic umbilical mutation system, hyperbolic umbilical mutation system and parabolic umbilical mutation system, but among them, cusp mutation System, dovetail mutation system, and butterfly mutation system are the three most common types. The corresponding mutation models and their normalization formulas are shown in Table 1.

ISSN: 2688-9323

Table 1. Three common mutation types

type	Cusp catastrophe system	Dovetail mutation system	Butterfly mutation system
q potential function	$f(x) = x^4 + ax^2 + bx$	$f(x) = \frac{1}{5}x^5 + \frac{1}{3}ax^3 + \frac{1}{2}bx^2 + cx$	$f(x) = \frac{1}{6}x^6 + \frac{1}{4}ax^4 + \frac{1}{3}bx^3 + \frac{1}{2}cx^2 + dx$
Normalized formula	$x_a = a^{\frac{1}{2}}, x_b = b^{\frac{1}{3}}$	$x_a = a^{\frac{1}{2}}, x_b = b^{\frac{1}{3}}, x_c = c^{\frac{1}{4}}$	$x_a = a^{\frac{1}{2}}, x_b = b^{\frac{1}{3}}, x_c = c^{\frac{1}{4}}, x_d = d^{\frac{1}{5}}$
Icon			

In a dynamic system, f (x) is the potential function of the abrupt system, x is the independent variable, and a, b, c, and d are the control variables of the state variable. As far as the classification of three common mutation systems is concerned, if an indicator can be decomposed into two sub-indicators, the system is a cusp catastrophe system; if a target can be divided into three sub-indicators, the system is a dovetail mutation. System; if an object can be divided into four sub-indicators, we call the system a butterfly mutation system.

4.3. Standardized Processing

Because the value ranges of the control variables and state variables in the indicator system are not consistent, and some of the original data values are not between 0 and 1, in order to make the value ranges of the state variables and control variables in the indicator system be 0 to 1 In the meantime, according to the principle of "the mutation result of the addition, subtraction, multiplication, and division remains unchanged", simple four arithmetic changes are performed on the original data, and the value range of the data is controlled between 0 and 1. between.

4.4. Comprehensive Evaluation

After processing by the normal formula, the mass state of the control variable is transformed into the mass state represented by the state variable. There are two situations that need to be considered in the comprehensive evaluation. First, if there are no mutually replaceable or complementary relationships between the control variables in the system, then when selecting the value of x as the system, "large out of small" should be used. in principle. If there is a clear complementary or alternate relationship between the control variables in the system, then the average value of the corresponding mutation order of each control variable should be taken as the x value of the system.

5. Empirical Analysis

5.1. Construction of Indicator System

To build an index system, first of all, we must decompose the total index layer by layer for evaluation purposes. When the index can be decomposed to be directly measurable, the decomposition can be stopped at this time. Secondly, when discharging indicators at all levels,

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they need to be discharged according to the importance of the indicators, that is, for the indicators of the same level, relatively important indicators should be placed first, and relatively less important indicators should be emitted behind.

Based on domestic and foreign research data, this article breaks down the company's growth indicators into four indicators: growth rate(GR) growth quality(GQ), innovation ability(IA), and enterprise size(ES). These four secondary indicators are further decomposed. Main business Revenue growth rate(MBRG), net profit growth rate(NPGR), total asset growth rate(TAGR), Receivables Turnover Ratio(RTR), Per Share Cash Flow From Operations (PSCFFO), R&D expenses(R&DE), R&D intensity(R&DI), Number of technicians (NOT), Technical staff ratio(TSR),Total assets(TA), Number of employees(NOE). Figure picture one.

5.2. Determine the Mutation Type

Combining the classification of the mutation series and the constructed index system, we can find that the growth of technology-based SMEs is a sharp point mutation system; both time and space are sharp point mutation systems; the growth rate corresponds to the dovetail mutation system; the growth quality is sharp. The point mutation system can be deduced by analogy. The market expectation and the scale of the company are both point mutation systems.

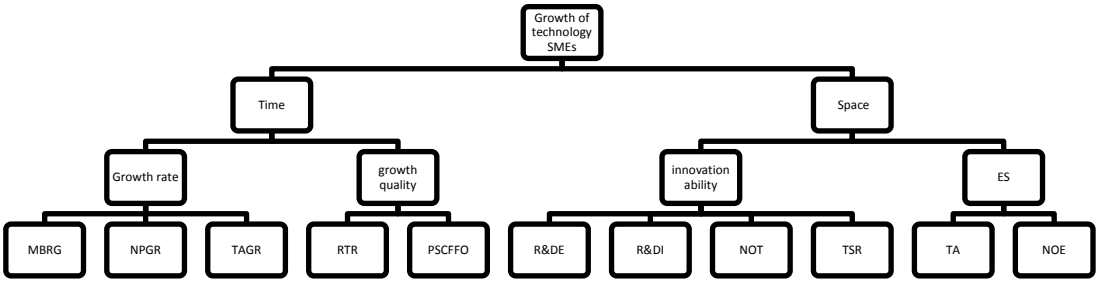

Fig. 1 Index system for evaluating the growth of technology-based SMEs

5.3. Indicator Data Processing and Results

Due to the different properties of the lowest level indicators in this indicator system, the dimensions and value ranges are not the same. If the comparison is made directly, the effect of a larger value will be inflated and the effect of a smaller value will be weakened. And according to the data requirements of the catastrophe series method, this paper must first process the data and control all the data in the range of 0 to 1. The original data in this paper are shown in Tables 2, 3 and 4.

Table 2. Raw data of related indexes of science and technology SMEs in Shaanxi Province in 2017

Name	MBRG	NPGR	TAGR	RTR	PSCFFCO	R&DE	R&DI	NOT	TSR	TA	NOE
Flag Electronics	8.53%	186.72%	11.83%	2.43	0.266403832	8,837,100.00	0.057033034	110	0.25404157	162,563,462.12	433
LiDeYa Electronic	30.62%	-21.58%	17.34%	1.57	-0.152059234	3,512,727.14	0.040284527	45	0.409090909	180,948,080.72	110

TIRAIN	33.52%	28.39%	7.38%	1.98	0.556672912	6,385,614.26	0.063225453	77	0.218130312	144,224,788.26	353
CLUbank	29.06%	10.33%	27.78%	1.36	0.047902073	4,972,365.59	0.080536639	91	0.551515152	127,574,869.93	165
BoDa software	33.07%	11.63%	62.10%	3.7	0.42305347	3,423,848.64	0.070690887	138	0.627272727	78,107,341.81	220
Bangzheng technology	-35.35%	-95.65%	-8.53%	0.61	0.160821753	6,573,011.34	0.084528232	61	0.455223881	156,107,446.30	134
MICROSENSOE	14.94%	-12.36%	5.99%	12.48	0.30442909	9,735,897.61	0.074961114	77	0.216292135	188,983,527.51	356
Day Naturay	44.83%	-80.80%	13.85%	4.65	0.009487392	1,469,587.31	0.063387769	29	0.3625	31,727,104.30	80
WeiHeng Naturay	9.13%	-232.42%	5.00%	3.83	1.134557255	3,186,122.09	0.021898619	3	0.065217391	183,760,776.75	46
ZhengChang Electronics	2.91%	17.60%	-5.83%	1.89	0.042665043	2,428,627.45	0.055860459	8	0.150943396	64,141,355.16	53
Maurer	-22.14%	-67.51%	-2.48%	1.59	0.106233171	8,231,124.83	0.205437196	44	0.234042553	129,693,175.86	188
Fang YuanMing	-59.25%	-135.67%	-13.14%	0.74	0.167553983	2,370,645.30	0.140686051	77	0.620967742	95,859,197.08	124
ShanKong	1.89%	57.81%	9.57%	1.5499	-0.084035724	2,769,756.90	0.04317296	13	0.178082192	164,586,431.57	73
SATPROM&C	-7.60%	-180.65%	-8.38%	1.23	-0.21458116	7,160,964.35	0.094531647	95	0.429864253	173,046,623.40	221
XICI Electronic	14.26%	16.19%	5.52%	3.26	-0.151933229	9,880,843.16	0.094404223	69	0.247311828	130,287,305.87	279

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Senwas	-60.11%	287.16%	-19.88%	0.57	-0.168151605	2,767,292.23	0.159539254	24	0.292682927	56,407,711.95	82
Reactor Microelectronics	-8.07%	-40.54%	6.15%	2.8812	-0.104854321	1,088,524.05	0.015428208	47	0.5875	97,173,451.41	80
CMEC	-5.71%	-67.79%	18.51%	0.8	-0.13817863	1,347,818.64	0.066695132	13	0.26	50,580,181.92	50

Table 3. Raw data of relevant indicators for technology-based SMEs in Shaanxi Province in 2016

Name	MBRG	NPGR	TAGR	RTR	PSCFFCO	R&DE	R&DI	NOT	TSR	TA	NOE
Flag Electronics	-0.72%	0.47%	0.99%	2.23	0.067484459	9,322,216.71	0.06529439	112	0.24561404	145,363,643.58	456
LiDeYa Electronic	23.02%	261.21%	-10.00%	1.32	-0.0600349	2,908,035.24	0.04356163	41	0.42268041	154,203,780.82	97
TIRAIN	3.93%	5.30%	22.51%	1.6	0.291674453	4,360,305.30	0.05764425	65	0.21812081	134,311,934.75	298
CLUbank	51.84%	70.98%	105.60%	1.78	-0.354003	4,065,224.60	0.08497995	87	0.61702128	99,840,435.96	141
BoDa software	44.48%	69.03%	61.29%	2.97	0.113900434	1,447,793.58	0.03977709	112	0.7	48,104,594.47	160
Bangzheng technology	19.89%	38.54%	20.99%	1.13	-0.1070073	7,046,640.78	0.0585883	57	0.43846154	170,658,199.88	130
MICROSENSOE	9.78%	10.97%	9.70%	11.85	0.342959976	8,393,575.97	0.07427853	70	0.20408163	178,301,102.87	343
Day Naturay	43.99%	281.40%	25.37%	5.69	-0.0257103	1,036,290.67	0.06473742	31	0.3875	27,866,401.01	80
WeiHeng Naturay	-7.68%	63.95%	27.62%	4.67	-0.0110934	5,363,601.64	0.04022906	3	0.06521739	175,011,116.90	46
ZhengChang Electronics	31.37%	-10.24%	4.90%	2.02	0.027900756	2,272,765.43	0.05379643	6	0.125	68,114,731.68	48

Maurer	-7.78%	-1.18%	14.13%	2.35	0.4582536	7,776,115.69	0.151118	75	0.56818182	132,989,394.56	132
Fang YuanMing	-17.77%	-26.92%	6.19%	1.87	-0.251108	1,485,846.41	0.03592953	77	0.6015625	110,364,557.06	128
ShanKong	-10.38%	-18.37%	32.59%	1.57	-0.1041019	402,042.11	0.00638487	13	0.17333333	150,213,783.47	75
SATPROM&C	11.83%	-1.23%	65.77%	1.59	-0.2421948	2,684,496.62	0.03274411	63	0.39375	188,869,406.06	160
XICI Electronic	-60.11%	287.16%	-19.88%	0.57	-0.1681516	2,767,292.23	0.15953925	24	0.29268293	56,407,711.95	82
Senwas	54.10%	-47%	-11.44%	1.14	0.06992008	2,990,539.24	0.159539254	24	0.29268292927	56,407,711.95	82
Reactor Microelectronics	44.41%	-10.70%	13.71%	3.16	-3.7310145	1,699,134.73	0.02214043	47	0.39830508	91,546,637.66	118
CMEC	-17.77%	-26.92%	6.19%	1.87	-0.221508	1,485,846.41	0.03592953	77	0.6015625	110,364,557.06	128

Table 4. Raw data of relevant indexes of technology-based SMEs in Shaanxi Province in 2015

Name	MBRG	NPGR	TAGR	RTR	PSCFFCO	R&DE	R&DI	NOT	TSR	TA	NOE
Flag Electronics	-20.16%	-63.71%	-2.69%	2.07	0.089624185	6,944,180.87	0.04828737	131	0.27813 1635	142,485,174.00	471
LiDeYa Electronic	-18.40%	-59.77%	22.81%	1.19	0.174691938	3,254,310.44	0.05997115	40	0.43956044	171,344,386.32	91
TIRAIN	10.22%	10.60%	35.96%	1.94	0.011915827	4,613,716.14	0.06339111	50	0.20161 2903	109,635,458.43	248
CLUbank	50.48%	57.13%	92.00%	2.51	0.234930253	2,153,345.96	0.06834906	69	0.59482 7586	48,560,090.04	116
BoDa software	23.14%	51.06%	81.34%	4.64	0.713726051	2,288,624.47	0.09084737	77	0.64166 6667	29,825,669.34	120

ISSN: 2688-9323

Bangzheng technology	66.04%	413.38%	73.47%	1.65	-0.239344241	2,272,793.42	0.02265537	48	0.461538462	141,049,758.93	104
MICROSENSOE	0.76%	3.06%	31.43%	14.05	0.262981381	6,073,969.21	0.05900663	56	0.181229773	162,533,784.12	309
Day Naturay	18.80%	-386.66%	223.46%	28.63	-0.270613825	1,442,415.10	0.12974802	29	0.475409836	22,226,818.51	61
WeiHeng Naturay	47.48%	155.25%	30.56%	10.56	-0.109971143	5,921,201.98	0.041	3	0.065217391	137,138,000.59	46
ZhengChang Electronics	7.26%	154.83%	3.88%	1.95	-0.106445693	964,901.95	0.03000378	6	0.146341463	64,934,089.02	41
Maurer	-1.14%	7.30%	0.37%	3.29	0.066208581	5,097,619.32	0.09135303	31	0.190184049	116,523,658.89	163
Fang YuanMing	281.81%	676.39%	172.50%	3.13	-0.123572561	1,019,514.39	0.01357104	82	0.611940299	126,778,485.12	134
ShanKong	23.19%	85.18%	46.77%	2.03	0.179811191	60,630.95	0.00086291	11	0.144736842	113,288,693.22	76
SATPRO M&C	36.34%	409.06%	170.48%	3.03	-1.066051042	5,533,507.76	0.07547724	60	0.434782609	113,935,247.23	138
XICI Electronic	-11.12%	-52.88%	13.10%	2.78	0.358147162	6,789,524.67	0.08248422	83	0.321705426	121,613,280.76	258
Senwas	-54.15%	-282.10%	-11.04%	-0.016828512	3,644,458.24	3,644,458.24	0.1291498	21	0.25	79,496,529.56	84
Reactor Microelectronics	89.48%	100.47%	79.41%	-0.23641191	876,642.38	876,642.38	0.01649571	42	0.6	80,509,206.25	70
CMEC	60.71%	130.77%	113.90%	-0.38233028	1,215,369.59	1,215,369.59	0.06151257	12	0.24	41,869,887.84	50

The standardized formula used is:

$$y_{ij} = \frac{x_{ij} - \min\limits_{1 \le j \le n} x_{ij}}{\max\limits_{1 \le j \le n} x_{ij} - \min\limits_{1 \le j \le n} x_{ij}} \quad (1 \le i \le n)$$

ISSN: 2688-9323

The standardized data are shown in Table 4 and Table 5.

Table 5. Standardization data of related indicators of 2017 technology-based SMEs in Shaanxi Province

Name	MBRG	NPGR	TAGR	RTR	PSCFFCO	R&DE	R&DI	NOT	TSR	TA	NOE
Flag Electronics	0.65408805	0.80669002	0.38680166	0.15617128	0.35651271	0.88128921	0.21896241	0.79259259	0.33595301	0.83	1
LiDeYa Electronic	0.86458929	0.40578929	0.45401317	0.08396306	0.04634211	0.27571828	0.13081654	0.31111111	0.61181435	0.95	0.16537468
TIRAIN	0.89222413	0.50196312	0.33252013	0.11838791	0.57166416	0.60246792	0.25155255	0.54814815	0.27206026	0.72	0.79328165
CLUbank	0.84972365	0.46720428	0.58136131	0.06633081	0.19455619	0.44173119	0.34265974	0.65185185	0.86521331	0.61	0.30749354
BoDa software	0.88793596	0.4697063	1	0.26280437	0.47262358	0.26560963	0.29084245	1	1	0.29	0.4496124
Bangzheng technology	0.23594435	0.26323184	0.1384484	0.00335852	0.27825382	0.62378165	0.36366714	0.42962963	0.6938934	0.79	0.22739018
MICROSENSOE	0.71517057	0.42353439	0.31556477	1	0.38469756	0.98351453	0.31331626	0.54814815	0.2687898	1.00	0.80103359
Day Naturay	1	0.29181262	0.41144182	0.34256927	0.1660827	0.04334047	0.2524068	0.19259259	0.52892053	0.00	0.0878553
WeiHeng Naturay	0.6598056	0	0.30348866	0.27371956	1	0.23857165	0.03405318	0	0	0.97	0
ZhengChang Electronics	0.60053364	0.48119635	0.17138326	0.11083123	0.19067443	0.15241751	0.21279126	0.03703704	0.15252236	0.21	0.01808786

Maurer	0.3618 2581	0.3173 9097	0.2122 4689	0.0856 4232	0.2377 9201	0.8123 6824	1	0.3037 037	0.3003 7107	0. 62	0.3669 2506
Fang YuanMin g	0.0081 9516	0.1862 0809	0.0822 1517	0.0142 7372	0.2832 4384	0.1458 2287	0.6592 2062	0.5481 4815	0.9887 8227	0. 41	0.2015 5039
ShanKon g	0.5908 138	0.5585 8578	0.3592 3396	0.0822 754	0.0967 6208	0.1912 1609	0.1460 1811	0.0740 7407	0.2008 0728	0. 84	0.0697 6744
SATPRO M&C	0.5003 8117	0.0996 3817	0.1402 7812	0.0554 1562	0	0.6906 5286	0.4163 142	0.6814 8148	0.6487 7395	0. 90	0.4521 9638
XICI Electroni c	0.7086 9068	0.4784 8262	0.3098 3167	0.2258 6062	0.0464 3551	1	0.4156 4357	0.4888 8889	0.3239 7955	0. 63	0.6020 6718
Senwas	0	1	0	0	0.0344 1423	0.1909 3577	0.7584 4331	0.1555 5556	0.4047 031	0. 16	0.0930 2326
Reactor Microele ctronics	0.4959 0242	0.3692 9828	0.3175 1647	0.1940 5542	0.0813 3105	0	0	0.3259 2593	0.9292 3699	0. 42	0.0878 553
CMEC	0.5183 9146	0.3168 5207	0.4682 8495	0.0193 115	0.0566 3061	0.0294 9103	0.2698 1315	0.0740 7407	0.3465 5415	0. 12	0.0103 3592

Table 6. Standardization data of relevant indicators for 2016 technology-based SMEs in Shaanxi Province

Name	MBRG	NPGR	TAGR	RTR	PSCFF CO	R&DE	R&DI	NOT	TSR	T A	NOE
Flag Electroni cs	0.5200 07	0.1420 577	0.1663 2133	0.1471 6312	0.9067 2141	1	0.3846 4144	1	0.2841 8649	0. 73	1
LiDeYa Electroni c	0.7278 6971	0.9223 4259	0.0787 3765	0.0664 8936	0.8762 8185	0.2809 3543	0.2427 4045	0.3486 2385	0.5631 2668	0. 78	0.1243 9024

TIRAIN	0.5607 2148	0.1565 1185	0.3378 2276	0.0913 1206	0.9602 3671	0.4437 4279	0.3346 9089	0.5688 0734	0.2408 7524	0. 66	0.6146 3415
CLUbank	0.9802 1189	0.3530 644	1	0.1072 695	0.8061 1013	0.4106 6264	0.5131 7552	0.7706 422	0.8692 8009	0. 45	0.2317 0732
BoDa software	0.9157 692	0.3472 2887	0.6468 76	0.2127 6596	0.9178 0205	0.1172 3442	0.2180 2978	1	1	0. 13	0.2780 4878
Bangzheng technology	0.7004 6406	0.2559 8516	0.3257 0928	0.0496 4539	0.8650 693	0.7448 9558	0.3408 5494	0.4954 1284	0.5879 8736	0. 89	0.2048 7805
MICROSENSOE	0.6119 4291	0.1734 7977	0.2357 3478	1	0.9724 7876	0.8958 9433	0.4433 0212	0.6146 789	0.2187 5874	0. 93	0.7243 9024
Day Naturay	0.9114 7885	0.9827 6275	0.3606 1524	0.4539 0071	0.8844 7531	0.0711 0271	0.3810 048	0.2568 8073	0.5077 0548	0. 00	0.0829 2683
WeiHeng Naturay	0.4590 6663	0.3320 2657	0.3785 4638	0.3634 7518	0.8879 6444	0.5562 1776	0.2209 8089	0	0	0. 91	0
ZhengChang Electronics	0.8009 8065	0.1100 0718	0.1974 8167	0.1285 461	0.8972 7417	0.2097 1824	0.3095 6713	0.0275 2294	0.0941 7808	0. 25	0.0048 7805
Maurer	0.4581 9105	0.1371 1994	0.2710 3921	0.1578 0142	1	0.8266 7368	0.9450 146	0.6605 5046	0.7923 4122	0. 65	0.2097 561
Fang YuanMing	0.3707 206	0.0600 9097	0.2077 6219	0.1152 4823	0.8377 374	0.1215 0035	0.1929 0769	0.6788 9908	0.8449 2723	0. 51	0.2
ShanKong	0.4354 2597	0.0856 7752	0.4181 5429	0.0886 5248	0.8657 6283	0	0	0.0917 4312	0.1703 1963	0. 76	0.0707 3171
SATPROM&C	0.6298 923	0.1369 7031	0.6825 789	0.0904 2553	0.8327 9933	0.2558 7554	0.1721 0893	0.5504 5872	0.5175 5137	1. 00	0.2780 4878

ISSN: 2688-9323

XICI Electronic	0	1	0	0	0.85047383	0.26515738	1	0.19266055	0.35833612	0.18	0.08780488
Senwas	1	0	0.06726172	0.05053191	0.90730278	0.29018458	0.40734794	0.19266055	0.33183751	0.26	0.1
Reactor Microelectronics	0.91515629	0.1086306	0.26769206	0.22960993	0	0.14541112	0.10287374	0.40366972	0.52472719	0.40	0.17560976
CMEC	0.3707206	0.06009097	0.20776219	0.11524823	0.8377374	0.12150035	0.19290769	0.67889908	0.84492723	0.51	0.2

Table 7. Standardization data of relevant indicators for technology-based SMEs in Shaanxi Province in 2015

Name	MBRG	NPGR	TAGR	RTR	PSCFFCO	R&DE	R&DI	NOT	TSR	TA	NOE
Flag Electronics	0.10117276	0.30379568	0.03560768	0.05244381	0.46347454	1	0.36795918	1	0.36935469	0.81	1
LiDeYa Electronic	0.10641148	0.307502	0.14434968	0.02104888	0.4975903	0.46395821	0.45861191	0.2890625	0.6493946	1.00	0.11627907
TIRAIN	0.19160019	0.37369832	0.20042644	0.04780592	0.43231021	0.66144435	0.48514683	0.3671875	0.23661321	0.59	0.48139535
CLUbank	0.31143589	0.4174686	0.43940299	0.06814128	0.52174841	0.30401683	0.52361479	0.515625	0.91874553	0.18	0.1744186
BoDa software	0.23005715	0.41175862	0.39394456	0.14413129	0.71376573	0.32366926	0.69817576	0.578125	1	0.05	0.18372093
Bangzheng technology	0.35775092	0.75258925	0.3603838	0.03745986	0.33154432	0.32136942	0.16908441	0.3515625	0.68752115	0.80	0.14651163
MICROSENSOE	0.16344208	0.36660552	0.18110874	0.47984303	0.53299809	0.87358098	0.45112829	0.4140625	0.20125341	0.94	0.62325581

Day Naturay	0.2171 3895	0	1	1	0.3190 039	0.2007 3714	1	0.203 125	0.7115 8463	0. 00	0.0465 1163
WeiHeng Naturay	0.3025 0625	0.5097 6906	0.1773 9872	0.3553 3357	0.3834 2839	0.8513 8789	0.3114 1761	0	0	0. 77	0.0116 2791
ZhengChang Electronics	0.1827 8962	0.5093 7397	0.0636 2473	0.0481 6268	0.3848 4225	0.1313 6696	0.2260 9958	0.023 4375	0.1407 3063	0. 29	0
Maurer	0.1577 8664	0.3705 9405	0.0486 5672	0.0959 6861	0.4540 839	0.7317 4284	0.7020 9909	0.218 75	0.2167 8691	0. 63	0.2837 2093
Fang YuanMing	1	1	0.7826 8657	0.0902 6044	0.3779 7365	0.1393 0072	0.0986 0051	0.617 1875	0.9484 3194	0. 70	0.2162 7907
ShanKong	0.2302 0598	0.4438 5495	0.2465 2452	0.0510 1677	0.4996 4334	0	0	0.062 5	0.1379 47	0. 61	0.0813 9535
SATPROM&C	0.2693 4754	0.7485 2547	0.7740 7249	0.0866 9283	0	0.7950 6604	0.5789 2124	0.445 3125	0.6411 0622	0. 62	0.2255 814
XICI Electronic	0.1280 8072	0.3139 8335	0.1029 4243	0.0777 7381	0.5711 6359	0.9775 3249	0.6332 8736	0.625	0.4449 4467	0. 67	0.5046 5116
Senwas	0	0.0983 585	0	0	0.4207 8252	0.5206 3649	0.9953 5847	0.140 625	0.3205 5311	0. 38	0.1
Reactor Microelectronics	0.4275 2113	0.4582 3809	0.3857 1429	0.0924 01	0.3327 2031	0.1185 4515	0.1212 9255	0.304 6875	0.9277 1842	0. 39	0.0674 4186
CMEC	0.3418 8594	0.4867 4098	0.5327 9318	0.0449 5184	0.2742 0088	0.1677 5336	0.4705 7149	0.070 3125	0.3032 0553	0. 13	0.0209 3023

This article uses 2017 Xi'an Jingqi Electronics Co., Ltd. as an example to illustrate the calculation process of related indicators. The calculation should start from the lowest index, and then calculate each index in order from bottom to top.

The main business income growth rate, net profit growth rate and total asset growth rate three three-level indicators constitute the growth rate. Because the growth rate is a dovetail catastrophe model, then:

$$x_{c_1} = C_1^{\frac{1}{2}} = 0.65408805^{\frac{1}{2}} = 0.8087571$$

ISSN: 2688-9323

$$x_{C_2} = C_2{}^{\frac{1}{3}} = 0.80669003^{\frac{1}{3}} = 0.93089828$$
$$x_{C_3} = C_3{}^{\frac{1}{4}} = 0.38680166^{\frac{1}{4}} = 0.7886278$$

Because it is a non-complementary system, according to the principle of non-complementary "big, medium and small", the growth rate B_1 has:

$$x_{B_1} = min\{x_{C_1}, x_{C_2}, x_{C_3}\} = min\{0.8087571, 0.93089828, 0.7886278\} = 0.7886278$$

As for the quality of indicator growth, it is decomposed into two three-level indicators of accounts receivable turnover rate and operating cash flow per share, which are cusp catastrophe models, then:

$$x_{C_4} = C_4{}^{\frac{1}{2}} = 0.15617128^{\frac{1}{2}} = 0.39518513$$
$$x_{C_5} = C_5{}^{\frac{1}{3}} = 0.35651271^{\frac{1}{3}} = 0.70907418$$

Because it is a non-complementary system, according to the principle of non-complementary "big, medium and small", the quality of growth B_2 has:

$$x_{B_1} = min\{x_{C_5}, x_{C_6}\} = min\{0.39518513, 0.70907418\} = 0.39518513$$

The index technology is decomposed into four three-level indicators of total research investment, research and development investment intensity, number of technical staff, and proportion of technical staff. For the butterfly mutation model, then:

$$x_{C_6} = C_6{}^{\frac{1}{2}} = 0.88128921^{\frac{1}{2}} = 0.93877005$$
$$x_{C_7} = C_7{}^{\frac{1}{3}} = 0.21896241^{\frac{1}{3}} = 0.60273053$$
$$x_{C_8} = C_8{}^{\frac{1}{4}} = 0.79259259^{\frac{1}{4}} = 0.94354475$$
$$x_{C_9} = C_9{}^{\frac{1}{5}} = 0.33595301^{\frac{1}{5}} = 0.80399937$$

Since it is a complementary system, according to the principle of averaging complementary values, the market expectation B_3 has:

$$x_{B_3} = \frac{x_{C_6} + x_{C_7} + x_{C_8} + x_{C_9}}{4} = \frac{0.93877005 + 0.60273053 + 0.94354475 + 0.80399937}{4} = 0.82226117$$

The two three-level indicators of the total assets of the enterprise and the total number of employees of the enterprise constitute the second-level indicator of enterprise size, which is a sharp point mutation model, then:

$$x_{C_{10}} = C_{10}{}^{\frac{1}{2}} = 0.83^{\frac{1}{2}} = 0.9121369$$
$$x_{C_{11}} = C_{11}{}^{\frac{1}{3}} = 1^{\frac{1}{3}} = 1$$

Since it is a complementary system, according to the principle of averaging complementary, for the size of the enterprise B_4:

$$x_{B_4} = \frac{x_{C_8} + x_{C_9}}{2} = \frac{0.9121369 + 1}{2} = 0.95606845$$

After the calculation of the lowest-level indicator is completed, the upper-layer indicator is calculated.

The primary indicator time A_1 is decomposed into two secondary indicators of growth rate B_1 and growth quality B_2, which are cusp catastrophe models, then:

$$x_{B_1} = B_1{}^{\frac{1}{2}} = 0.7886278^{\frac{1}{2}} = 0.88804718$$
$$x_{B_2} = B_2{}^{\frac{1}{3}} = 0.39518513^{\frac{1}{3}} = 0.733838$$

ISSN: 2688-9323

Since it is a complementary system, according to the principle of taking the average value of complementarity, the time index A_1 has:

$$x_{A_1} = \frac{x_{B_1} + x_{B_2}}{2} = \frac{0.88804718 + 0.733838}{2} = 0.81094259$$

The secondary indicator market expectation and the size of the enterprise constitute the primary indicator space A_2, which is a sharp point mutation model, then:

$$x_{B_3} = B_3^{\frac{1}{2}} = 0.82226117^{\frac{1}{2}} = 0.90678618$$

$$x_{B_4} = B_4^{\frac{1}{3}} = 0.95606845^{\frac{1}{3}} = 0.98513632$$

Since it is a non-complementary system, according to the principle of non-complementary "big, medium and small", the spatial indicator A_2 has:

$$x_{A_2} = min\{x_{B_3}, x_{B_4}\} = min\{0.90678618,0.98513632\} = 0.90678618$$

According to the decomposition requirements of the catastrophe series method, the index system for the growth evaluation of technology SMEs is decomposed into two first-level indicators of time A_1 and space A_2.

$$x_{A_1} = A_1^{\frac{1}{2}} = 0.81094259^{\frac{1}{2}} = 0.846947594$$
$$x_{A_2} = A_2^{\frac{1}{3}} = 0.90678618^{\frac{1}{2}} = 0.96790997$$

Because it is a complementary system, according to the principle of taking the average of complementarity, the growth evaluation indicators for technology-based SMEs are:

$$x = \frac{x_{A_1} + x_{A_2}}{2} = \frac{0.846947594 + 0.96790997}{2} = 0.91227671$$

According to the above steps, the results of the two first-level evaluation indicators of growth rate, growth quality, innovation capacity, and enterprise size and time and space of Shaanxi Province from 2015 to 2017 can be calculated. The final evaluation results of 10 enterprises from each province and the country are ranked according to Table 8.

ISSN: 2688-9323

Table 8. 2017-2015 growth value of science and technology SMEs in Shaanxi Province

Name	2017	2016	2015	Mean	Name	2017	2016	2015	Mean
Flag Electronics	0.9122 7671	0.9140 6089	0.8653 2325	0.8919 8801	ZhengChang Electronics	0.8623 5765	0.8587 539	0.8201 965	0.8533 4536
LiDeYa Electronic	0.8746 2417	0.8704 2964	0.8417 193	0.8603 4022	Maurer	0.8918 6245	0.9043 5927	0.8777 9897	0.8625 8084
TIRAIN	0.8961 5922	0.8856 7927	0.8679 8321	0.8861 140 9	Fang YuanMing	0.7477 5256	0.8667 2257	0.8778 0739	0.8833 8515
CLUbank	0.8814 279	0.8910 4957	0.8615 6306	0.8850 3853	ShanKong	0.8590 0227	0.7860 1208	0.7754 7251	0.7838 0751
BoDa software	0.9243 1101	0.9028 1122	0.8673 3891	0.9113 8218	SATPRO M&C	0.4867 2033	0.8803 991	0.4803 0342	0.8946 7042
Bangzheng technology	0.7938 5156	0.8735 2651	0.8519 1543	0.8535 6261	XICI Electronic	0.9077 8143	0.4555 6685	0.8749 0694	0.7699 9525
MICROSENSOE	0.9494 553 1	0.9171 009 2	0.8811 7735	0.9190 1211	Senwas	0.4546 091 8	0.4618 036 4	0.4670 9922	0.4620 0398
Day Naturay	0.8122 1211	0.8100 6232	0.4132 1174	0.4190 474 7	Reactor Microelectronics	0.8413 9213	0.4631 2497	0.8743 7442	0.4484 3458
WeiHeng Naturay	0.3833 569	0.7983 5007	0.8268 7875	0.7826 8958	CMEC	0.7942 5321	0.8667 2257	0.8265 2813	0.8555 105

6. Summary

According to the growth evaluation value, the growth of small and medium-sized enterprises is divided into high growth, medium growth and low growth, and the growth of technology-based SMEs is evaluated. The grading standards are shown in Table 9.

Table 9. Growth scale

Growth Evaluation Value	Growth of SMEs	Business growth
x>0.9	High growth	The company grows fast and stands out in the market competition
0.6<x<0.9	Medium growth	The growth rate of the company is average, and it can barely follow the development of the market
X<0.6	Low growth	The company's growth rate is low, and it is facing elimination from the market at any time

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After comparing the tables, we can conclude that among the 18 technology-based SMEs listed in Shaanxi Province for three years from 2015 to 2017, there are 2 high-growth technology-based SMEs, accounting for 11.11% of the participating companies; There are 13 high-tech SMEs, accounting for 72.22% of the participating enterprises; 3 low-tech SMEs, accounting for 16.67% of the participating enterprises, as shown in the figure below.

Shaanxi Province's technology-based SMEs are less in low-growth state, and more in medium-growth may be because the government of Shaanxi Province has gradually realized the importance of technology-based SMEs in promoting regional economic development and job creation In time, relevant support policies for technology-based SMEs were introduced in a timely manner. Another part may be that Shaanxi has more relevant research institutes and universities in the information technology industry, which provide certain technical support for the information technology industry and enable it to acquire technology. It has a greater advantage over other provinces. Although there are more medium-growth, it is also less for high-growth. According to the annual reports of 10 technology-based SMEs in Shaanxi Province, it can be found that most of their suppliers are from the western region. Shaanxi Province's technology-based SMEs have a low degree of networking, the value chain channels in the network are not smooth, the division of labor among enterprises is not clear, the coordination mechanism is not perfect, and the growth of networking is insufficient. (1) Small and medium-sized enterprises are in the initial stage of networked growth. SMEs are in the rising development stage, but most of them are operating on a small scale. (2) The role of government organizations in the network is not obvious. The government's role in the management and regulation of SMEs' networked growth is not standardized, and there are problems of their own policies and unclear boundaries.

Even though the current network level of technology-based SMEs in Shaanxi Province has improved a lot, it has severely restricted the development of enterprise clusters. There are many business relationships between technology-based SMEs, especially cluster technology-based SMEs. The specialized division of labor is weak in assisting and cooperating, but there is still no interdependence among enterprises, mutual trust between enterprises in the network, and their industries and products. The structure of this aspect is oriented towards the market for enterprise development, and the risks are relatively high. At present, there are many incomplete cooperation mechanisms, and the cooperation and interaction mechanisms are also lacking. University research and development capabilities and scientific research institutions are currently not fully utilized. In order to achieve healthy development for enterprises, cluster enterprises have technological innovation as the core, low degree of networking, and insufficient technological innovation capabilities. They cannot form complementary advantages among enterprises, which will inevitably have an adverse impact on the growth of enterprise networks.

At the same time, the degree of networking is low, and the core competitiveness of enterprises located in the center of the network is poor, and the impact on surrounding enterprises is small. Small and medium-sized enterprises located around the network use resources inefficiently and rely heavily on the environment. Although the technology-based SMEs in the network can improve their competitiveness to a certain extent, the cooperation with the school's "industry-study-research" is not strong. Many technology-based SMEs entering the network are not using resources to grow, but through administrative means or Imitating the economy to grow, for example, through government tax cuts or government concessions, not through the value chain channels in the network, which will lead to unfavorable division of labor and affect the coordination mechanism. This brings great disadvantages to the overall networked growth.

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