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Research Article

A Selection Model of Strategic Emerging Industries in Fujian Based on Entropy-VIKOR Algorithm

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The cultivation of strategic emerging industries is strategic to the economic transformation and upgrading in Fujian, a southeastern province of China. It is of great significance to study its selection model. In this paper, according to the characteristics of strategic emerging industries, drawing on the double helix model, this paper sets up an evaluation system for strategic emerging industries. Then, the entropy-VIKOR algorithm was introduced to evaluate and rank the backbone enterprises in Fujian, based on the data on 21 listed enterprises of strategic emerging industries in the province from 2017 to 2019. The empirical research results are consistent with the actual situation of the development of strategic emerging industries in Fujian Province, which proves the feasibility of this research method. Finally, according to the empirical analysis results, this study puts forward some countermeasures for the development of strategic emerging industries in Fujian province.

1. Introduction

Based on major technological breakthroughs and major development needs, strategic emerging industries play a leading role in overall economic and long-term social development. Strategic emerging industries are featured by low consumption of material resources, intensive knowledge and technology, good comprehensive benefits, and huge growth potential. They mainly include nine areas, such as new-generation information technology industries, high-end equipment manufacturing industry, new materials industry, biological industry, new energy vehicle industry, new energy industry, energy conservation and environmental protection industry, digital creative industry, and related service industry [1].

Fujian, a southeastern province of China, is at a critical stage to transform and upgrade its economy. To nurture and develop strategic emerging industries, the province needs to seize the opportunities of Internet Plus, Made in China 2025, and Industrial 4.0, and make full use of its advantages in resources in the coming years.

Based on the entropy-VIKOR algorithm, this paper designs a generally applicable model of strategic emerging industries with regional relevance. With the aid of the model, the authors pinpointed the backbone enterprises that propel the development of Fujian. According to the results of empirical analysis, several suggestions were presented for the province to cultivate and manage strategic emerging industries.

2. Literature Review

There are two important concepts associated with strategic emerging industries need to be clearly defined. One is pillar industries, which refer to the leading industries in the national economy, which have a fast production development speed and play a guiding and promoting role in the whole economy [2]. Pillar industries have the following characteristics: strong chain effect, large-scale output, emphasis on the present, emphasis on development, emphasis on expanding employment and energy, and resource conservation [3]. China's current ten pillar industries are as

follows: color metal industry, automobile industry, steel industry, equipment manufacturing industry, company electronic information industry, textile industry, shipbuilding industry, petrochemical industry, real estate industry, and light industry. The other is high-tech industry, which is a type of knowledge-intensive and technology-intensive industry [4]. The leading technology of the product must belong to the industrial cluster producing high-tech products in the identified high-tech fields (mainly referring to the fields of information technology, biological engineering, and new materials). It is featured by the high research and development investment [5]. High-tech industry has a high fast development speed and has strong penetration ability to other industries. Obviously, strategic emerging industries have relevance with the previously mentioned two kinds of industries, but differences exist.

On the cultivation and selection of strategic emerging industries, the previous studies mainly probe into the inherent mechanism and development paths of industrial development with three models, namely, industrial resources, industrial demand, and innovation-driven development.

In terms of industrial resources, Cheng et al. [6] suggested that the formation and development of China's strategic emerging industries were influenced by market demand, technological progress, factor endowment, and industrial policies. Huang and Zhang [7] evaluated the development of strategic emerging industries in four dimensions (i.e., industrial resource potential, industrial demand capacity, industrial linkage effects, and industrial competitiveness), with opportunity and government as auxiliary impactors, and demonstrated that the six factors can effectively improve the allocation efficiency of science and technology resources in China's strategic emerging industries. He et al. [8] measured the resource endowment and innovation investment of the industry and selected strategic emerging industries from the perspective of government support, economic benefits, research and development (R&D) investment, social sciences and humanities, and so on.

As industrialization picks up speed, China bears witness to increasingly serious environmental pollution and resource shortage. These inevitably bottleneck the development of strategic emerging industries. On the scales of industry and region, Chen [9] measured the growth of environmental technology innovation (ETI) efficiency in China's strategic emerging industries from 2005 to 2014, using the directional distance function (DDF) of slack-based measure (SBM) and the global Malmquist–Luenberger (GML) index, and decomposes the growth into four factors, technical efficiency, technical progress, scale efficiency, and technology scale. The main results of Chen's research include the following: China's strategic emerging industries have an overall low ETI efficiency, due to the drastic drop in technical efficiency and scale efficiency; regionally, the ETI efficiency of China's strategic emerging industries decreases from east to west, with significant spatial agglomeration and distinct growth channels. In fact, the GML index that considers environmental factors is generally smaller than that excluding these factors, because pollution discharge reduces the efficiency of regional ETI [10].

In terms of industrial demand, Wang et al. [11] proved technology development and market demand as the primary risks of nurturing and developing new industries. They designed a double spiral cultivation model for regional strategic emerging industries driven by technology innovation and market demand, providing decision support and reference for the strategic management of regional emerging industries. Zhang and Zhao [12] established an evaluation index system for the competitiveness of strategic emerging industries, which covers 49 indices in seven aspects: competitive strength, growth competitiveness, market competitiveness, cost competitiveness, innovation competitiveness, investment competitiveness, and management competitiveness. At present, government subsidy acts as an important financial instrument to support and guide the development of strategic emerging industries and reduce the risk of technology development. With the aim to enhance the efficiency of fiscal subsidy, many scholars have demonstrated that both direct and indirect government subsidies significantly promote the research and development (R&D) input of emerging enterprises, and the indirect subsidy has the stronger promoting effect. Meanwhile, the incentive effect of government subsidy varies with the scale and ownership of enterprises. Therefore, China should establish a comprehensive mechanism for government subsidy to diversify the subsidies at the governmental level, optimize the governance structure at the enterprise level, and foster the internal capital supervision [13].

In terms of innovation-driven development, the relevant research starts from the innovative nature of strategic emerging industries. Focusing on the efficiency of innovative technology in strategic emerging industries, Cheng et al. [14] adopted the Banker–Chames–Cooper (BCC) model of data envelopment analysis (DEA) to empirically analyze the relative efficiency of the listed enterprises in strategic emerging industries during 2005–2011 and discovered technological innovation as the focus of industrial development. Through evaluation of innovative capability, Wu et al. [13] showed that innovation capability mainly manifests as the abilities to realize innovative transformation, protect innovation security, and achieve innovation. Guo and Hui [15] built the Crictic-Bustophedon cloud barycenter model, which enables strategic emerging industries to easily innovate business models. Zhang and Tuo [5] learned that China's strategic emerging industries had a low and fluctuating technical efficiency; the technological progress was fast, but the rate of progress decreased over time. Wu et al. [13] evaluated the technological innovation capability of strategic emerging industries in China and found that the new generation of information technology has the strongest capability of technological innovation among these industries. Compared with universities and research institutions, enterprises are the subjects of technological innovation in strategic emerging industries. Therefore, China should implement the following measures to optimize its strategic emerging industries: encourage the development of new industries, promote civil-military integration and

agglomeration of strategic emerging industries, deepen the cooperation and innovation between industries, universities, and research institutes, and renovate the financial and tax supports to industrial development [16].

To sum up, many researchers have explored strategic emerging industries from different angles, laying a foundation for follow-up research. Nevertheless, the previous studies have several common deficiencies. Firstly, there is no systematic or in-depth analysis on the connotations of strategic emerging industries; these industries are often confused with leading industries, pillar industries, and high-tech industries. The confusion distorts the results of many researchers. Second, scholars have done many studies on the evaluation index of strategic emerging industries, but the application in professional regional markets is lack of pertinence. From the macroperspective, most scholars merely studied the factors affecting the innovation of specific strategic emerging industries. Not many have designed targeted evaluation indices on the microscale.

Therefore, this paper tries to extend, improve, and optimize the selection model of evaluation indices for strategic emerging industries, which are leading and pillar industries in the future. Apart from the emerging characteristic, the evaluation of strategic emerging industries should measure the aspects of resource endowment and market demand. It must be noted that the same set of indices may have different impacts on different industries and cannot be directly applied to all strategic emerging industries. The previously used techniques, namely, analytic hierarchy process (AHP), factor analysis, and gray correlation, could not fully quantized multiple evaluation indices selected for strategic emerging industries. In order to solve the shortcomings of these traditional methods, later scholars also utilize many new mathematics methods to solve the problems in the field of strategic management, such as picture fuzzy information measure, exponential fuzzy entropy in multiple-attribute decision making, and multicriteria decision-making method based on intuitionistic fuzzy information [17,18]. Moreover, the selection of methods is more important than the application of mathematics, which does not identify the effectiveness of the method itself and the referential value of the investigation results. Therefore, this paper decides to combine entropy and VIKOR into an evaluation system that selects strategic new industries in a practical manner.

3. Construction of Evaluation Index System

3.1. Theoretical Basis. Our selection model for strategic emerging industries is based on the novel double helix model. Inspired by the theories on absorption and Innovation 2.0, an evaluation index system was built with the double helix structure, with technological innovation and market demand as a pair of interactive helixes. The design of the double helix model fully considers the regional differences in environment and natural resources and the development of regional competitive industries.

As shown in Figure 1, the double helix model mainly consists of regional environment analysis, industrial dynamics analysis, and design of industrial cultivation strategy.

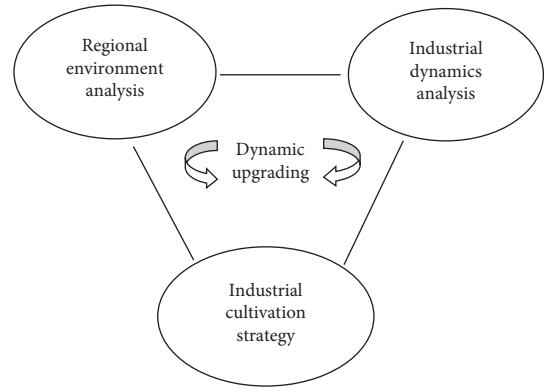

Figure 1: Double helix model.

Specifically, the regional environment analysis tackles the industrial base and resource endowment of each region, which are the basic works of industrial cultivation. The industrial dynamics analysis explores the development of regional competitive industries from two aspects: technological innovation and market demand. Based on the results of the two analyses, a cultivation strategy was designed to overcome the weak links in the current stage of industrial development.

3.2. Evaluation Indices

3.2.1. Resource Endowment. Unlike other enterprises, strategic emerging enterprises have unique and scarce resources. Some of these resources are tangible, and some are intangible [19].

(1) Tangible Resources. Fixed assets growth rate, stocks, and monetary assets (e.g., accounts receivable and cash ratio) are important indicators of the tangible resources of an enterprise [20]. Due to the limited cash flow at startup, many enterprises might face the loss of confidence among key employees and the loss of personnel. These losses can be avoided if the enterprises could achieve a high growth, a guarantee of the steady growth of capital [21].

(2) Intangible Resources. In strategic emerging industries, the enterprises are good at converting personal skills and talents into intellectual property rights [22], a unique kind of light asset in the asset structure. In this paper, the intangible resources of a strategic emerging enterprise is defined as the sum of the proportion of intangible assets and the growth rate of these assets [23].

3.2.2. Market Demand. The capability of strategic emerging industries in meeting market demand can be measured by their marketing capability and market forecast ability.

(1) Marketing Capability. This paper describes the marketing capability of strategic emerging enterprises by the net profit margin and market share. The net profit margin refers to the ratio of net profit and net sales revenue, which reflect the

ability to earn profits through sales [12,20]. The market share of products/services, a core measure of sales capability, mirrors the position of the enterprise in market competition and its controlling ability [24].

(2) Market Forecast Ability. This paper describes the market forecast ability of strategic emerging enterprises by price-to-earnings ratio (P/E) and price-to-book (P/B) ratio. P/E, a metric of the relative value of strategic emerging enterprises, promotes the stock price and expectation of future profit [24]. Focusing on the profitability of stocks, P/B is positively correlated with the investors' willingness to pay for the unit net assets of the strategic emerging enterprise and the brightness of the future of the enterprise [25].

3.2.3. Technological Innovation. The development of strategic emerging industries can be understood as the adaptation to the changing environments through constant innovation. This paper measures technological innovation in two dimensions: innovation capability and sustainable development capability.

(1) Innovation Capability. In 1996, Arthur pointed out that knowledge-intensive industries should increase their dynamic income through continuous technical upgrading. There is an inverted U-shape relationship between technology innovation and enterprise growth [26]. For strategic emerging enterprises, their innovation capability can be measured by various indices, such as growth rate of R&D expense, intensity of technical staff investment, R&D capital investment, and number of patents [27]. Drawing on the previous research, this paper decides to measure the innovation capability of strategic emerging enterprises with the growth rate of R&D expense, and R&D input intensity.

(2) Sustainable Development Capability. In a highly competitive market, sustainable development capability determines the survival time and social contribution of strategic emerging enterprises [28]. Two indices, namely, economic contribution rate and tax contribution rate, were selected to check whether the economic growth of strategic emerging enterprises is in harmony with the rise in social and economic benefits. The higher the two indices, the greater the social contribution of the enterprise.

Considering the data reliability and availability, a multilayer evaluation index system was established for fully evaluate the development of strategic emerging industries. As shown in Table 1, the established system covers 14 tertiary indices, 6 secondary indices, and 3 primary indices.

3.3. Methodology. Entropy and VIKOR were adopted for this research, because of their advantage in principal component analysis (PCA), simplicity in calculation, and excellence on a small sample size. Suppose our multiple-attribute decision problem involves n evaluation indices and m evaluation objects. Then, the values of the n indices can be expressed as a matrix X, where X_{ij} is the value of the j-th index of the i-th object. Then, the decision matrix can be defined as

$$\left(X_{ij}\right)_{m\times n} = \begin{bmatrix} X_{11} & X_{21} & \dots & X_{m1} \\ X_{12} & X_{22} & \dots & X_{m2} \\ \vdots & \vdots & \vdots & \vdots \\ X_{1n} & X_{2n} & \dots & X_{mn} \end{bmatrix}. \tag{1}$$

According to the degree of difference between indices, entropy-VIKOR method was implemented to compute the weight of each index, and the ranking of backbone enterprises in strategic emerging industries. The computation consists of the following steps.

Step 1. Index quantification.

The indices were normalized to obtain a standard state matrix $X = (x_{ij})_{mn}$. If the index is profit type (the larger, the better), then X_{ij} can be calculated by

$$x_{ij} = \frac{x'_{ij} - \min_i\left(x'_{ij}\right)}{\max_i\left(x'_{ij}\right) - \min_i\left(x'_{ij}\right)}. \tag{2}$$

If the index is cost type (the smaller, the better), then X_{ij} can be calculated by

$$x_{ij} = \frac{\max_i\left(x'_{ij}\right) - x'_{ij}}{\max_i\left(x'_{ij}\right) - \min_i\left(x'_{ij}\right)}. \tag{3}$$

If the index is fixed type (the closer to the ideal value, the better), then X_{ij} can be calculated by

$$x_{ij} = 1.0 - \frac{\left|x'_{ij} - \beta\right|}{\max_i\left|x'_{ij} - \beta\right|}. \tag{4}$$

Step 2. Calculating the normalized decision matrix.

The normalized decision matrix can be expressed as $\widehat{x}^{(0)}(k)$, with

$$p_{ij} = \frac{x_{ij}}{\sum_{i=1}^{m} x_{ij}}, \quad i = 1, 2, \dots, m,\ j = 1, 2, \dots, n. \tag{5}$$

Step 3. Assigning entropy weight to each index.

First, the entropy of the j-th index can be computed by

$$E_j = -K \sum_{i=1}^{m} p_{ij} \ln\ p_{ij}, \quad i = 1, 2, \dots, m,\ j = 1, 2, \dots, n, \tag{6}$$

where $k = (1/\ln\ m) > 0$, $0 \le E_j \le 1$.

Then, the difference coefficient of the j-th index was calculated as $g_j = 1 - E_j$. For the given j, the smaller the g_j, the larger the E_j. Thus, the weight of each index can be defined as

$$W_j = \frac{g_j}{\sum_{j=1}^{n} g_j}. \tag{7}$$

Table 1: Evaluation indices and their weights.

Goal layer	Primary indices	Secondary indices	Weight	Tertiary indices	Index weight
Evaluation of strategic emerging industries	Resources (0.4271)	Intangible resources	0.13684	Ratio of intangible assets	0.06532
				Growth rate of intangible assets	0.07152
		Tangible resources	0.29027	Growth rate of fixed assets	0.07125
				Ratio of cash	0.07452
				Stock	0.07025
				Accounts receivable	0.07425
	Market demand (0.2815)	Marketing capability	0.1411	Net profit margin	0.07256
				Market share	0.06854
		Market forecast capability	0.14043	P/E	0.06832
				P/B	0.07211
	Technological innovation (0.2914)	Innovation capability	0.14549	Growth rate of R&D expense	0.07025
				R&D input intensity	0.07524
		Sustainable development capability	0.14587	Economic contribution rate	0.07115
				Tax contribution rate	0.07472

The data and results are from this research.

Step 4. Determining ideal and negative ideal solutions.

If the j-th index is profit type, the ideal solution set A^* and the negative ideal solution set A^- can be, respectively, expressed as

$$A^* = \left\{\max_{j=1}^{n} f_{ij} | i = 1, 2, \ldots, m\right\} = \left\{f_1^*, f_2^*, \ldots, f_j^*, \ldots, f_n^*\right\},$$
$$A^- = \left\{\min_{j=1}^{n} f_{ij} | i = 1, 2, \ldots, m\right\} = \left\{f_1^-, f_2^-, \ldots, f_j^-, \ldots, f_n^-\right\}. \tag{8}$$

If the j-th index is cost type, sets A^* and A^- can be, respectively, expressed as

$$A^* = \left\{\min_{j=1}^{n} f_{ij} | i = 1, 2, \ldots, m\right\} = \left\{f_1^*, f_2^*, \ldots, f_j^*, \ldots, f_n^*\right\},$$
$$A^- = \left\{\max_{j=1}^{n} f_{ij} | i = 1, 2, \ldots, m\right\} = \left\{f_1^-, f_2^-, \ldots, f_j^-, \ldots, f_n^-\right\}. \tag{9}$$

Step 5. Computing the distance ratio of ideal and negative ideal solutions.

The distance of the i-th object to the ideal solution and the negative ideal solution can be, respectively, calculated by

$$S_i = \sum_{j=1}^{n} \frac{w_j\left(f_j^* - f_{ij}\right)}{\left(f_j^* - f_j^-\right)},$$
$$R_i = \max_j \left[\frac{w_j\left(f_j^* - f_{ij}\right)}{\left(f_j^* - f_j^-\right)}\right], \tag{10}$$

where w_j is the weight of the j-th index. S_j and R_i can be regarded as indicators of agreement and disagreement, respectively. Suppose each decision maker can vote for or against each decision. Then, the agreement increases with S_j value, and the disagreement increases with R_i value. Together, S_i and R_i carry the features of smaller-the-better (STB).

Step 6. Computing and sorting VIKOR composite indices.

The VIKOR composite index of the i-th object can be derived by

$$Q_i = v\left[\frac{S_i - S^*}{S^- - S^*}\right] + (1 - v)\left[\frac{R_i - R^*}{R^- - R^*}\right], \tag{11}$$

where $S^* = \mathrm{Min}_i S_i$, $S^- = \mathrm{Max}_i S_i$; $R^* = \mathrm{Min}_i R_i$, $R^- = \mathrm{Max}_i R_i$; v is the weight of the ratio of the ideal solution to the negative ideal solution (usually set as 0.5).

In the previously mentioned formula, v refers to the coefficient of decision-making mechanism, $v > 0.5$ refers to decision-making based on most resolutions, $v = 0.5$ refers to decision-making based on consent, and $v < 0.5$ refers to decision-making based on opposition. In VIKOR, we set v as 0.5 and pursue the maximization of group utility and the minimization of individual regret.

Step 7. According to the idea of VIKOR method, the selected objects are ranked from small to large according to S, R, and Q values.

4. Empirical Analysis

4.1. Data Sources and Sample Analysis. The sample enterprises were selected through the following process. First, several enterprises of Fujian were selected preliminarily by comparing their main business scope and main product types in 2017–2019 against the Classification of Strategic Emerging Industries (2020), released by China's National Bureau of Statistics. Second, the strategic emerging enterprises whose listing time is shorter than 5 years were removed from the preliminary samples. Third, the enterprises with missing data and suspended from listing were removed, leaving only those with no major violations in the recent year. The remaining 21 listed enterprises can basically reflect the overall performance of strategic emerging enterprises

from Fujian in Shanghai and Shenzhen Stock Exchanges. Spatially, the 21 enterprises are located in Fuzhou (9), Xiamen (7), Zhangzhou (2), and Quanzhou (2). The distribution ratio is close to the proportion of strategic emerging enterprises in the province, reflecting the overall performance of the backbone enterprises.

4.2. Index Weighting.

(1) The original data were preprocessed by quantifying and normalizing the indices. The quantification index can be expressed as

$$x_{ij} = \begin{cases} 0.0209\ 0.0352\ 0.0495\ 0.6854\ 0.7785\ 0.9021\ 0.3854\ 0.1124\ 0.0296\ 0.0985\ 0.1125\ 0.3565\ 0.2574\ 0.4121 \\ 0.4435\ 0.7856\ 0.0398\ 0.3985\ 0.9985\ 0.8654\ 0.5214\ 0.1121\ 0.0256\ 0.1224\ 0.1421\ 0.5875\ 0.2412\ 0.4895 \\ 0.1587\ 0.0258\ 0.0512\ 0.8459\ 0.9754\ 0.9958\ 0.7785\ 0.0295\ 0.0321\ 0.0895\ 0.1121\ 0.5423\ 0.1874\ 0.4125 \\ M \\ 0.3256\ 0.0201\ 0.0774\ 0.5985\ 0.9545\ 0.9025\ 0.4348\ 0.2041\ 0.0652\ 0.1354\ 0.0821\ 0.5012\ 0.2541\ 0.3329. \end{cases} \quad (12)$$

The normalized decision matrix can be described as

$$F = \begin{bmatrix} 0.0012\ 0.0035\ 0.0067\ 0.0325\ 0.0101\ 0.0254\ 0.0075\ 0.0032\ 0.0049\ 0.0074\ 0.0135\ 0.0105\ 0.0079\ 0.0015 \\ 0.0235\ 0.0874\ 0.0054\ 0.0074\ 0.0098\ 0.0047\ 0.0065\ 0.0076\ 0.0189\ 0.0075\ 0.0054\ 0.0125\ 0.0101\ 0.0098 \\ 0.0075\ 0.0035\ 0.0078\ 0.0098\ 0.0145\ 0.0187\ 0.0085\ 0.0025\ 0.0061\ 0.0078\ 0.0158\ 0.0101\ 0.0095\ 0.0075 \\ M \\ 0.0245\ 0.0014\ 0.0156\ 0.0114\ 0.0174\ 0.0087\ 0.0058\ 0.0154\ 0.0038\ 0.0074\ 0.0014\ 0.0146\ 0.0157\ 0.0081 \end{bmatrix}. \quad (13)$$

(2) The weight of each index was obtained by the entropy weight method:

$$W = [0.0653\ 0.0715\ 0.0713\ 0.0745\ 0.0703\ 0.0743\ 0.0726\ 0.0685\ 0.0683\ 0.0721\ 0.0703\ 0.0752\ 0.0712\ 0.0747]. \quad (14)$$

The results of index weighting are presented in Table 1.

As shown in Table 1, tangible resources (weight: 0.2903) had the largest contribution rate, followed in turn by sustainable development capability (weight: 0.1459), innovation capability (weight: 0.1455), and marketing capability (weight: 0.1411). Therefore, the selected listed enterprises should enhance their market competitiveness by improving their capabilities in tangible resources, sustainable development, innovation, and marketing.

4.3. Ranking of Backbone Enterprises. By entropy-VIKOR, the ideal solution and the negative ideal solution can be respectively obtained as

$$\begin{aligned} A^* &= [0.6754\ 0.6589\ 0.9542\ 1.0000\ 0.9987\ 1.0000\ 0.8987\ 0.9985\ 1.0000\ 0.9987\ 1.0000\ 0.9658\ 1.0000\ 0.9952], \\ A^- &= [0.0014\ 0.0038\ 0.0000\ 0.0001\ 0.0085\ 0.0064\ 0.0985\ 0.0784\ 0.0000\ 0.0046\ 0.0008\ 0.0478\ 0.0354\ 0.0045]. \end{aligned} \quad (15)$$

Then, the VIKOR composite indices of each enterprise in 2017–2019 were obtained and used to sort the enterprises. For the lack of space, only the results and ranking of 2019 are provided (Table 2). Among the selected enterprises, Zhangzhou Pientzehuang Pharmaceutical and Fujian Superpipe rank top 1 and top 2 in the comprehensive ranking, with comprehensive Q values of 0.0000 and 0.5014, respectively.

As shown in Table 2, the selected enterprises differed sharply in VIKOR composite index, exposing a realistic problem: the serious imbalance of development among the backbone enterprises. Judging by industry distribution, the top seven enterprises are mainly engaged in Biomedicine (Zhangzhou Pientzehuang Pharmaceutical and Kingdomway), computer application (Newland Computer), communication equipment (STAR-NET, CASTECH), and

Table 2: VIKOR composite indices of the backbone enterprises (2019).

Serial number	Enterprise	VIKOR composite index	Ranking	Resources	Ranking	Market demand	Ranking	Technological innovation	Ranking
1	Newland Computer	0.7160	7	0.3177	2	0.7655	8	0.2801	8
2	Guomai Technologies	0.8652	14	0.7981	11	0.5964	4	0.3574	10
3	CASTECH	0.7045	6	0.8021	12	0.3528	2	0.2487	7
4	Kehua Hengsheng	0.8294	11	0.4681	4	0.8456	14	0.5514	13
5	STAR-NET	0.6614	5	0.8065	13	0.7787	9	0.0725	3
6	Rongji Software	0.8495	13	0.9056	19	0.8052	11	0.1762	5
7	Haiyuan Automatic Equipment	0.9247	20	0.9077	20	0.9520	21	0.2145	6
8	Kingdomway	0.6311	4	0.5031	6	0.7115	6	0.9658	21
9	Fujian Snowman	0.8854	15	0.7625	8	0.8602	16	0.5571	14
10	Xiamen Savings Environmental	0.8965	18	0.7451	7	0.8788	18	0.6422	19
11	YLZ Information Technology	0.8951	17	0.8865	17	0.8215	13	0.0045	2
12	Xiamen Change Light	0.9124	19	0.0283	1	0.8845	19	0.5265	12
13	Yuanli Active Carbon	0.7856	9	0.4671	3	0.8214	12	0.4258	11
14	Meiya Pico	0.7439	8	0.7830	9	0.7324	7	0.0854	4
15	Fujian Superpipe	0.5014	2	0.8475	15	0.0000	1	0.5982	17
16	Fuchun Communications	0.9325	21	0.9245	21	0.9212	20	0.0000	1
17	Furi Electronics	0.8856	16	0.8874	18	0.8665	17	0.6325	18
18	Fujian Longking	0.5078	3	0.8625	16	0.7987	10	0.5852	16
19	Zhangzhou Pientzehuang Pharmaceutical	0.0000	1	0.7845	10	0.5265	3	0.8298	20
20	Xiamen Tungsten	0.8327	12	0.4785	5	0.8547	15	0.5824	15
21	Fujian Longxi Bearing	0.7898	10	0.8257	14	0.6523	5	0.3125	9

The data and results are from this research.

environmental protection equipment (Fujian Longking and Fujian Superpipe). The result is basically consistent with the goals of Fujian for the cultivation and development of strategic emerging industries in 2016–2020.

Owing to the constraints of industrial base and geographical conditions, four enterprises, namely, Fuchun Communications, Haiyuan Automatic Equipment, Xiamen Changelight, and Xiamen Savings Environmental ranked at low places, suggesting the weak growth of energy saving and environmental protection and optics and optoelectronics. These strategic emerging enterprises need to break lots of growth limits, such as high risk, limited financial resources, and complex management. Furthermore, the VIKOR composite indices of each enterprises in 2017–2019 were compared laterally (Table 3).

4.4. Results Analysis

4.4.1. Longitudinal Comparison. As shown in Table 3, sample enterprises developed in three different patterns from 2017 to 2019: progress, retrogression, and fluctuation. In general, the strong enterprises continued to perform well, the weak ones continued to perform poorly, while the medium ones experienced ups and downs.

During 2017–2019, six enterprises made progress, five achieved poorer results than before, and ten had unstable performance. There are less than half of strategic emerging enterprises, indicating that strategic emerging enterprises in Fujian remain in the early phase (the so-called strength-gathering phase) of industrial development. This is because most of these enterprises are small in scale and weak in scientific foundation, lacking high-level talents of technological innovation. More time is needed for them to absorb key technologies and make breakthroughs in research. Meanwhile, the large number of unstable enterprises reflects the fierce competition in strategic emerging industries.

4.4.2. Horizontal Comparison. Take the VIKOR composite indices of the enterprises in 2019 for example. From the perspective of resource endowment, Xiamen Change Light, STAR-NET, Newland Computer, Rongji Software, Yuanli Active Carbon, and Kingdomway occupied the top three rankings, suggesting that these three enterprises boast more and make better use of resources.

From the perspective of market demand, Fujian Superpipe, Rongji Software, CASTECH, YLZ Information Technology, Zhangzhou Pientzehuang Pharmaceutical, and Fuchun Communications were the top three enterprises. Focusing on their main businesses, the three enterprises achieved higher net profit margin and earnings per share than others, which signify high market returns.

From the perspective of technological innovation, Fuchun Communications, YLZ Information Technology,

Table 3: Trend of VIKOR composite index of each backbone enterprise (2017–2019).

Serial number	Enterprise	Trend	Composite ranking			Resource ranking			Market demand ranking			Technological innovation ranking		
		Year	2017	2018	2019	2017	2018	2019	2017	2018	2019	2017	2018	2019
1	Newland Computer	⟶	2	8	7	4	1	2	7	7	8	10	9	8
2	Guomai Technologies	↓	12	13	14	18	3	11	8	6	4	16	13	10
3	CASTECH	⟶	4	3	6	8	9	12	1	1	2	8	7	7
4	Kehua Hengsheng	⟶	8	15	11	11	4	4	6	16	14	14	14	13
5	STAR-NET	↑	6	5	5	9	6	13	10	9	9	2	4	3
6	Rongji Software	↑	17	14	13	10	21	19	16	15	11	7	5	5
7	Haiyuan Automatic Equipment	↓	18	19	20	12	2	20	17	21	21	9	1	6
8	Kingdomway	⟶	3	1	4	19	16	6	2	2	6	19	20	21
9	Fujian Snowman	↑	19	18	15	5	20	8	20	17	16	11	17	14
10	Xiamen Savings Environmental	⟶	15	21	18	1	18	7	17	20	18	17	12	19
11	YLZ Information Technology	↓	16	17	17	21	19	17	15	13	13	1	3	2
12	Xiamen Change Light	⟶	11	10	19	14	5	1	5	5	19	12	11	12
13	Yuanli Active Carbon	⟶	10	6	9	17	11	3	12	12	12	4	10	11
14	Meiya Pico	↓	7	7	8	6	12	9	4	4	7	3	2	4
15	Fujian Superpipe	⟶	13	20	2	3	13	15	14	19	1	21	19	17
16	Fuchun Communications	⟶	21	12	21	2	17	21	21	8	20	5	6	1
17	Furi Electronics	↑	20	16	16	20	10	18	19	18	17	18	18	18
18	Fujian Longking	↑	5	4	3	15	14	16	9	10	10	13	15	16
19	Zhangzhou Pientzehuang Pharmaceutical	⟶	1	2	1	16	15	10	3	3	3	20	21	20
20	Xiamen Tungsten	↓	9	9	12	13	8	5	13	14	15	15	16	15
21	Fujian Longxi Bearing	↑	14	11	10	7	7	14	11	11	5	6	8	9

The data and results are from this research.

Meiya Pico and STAR-NET, and Newland Computer were the best performers. These enterprises offered the highest ratio of R&D investment to comprehensively enhance their core competitiveness. By contrast, most enterprises invested too little in innovation.

5. Countermeasures and Proposals

The backbone enterprises with good growth potential are the key to the development of strategic emerging industries in Fujian. The previously mentioned empirical analysis shows that innovation capability and market development capability are the signature capabilities of the backbone enterprises in strategic emerging industries. It is difficult for the enterprises to enhance the two capabilities by themselves. The government must act as an important facilitator.

5.1. Implementing the Cultivation Plan for Backbone Enterprises. Fujian needs to promote strategic emerging industries by the principles of government guidance, market selection, and dynamic management. Resources should be diverted to the key development areas to cultivate a number of backbone enterprises. The key features of these enterprises include a strong ability of independent innovation, mastery of core technologies, good operating conditions, prominent main businesses, and good prospects of product market [29]. The backbone enterprises will greatly drive the development of strategic emerging industries and achieve the initial scale of development. Moreover, the government should develop a scientific evaluation index system for backbone enterprises in strategic emerging industries, improve their awareness of innovation, and encourage them to invest more in independent innovation. In this way, the enterprises will acquire independent innovation capabilities and climb to the high end of the industrial value chain.

5.2. Supporting Major Projects of Backbone Enterprises. Fujian needs to provide special funds to support the backbone enterprises in implementing major industrialization projects, which cover and drive important aspects of the national economy [30]. The enterprises should also be enabled to fully display their leading and driving roles and thoroughly integrate resources. In addition, the government at all levels should invite investment through business, focus on improving the industrial chain, and actively attract large domestic and foreign enterprises to invest in major projects in Fujian. In particular, the top 100 projects in strategic emerging industries must be included in the cultivation plan for backbone enterprises.

5.3. Enhancing the Technological Innovation Capability of Backbone Enterprises. Fujian needs to guide the backbone enterprises to step up investment in R&D and gather more innovation factors. The government should support the enterprises in building innovation platforms, such as key labs, technology centers, and national research centers, and back the growth of small and medium-sized innovative enterprises by setting up demonstration platforms for

public/technical services, as well as demonstration bases for the industrialization of innovative designs. Centering on Fuzhou and Xiamen, Fujian must constantly improve the software and hardware for industrial innovation, launch a new round of technological transfer with multinationals, and seek national support for the construction of R&D infrastructure and innovation platforms for emerging industries, especially agricultural strategic emerging industries [31]. Furthermore, the government also needs to further optimize the industrial policies and optimize the division of labor and cooperation between Fujian and Taiwan. These efforts will boost the independent innovation and market competitiveness of backbone enterprises in strategic emerging industries, promoting the economic transformation and upgrading in the province.

5.4. Building a Talent Support System for Strategic Emerging Industries. The innovative development of strategic emerging industries depends on talents, and the innovative potential of all kinds of talents should be fully stimulated and released. As a relatively developed city in China, Fujian can use its geographical advantages and urban vitality to attract more high-end talents in emerging industries. Come up with attractive policies to introduction and development talents, to prevent brain drain [32]. Focus on improving the quality of professional talents, relying on the existing universities, research institutes, and backbone enterprises, and actively introduce a number of high-level professional and technical talents and innovation teams required by strategic emerging industries at home and abroad. We will encourage universities and enterprises to jointly train talents at all levels in strategic emerging industries. In order to better connect with the development needs of strategic emerging industries. In addition, pay attention to the construction of scientific and reasonable talent assessment standards and indicators, stimulate the enthusiasm of production, and promote the continuous emergence of scientific and technological innovation achievements.

6. Summary and Prospect

6.1. Prioritizing the Cultivation and Development of Competitive Industries. The strategic emerging industries in Fujian have a good foundation and development trend in the following areas: energy conservation and environmental protection, high-tech equipment manufacturing, new-generation information technology, and new material. These competitive industries must be the emphasis in the cultivation of strategic emerging industries. Meanwhile, biomedicine, new energy, and marine industry have relatively high output and profitability but remain in the initial phase of development. Considering their potential, these industries should be attached much importance in future.

6.2. Speeding Up the Institutional Reform. After comparing the VIKOR composite indices of 21 backbone enterprises, it was learned that some enterprises boast strong independent innovation capability and lead in technology innovation. However, these enterprises face many institutional constraints during the development. Taking biomedicine for example, medical products and health services are severely limited by the current health care system. Therefore, it is necessary to speed up the institutional reform, creating a more flexible environment for the development of the backbone enterprises in strategic emerging industries.

6.3. Cultivating Professional Regional Markets. The strategic emerging industries in Fujian do not have a clear competitive advantage over those in the Yangtze River Delta and Pearl River Delta, failing to form an influential professional market. Currently, strategic emerging industries mainly concentrate in Xiamen, Fuzhou, Quanzhou, and Zhangzhou, four large cities in Fujian, and their development depends heavily on foreign investment. Besides, the products/services, for example, the optoelectronic products in Xiamen, are mostly exported to foreign markets. The investment in domestic market development is still inadequate. Thus, it is important to cultivate professional regional markets for strategic emerging industries.

In summary, this paper achieves valuable results on how to select and cultivate strategic emerging industries in Fujian. The future research will improve and expand in two areas: the empirical analysis and index selection. As for the empirical analysis, this paper selects the most representative listed enterprises. However, they might not fully reflect the situation of all strategic emerging industries. In the future research, more data need to be selected to draw more robust conclusions. What is more, only seven strategic emerging industries were discussed, due to the limitations of research conditions and data sources. More industries should be taken into account. As for index selection, only a few typical indices were selected, owing to data availability and calculation complexity. The incompleteness of evaluation index system might affect the quality of analysis results. The future research will choose even more indices to measure the development of strategic emerging industries.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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References

[1] Q. Wang and Z. J. Zhou, "Policy choice for the development of strategic emerging industries during the 13th five-year plan capability orientation and mechanism innovation," *Journal of Beijing Normal University*, vol. 2, pp. 140–148, 2017.

[2] X. Su, X. Y. Peng, and Y. Zhao, "Open innovation drives the high-end of strategic emerging industries: a review and analysis framework," *Journal of Technology Economics and Management*, vol. 12, pp. 115–118, 2019.

[3] H. N. Wang, L. H. Wang, and Z. Zhou, "Research on the development strategy of emerging industry (2035)," *Engineering and Science*, vol. 22, pp. 1–8, 2020.

[4] W. Liu and J. Q. Xu, "Analysis of influencing factors of green technology innovation in strategic emerging industries," *Ecological Economics*, vol. 34, pp. 116–119, 2018.

[5] B. S. Zhang and X. R. Tuo, "Research on technology information of strategic emerging industries for government decision-making," *Science and Technology Management Research*, vol. 34, pp. 38–42, 2020.

[6] G. S. Cheng, W. R. Qiao, and Q. Li, "The cause, mechanism and path of the formation of strategic emerging industry in China," *Reform of Economic System*, vol. 6, pp. 107–110, 2014.

[7] H. X. Huang and Z. H. Zhang, "Research on DEA model of the allocation efficiency of scientific and technological resources in China's strategic emerging industries," *China soft science*, vol. 1, pp. 150–159, 2015.

[8] Z. C. He, X. Zhang, W. J. Chen, and Y. Wu, "The study of strategic emerging industries' appraisal system and selection," *Journal of Hunan University (Social Sciences)*, vol. 6, pp. 63–68, 2013.

[9] H. L. Chen, "Research on technology innovation efficiency of China's strategic emerging industries under environmental constraints," *Economic latitude and longitude*, vol. 184, pp. 96–101, 2018.

[10] H. Gulen and M. Ion, "Policy uncertainty and corporate investment," *Review of Financial Studies*, vol. 29, no. 3, pp. 523–564, 2016.

[11] H. Q. Wang, Z. J. Yang, and N. An, "Study on the foster mode of regional strategic emerging industries from creative double helix perspective and its application," *In Forum on Science and Technology in China*, vol. 8, pp. 55–59, 2014.

[12] R. F. Zhang and Y. Y. Zhao, "A study on the measurement of competitiveness of China's strategic emerging industries," *Modern Management Science*, vol. 12, pp. 33–35, 2014.

[13] Z. T. Wu, D. Zhang, and Y. Gong, "Empirical research of review of regional innovation networks of strategic emerging industries in Xi'an high-tech zone," *Statistics & Information Tribune*, vol. 11, pp. 84–90, 2014.

[14] G. S. Cheng, Y. Zhang, and M. J. Rui, "Strategic emerging industries: an empirical analysis based on the data of listed companies from 2005 to 2011," *Contemporary Finance & Economics*, vol. 10, pp. 96–105, 2013.

[15] X. Y. Guo and X. F. Hui, "Evaluation research on the innovation ability of strategic emerging industry business model," *Journal of Tianjin University (Social Sciences)*, vol. 3, pp. 221–225, 2015.

[16] W. Hui, "Difficulties and countermeasures of financial support for strategic emerging industries in the new era--based on the perspective of government promotion," *Theoretical Discussion*, vol. 210, pp. 123–128, 2019.

[17] S. Murugan, G. Kulanthaivel, and V. Ulagamuthalvi, "Selection of test case features using fuzzy entropy measure and random forest," *Ingénierie des Systèmes d' Information*, vol. 24, no. 3, pp. 261–268, 2019.

[18] B. Beirami and M. Mokhtarzade, "An automatic method for unsupervised feature selection of hyperspectral images based on fuzzy clustering of bands," *Traitement du Signal*, vol. 37, no. 2, pp. 319–324, 2020.

[19] C. Wang and J. Hong, "Empirical analysis on the sustainable development of China's outward foreign direct investment from the perspective of economic institution," *International Journal of Sustainable Development and Planning*, vol. 15, no. 3, pp. 369–375, 2020.

[20] J. P. Mika, L. Warren, D. Foley, and F. R. Palmer, "Perspectives on indigenous entrepreneurship, innovation and enterprise," *Journal of Management & Organization*, vol. 23, no. 6, pp. 767–773, 2018.

[21] D. Z. Dong, C. Wu, and M. Gong, "Research on independent innovation ability evaluation of strategic emerging industries in Hubei province," *Science & Technology Progress and Policy*, vol. 12, pp. 143–147, 2016.

[22] B. Lev, *Intangibles: Management, Measurement and Reporting*, Brookings Inst Press, Washington, USA, 2001.

[23] D. M. Song, "Research on the measurement of regional strategic emerging industry competitiveness--taking Jiangsu as a case," *Enterprise Economy*, vol. 10, pp. 154–157, 2014.

[24] J. C. Zhang and X. D. Zuo, "The construction of enterprise competitiveness evaluation index system," *Management World*, vol. 10, pp. 172-173, 2013.

[25] Z. H. Zhang, J. J. Pan, and P. Li, "An evaluation, evolution and exploration about the innovation capability development of the strategic emerging industry," *Science Research Management*, vol. 3, pp. 1–12, 2015.

[26] X. Ke, "Performance evaluation of real estate listed companies based on factor analysis," in *Proceedings of the 2018 4th International Conference on Humanities and Social Science Research (ICHSSR 2018)*, pp. 700–704, Paris, France, 2018.

[27] L. Chen, "Discussion on the construction of enterprise financial evaluation index system from the perspective of market competitiveness," *Accounting Learning*, vol. 2, pp. 27-28, 2016.

[28] W. B. Arthur, "Increasing returns and the new world of business," *Harvard Business Review*, vol. 74, no. 4, pp. 100–109, 1996.

[29] R. Y. Jia and T. Liu, "SWOT analysis of strategic emerging industries in Hebei province based on analytic hierarchy process," *Scientific Management Research*, vol. 2, 2019.

[30] W. F. Chen and W. Liu, "Construction of evaluation index system of regional strategic emerging industry development quality," *Statistics & Decisions*, vol. 2, pp. 29–33, 2016.

[31] B. Liang, X. Lv, and Z. Zhang, "Study on the path of cultivating and developing agricultural strategic emerging industries from the perspective of agricultural modernization-taking Xinjiang production and construction corps as an example," *Agricultural Economics*, vol. 4, pp. 3–6, 2021.

[32] C. Jin, "Quantitative analysis of technological innovation capability of strategic emerging industries," *Statistics & Decision*, vol. 35, pp. 112–115, 2019.