












Analysis of the Current Situation of “Specialized and Special” Enterprises Based on GM (1.1) Model

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Abstract. Since the identification of the firstbatch of “specialized and special new” enterprises in 2019, China has continuously increased the cultivation of “specialized and special new” enterprises and achieved positive results. By 2022, a total of 4 batches of “specialized and special new” enterprises have been identified, totaling 9279, including 1317 listed enterprises. This paper analyzes the current situation of the development of “specialized, special and new” enterprises in China and the industrial distribution of “specialized, special and new” enterprises in Zhejiang Province, and uses the grey prediction method to predict the number of patent applications of 163 “specialized, special and new” enterprises established in Zhejiang Province for more than 10 years, with a view to providing a basis for the high-quality development of “specialized, special and new” enterprises. Through the prediction and analysis of 163 “specialized and special new” enterprises in Zhejiang Province, it is concluded that the number of patents applied by “specialized and special new” enterprises has increased from 2299 to 3860 in five years.

Keywords: Specialized · special and new · Zhejiang Province · listed companies · number of patents · grey prediction

1 Introduction

With the strong support of the national industrial policy, the innovation ability of “specialized and special” enterprises has been continuously strengthened, which is reflected in the increasing number of enterprise patents [1]. After analyzing the “specialized and special” enterprises in China, this paper forecasts the number of patents of listed companies in the “specialized and special” enterprises in Zhejiang Province based on GM (1.1) model, in order to provide reference for relevant industrial policies.

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2 Development Status of “Specialized and Special” Enterprises

2.1 The Development Status of China’s “Specialized and Innovation”

In China, “specialized and special” enterprises refer to small and medium-sized enterprises with the characteristics of “specialization, refinement, specialization and novelty”, and are “small giants” among small and medium-sized enterprises [2]. In 2011, the Ministry of Industry and Information Technology of the People’s Republic of China put forward the concept of “specialization, specialization and innovation” for the first time.

At present, China has a variety of evaluation methods for “specialized and special new” enterprises, such as “specialized and special new” enterprises evaluated by cities, “specialized and special new” enterprises evaluated by provinces, and “specialized and special new” enterprises evaluated by the Ministry of Industry and Information Technology of the People’s Republic of China. In this paper, 9279 “specialized and special new” enterprises announced by the Ministry of Industry and Information Technology as of 2022 are taken as the analysis objects to understand their geographical distribution characteristics, and 175 “specialized and new” enterprises in Zhejiang Province as the analysis object to understand their industry distribution characteristics and patent number.

2.2 The Development Status of China’s “Specialized and New” Enterprises

By 2023, the Ministry of Industry and Information Technology of the People’s Republic of China has released a list of four groups of “specialized and new” enterprises, 248 in 2019, 1744 in 2020, 2930 in 2021 and 4357 in 2022. In the past four years, a total of 9279 “specialized and new” enterprises have been established. The specific distribution is as follows (According to the list issued by the Ministry of Industry and Information Technology):

The “specialized and special new” enterprises are the leaders of the small and medium-sized enterprises, and also the main force of technological innovation of small and medium-sized enterprises. From Table 1, we can see that Zhejiang Province has the largest number of “specialized and special new” enterprises. Therefore, this paper makes a further analysis from the “specialized and special” enterprises in Zhejiang Province.

There are 1078 “specialized and new” enterprises in Zhejiang province, and the specific distribution is as follows (Table 2):

Among the 1,078 “specialized, special and new” enterprises, there are 175 listed companies, and the specific distribution is as follows (Table 3):

3 Prediction of Patent Number Based on GM (1.1) Model

3.1 GM (1.1) Model Construction [3]

The basic idea of GM (1.1) model is to generate the original sequence in a cumulative way. Because the accumulated sequence has an exponential growth trend, the model is established by using the approximate first-order differential equation, and finally the prediction sequence is generated by the cumulative generation of the modeling sequence to complete the prediction of the development trend of the original sequence [4].

Table 1. Distribution of “specialized, special and new” enterprises in China [7]

Province	Number of enterprises	Province	Number of enterprises
Zhejiang	1078	Tianjin	197
Guangdong	881	Shaanxi	166
Shandong	771	Shanxi	153
Jiangsu	715	Guangxi	106
Beijing	598	Yunnan	81
Shanghai	507	Guizhou	70
Anhui	494	Jilin	63
Hubei	483	Xinjiang	62
Hunan	415	Heilongjiang	61
Henan	379	Gansu	56
Fujian	360	Ningxia	40
Sichuan	350	Inner Mongolia	32
Hebei	347	Hainan	21
Liaoning	287	Qinghai	15
Chongqing	263	Xizang	4
Jiangxi	224		

Table 2. Distribution of “specialized, specialized and new” enterprises in Zhejiang Province [7]

A particular year	2019	2020	2021	2022	Total
Quantity	19	148	308	603	1078
Hangzhou City	2	20	32	155	209
Huzhou city	1	11	17	44	73
Jiaxing city	2	9	23	70	104
Jinhua City	1	11	22	35	69
Lishui city	0	6	6	14	26
Ningbo City	5	50	127	101	283
Quzhou City	1	1	6	13	21
Shaoxing city	1	9	18	57	85
Taizhou	3	9	19	59	90
Wenzhou City	2	19	31	55	107
Zhoushan city	1	3	7	0	11

Table 3. Distribution of “specialized, special and new” listed enterprises in Zhejiang Province [7]

A particular year	2019	2020	2021	2022	Total
Quantity	5	34	33	103	175
Hangzhou City	1	11	2	32	46
Huzhou city	0	4	2	12	18
Jiaxing city	2	4	3	15	24
Jinhua City	0	4	1	3	8
Lishui city	0	1	2	1	4
Ningbo City	0	4	10	8	22
Quzhou City	0	0	1	2	3
Shaoxing city	0	2	2	12	16
Taizhou	2	2	6	12	22
Wenzhou City	0	1	2	6	9
Zhoushan city	0	1	2	0	3

Set the original sequence as³:

$$X(0) = \{x(0)(1), x(0)(2), \dots, x(0)(n)\} \quad (1)$$

Next, perform an accumulation to generate the following³:

$$X^{(1)}(K) = \sum_{i=1}^K X(0)(i), K = 1, 2, 3, \dots, n \quad (2)$$

The sequence with exponential law is generated as follows³:

$$X^{(1)} = \{X^{(1)}(1), X^{(1)}(2), \dots, X^{(1)}(n)\} \quad (3)$$

The $X^{(1)}$ sequence is approximated to the solution of the first order differential Eq. 3.

$$\frac{dx^{(1)}}{dt} + ax^{(1)} = b \quad (4)$$

A is the development coefficient of the model; B is the amount of ash. Parameter³:

$$A = (B^T B)^{-1} B^T Y \quad (5)$$

The A is obtained by using the least-squares³:

In the formula³:

$$B = \begin{pmatrix} -\frac{1}{2}[X^1(1) + X^{(1)}(2)1] \\ -\frac{1}{2}[X^1(2) + X^{(1)}(3)1] \\ \vdots \\ -\frac{1}{2}[X^1(n-1) + X^{(1)}(n)1] \end{pmatrix} \quad (6)$$

$$Y = \{X^0(2), X^0(3) \cdots X^0(n)\}^T \tag{7}$$

Put the obtained a and b values into formula (4) to calculate³:

$$\hat{X}^1(K + 1) = [X^0(1) - \frac{b}{a}]e^{-ak} + \frac{b}{a} \tag{8}$$

Prediction function subtracted by Eq. (9)³:

$$\hat{X}^{(0)}(K + 1) = \hat{X}^{(1)}(K + 1) - \hat{X}^{(1)}(k) = (1 - e^a)[X^0(1) - \frac{b}{a}]e^{-ak} \tag{9}$$

3.2 Prediction of the Number of Patents of Zhejiang Specialized and Special New “Little Giant” Listed Companies

Patents are an important embodiment of the innovation ability of enterprises, so this paper uses the number of patents to measure the development of enterprises [5]. Because the use of GM (1,1) model requires certain data, this paper selects 163 of 175 listed companies for prediction.

It can be seen from Table 4 that the GM (1,1) model is established based on the number of patents (enterprises have been established for more than 10 years).

“Because the original data failed the level ratio test, a translation conversion was performed, adding 2299.00 to the original value. The ratio of the final translation conversion data level to the test value is within the standard range of [0.819, 1.221], indicating that this data can be used for the construction of the GM (1,1) model.”

It can be seen from Table 5 that after building the model. That the model accuracy level is very good (Table 6).

Table 4. GM (1,1) model-level ratio table (The data from 2013 to 2014 were compiled by ourselves) [6]

Year	Original value	Grade ratio λ	Original value + translation shift value (shift = 2299)	Stage ratio after conversion λ
2013 Year	515	-	2814.000	-
2014 Year	680	0.757	2979.000	0.945
2015 Year	1255	0.542	3554.000	0.838
2016 Year	1190	155	3489.000	1.019
2017 Year	1341	0.887	3640.000	0.959
2018 Year	1572	0.853	3871.000	0.940
2019 Year	1958	0.803	4257.000	0.909
2020 Year	2126	0.921	4425.000	0.962
2021 Year	2299	0.925	4598.000	0.962

Table 5. Results of the model construction

Development coefficient a	Grey action b	Posterior difference ratio C value	Small error probability p value
-0.0562	2891.1126	0.0341	1.000

Table 6. Table of model predictive values (The data from 2013 to 2014 were compiled by ourselves) [6]

T	Original value	Predicted value
2013 Year	515.000	515.000
2014 Year	680.000	837.710
2015 Year	1255.000	1019.144
2016 Year	1190.000	1211.071
2017 Year	1341.000	1414.101
2018 Year	1572.000	1628.874
2019 Year	1958.000	1856.070
2020 Year	2126.000	2096.407
2021 Year	2299.000	2350.646
2022 Year	-	2619.591
2023 Year	-	2904.092
2024 Year	-	3205.049
2025 Year	-	3523.414
2026 Year	-	3860.194

RMSE = 113.719

4 Conclusions

In this paper, the prediction model of the number of patent applications is established based on the gray system theory. From the prediction results, the total number of patents in Zhejiang province will show an upward trend in the next five years. From the results, the number of patents in “specialized, special and new” enterprises in Zhejiang province will grow rapidly from 2022 to 2026. From 2,299 cases in 2021 to 3,860 cases in 2026, an increase of 1.68 times, with an average annual growth rate of 321 cases, and an average increase of 1.9 cases per company.

Innovation is the soul of high-quality development of “specialized, specialized, and new” enterprises. As one of the most important achievements of innovation, owning high-quality patents is crucial for enterprise development. In the face of the current development situation of “specialized, specialized, and new” enterprises, the government should promote the rational allocation of market resources, encourage industrial

agglomeration, give play to comparative advantages and dislocation competition, and ultimately implement high-quality development of “specialized, specialized, and new” enterprises.

References

1. Lili Jing ,Hangqi Li . Research on green Development of Small and medium-sized Industrial Enterprises in Jilin Province under the guidance of “specialization, specialization and innovation” policy [J]. *Sme Management and Technology*, 2022 (23): 144-146.
2. Yuguan Xing ,Daoling Yang . Research on the development trend of national “specialized, special and new” enterprises based on big data [J]. *China market*, 2022 (28): 1-3.
3. Yuanxin Ma ,Yan Song . Application of the grey GM (1,1) model in the quantity prediction of patent applications [J]. *Journal of Changchun Normal University*, 2021,40 (08): 43-47.
4. Jinshan Xiao ,Tao He . Railway freight volume prediction based on the improved grey GM (1.1) model [J]. *Journal of Lanzhou Jiaotong University*, 2021,40 (03): 40-45.
5. Fei Yun. Research on regional patent application quantity prediction and evaluation of patent creation potential [D]. Zhenjiang: Jiangsu University, 2012.
6. Patent Star[EB/OL].<https://www.patentstar.com.cn/>
7. Ministry of Industry and Information Technology of the People’s Republic of China[EB/OL].<https://www.miit.gov.cn/>

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