

Research on Forecasting Demand of Science and Technology Talents in Guangxi Based on Grey Prediction Model

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Abstract: Scientific and technological talents play a leading and supporting role in the economic transformation and development. The prediction of scientific and technological talents is the scientific basis of formulating correct talent policies. In this paper, the gray GM (1,1) model is used to analyze the number of scientific and technological talents for Guangxi over the years, and the GM (1,1) prediction model is established. The results of statistical test and error analysis show that the model has high precision, and the model are used to predict the future ten years of Guangxi Science and Technology. The number of talents.

1. Introduction

Since the 21st century, science and technology have developed rapidly, and the knowledge economy has begun to emerge. Technology and innovation are playing an increasingly important role in economic development. As the carrier of science and technology, the bearer and pioneer of advanced productivity, talents are the key to improving core competitiveness. Scientific and technological talents refer to people who have moral character and have certain special scientific and technological skills. They are people that have mastered knowledge or production technology skills and have greater social contributions. Grey prediction is a method of predicting a system that contains both known information and unknown information. The amount of information required is small, and the original sequence of disordered discrete can be converted into an ordered sequence of higher accuracy and better comparison. Good reflection of the reality. This paper uses this model to predict the scientific and technological talents of Guangxi in the next five years.

2. Guangxi Science and Technology Talent Demand Forecast

2.1 Model selection

The relationship between talent system and social and economic development is very complicated. This system contains both known information and unknown information. It can be considered that the talent system is a semi-dark gray system, using GM (1, 1) gray modelled on technology. The prediction of talents has certain rationality. Xu Zedong (2016) pointed out that the gray theory are used for predictive analysis, especially when the data sequence is short and has a clear upward trend. The prediction accuracy is high ^[1], so the gray prediction has a wide range of applications in the field of human resources. The grey prediction method does not require too much sample data, which can make up for the lack of historical data onto talent statistics. In addition, this method can also avoid people's subjective assumptions due to personal experience, knowledge, preferences, etc. ^[2] ^[3]. Yan Xueqing (2017) established a gray model of talent supply and demand based on the supply and demand data of Guangdong high-skilled logistics talents in 2008-2014 and tested it to prove that the model is available, and then forecast the supply and demand of high-skilled logistics

talents in Guangdong [4]. Bai Xuguang (2017) combined with the gray system theory to study the change law of talent demanded in Shanxi's venture capital industry from 2011 to 2016, and constructed a gray model for the demand forecast of venture capital talents in Shanxi Province, and the venture capital industry for Shanxi Province for the next 6 years. The total amount of talent demand is predicted and analyzed [5]. From the above research, it can be found that the current use of the gray model to predict the development of talent trends is widely used and can withstand the test of many successful cases. Therefore, this paper uses GM (1,1) gray modelled to predict the scientific and technological talents in Guangxi in the next decade.

2.2 Data Processing

When forecasting scientific and technological talents, the data used are the number of scientific and technological personnel of Guangxi from 2007 to 2016. The reasons are mainly from two aspects: first, Guangxi Statistical Yearbook and Guangxi Science and Technology Statistical Yearbook The indicators used in the statistics of talents are “scientific and technological personnel” rather than “R&D personnel”; secondly, due to the lack of statistical data onto “scientific and technological personnel” in the 2018 Guangxi Statistical Yearbook and Guangxi Science and Technology Statistical Yearbook, The data onto this study used data onto 2007-2016.

Table 1 Number of scientific and technological personnel of Guangxi from 2007 to 2016 (unit: person)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Number of people	68659	70706	87073	89125	102920	104650	108715	107225	113703	120809

Source: Guangxi 10 Years of Science and Technology Statistical Yearbook and Guangxi Statistical Yearbook

2.3 GM (1,1) gray system model prediction

2.3.1 GM (1, 1) gray model form

To model the sequence of GM(1,1), $X^{(0)} = (x^{(0)}(1), x^{(0)}(2), \dots, x^{(0)}(n))$

$X^{(1)}$ is the 1-AGO sequence of $X^{(0)}$, $X^{(1)} = (x^{(1)}(1), x^{(1)}(2), \dots, x^{(1)}(n))$,

among them, $x^{(1)}(k) = \sum_{i=0}^k x^{(0)}(i)$, $k = 1, 2, \dots, n$

Another $Z^{(1)}$ is the sequence of the nearest mean (MEAN) of $X^{(1)}$:

$Z^{(1)} = (z^{(1)}(2), z^{(1)}(3), \dots, z^{(1)}(n))$, among them, $z^{(1)}(k) = 0.5x^{(1)}(k) + 0.5x^{(1)}(k-1)$

Then the definition of GM(1,1), that is, the gray differential equation model of GM(1,1) is

$$x^{(0)}(k) + az^{(1)}(k) = b$$

Let \hat{a} be the parameter vector to be estimated, that is, $\hat{a} = (a, b)^T$, then the least squares estimation parameter column of the gray differential equation satisfies $\hat{a} = (B^T B)^{-1} B^T Y_n$, among them

$$B = \begin{bmatrix} -z^{(1)}(2) & 1 \\ -z^{(1)}(3) & 1 \\ \vdots & \vdots \\ -z^{(1)}(n) & 1 \end{bmatrix}, \quad Y_n = \begin{bmatrix} x^{(0)}(2) \\ x^{(0)}(3) \\ \vdots \\ x^{(0)}(n) \end{bmatrix}$$

Let $\frac{dx^{(1)}}{dt} + ax^{(1)} = b$ be the whitening equation of the gray differential equation

$x^{(0)}(k) + az^{(1)}(k) = b$, also called the shadow equation.

As mentioned above, there are:

① The solution of the whitening equation $\frac{dx^{(1)}}{dt} + ax^{(1)} = b$ is also called the time response function,

$$\hat{x}^{(1)}(t) = (x^{(1)}(0) - \frac{b}{a})e^{-at} + \frac{b}{a}$$

② The time response sequence of GM(1,1) gray differential equation $x^{(0)}(k) + az^{(1)}(k) = b$ is

$$\hat{x}^{(1)}(t+1) = (x^{(1)}(0) - \frac{b}{a})e^{-at} + \frac{b}{a}, k=1,2,\dots,n$$

③ Take $x^{(1)}(0) = x^{(0)}(1)$, then $\hat{x}^{(1)}(t+1) = (x^{(0)}(1) - \frac{b}{a})e^{-at} + \frac{b}{a}, k=1,2,\dots,n$

④ Restore value, $\hat{x}^{(0)}(k+1) = \hat{x}^{(1)}(k+1) - \hat{x}^{(1)}(k)$

The above formula is the prediction equation [2].

Calculated from the data in Table 1: $a = -0.07, b = 47633.97$; substituted into the time response equation and derived to restore:

$$\hat{x}_1^{(1)} = 746406.02e^{0.07k} - 697706.02 \quad (1)$$

2.3.2 Model test

(1) Residual tested

The residual size test is a point-by-point test of the residuals of the model values and actual values.

First, calculate $\hat{x}^{(1)}(i+1)$ according to the model, subtract $\hat{x}^{(1)}(i+1)$ from $\hat{x}^{(1)}(i+1)$ to generate

$\hat{x}^{(0)}(i)$, and finally calculate the absolute residual sequence of the original sequences $x^{(0)}(i)$ and $\hat{x}^{(0)}(i)$:

$$\Delta^{(0)} = (\Delta^{(0)}(i), i=1,2,\dots,n), \quad \Delta^{(0)}(i) = \left| x^{(0)}(i) - \hat{x}^{(0)}(i) \right| \quad (2)$$

Relative residual sequence:

$$\Phi = (\varphi_i, i=1,2,\dots,n), \quad \varphi_i = \left[\frac{x^{(0)}(i) - \hat{x}^{(0)}(i)}{x^{(0)}(i)} \right] \% \quad (3)$$

And calculate the average relative residual

$$\bar{\Phi} = \frac{1}{n} \sum_{i=1}^n \Phi_i \quad (4)$$

The residuals, absolute residuals and relative residuals of the number of scientific and technological talents are obtained by using formulas (2) and (3) respectively. The results are shown in Table 2.

Table 2 2007-2016 Science and Technology Talents Forecast Residual Calculation Table

Years	Original value (person)	Fit value (person)	Absolute error (people)	Relative error (%)
2007	68659	69299	640	0.93
2008	70706	74195	3489	4.93
2009	87073	79438	7635	8.77
2010	89125	85051	4074	4.57
2011	102920	91060	11860	11.52
2012	104650	97494	7156	6.84
2013	108715	104383	4332	3.98
2014	107225	111758	4533	4.23
2015	113703	119655	5952	5.23
2016	120809	128109	7300	6.04

From the principle of gray prediction method, it can be known that the magnitude of the development trend of $-a$ main control system, that is, the development trend reflecting the prediction, is called the development coefficient; the size of b reflects the relationship of data changes, which is called the gray action amount.

Among them: when $-a < 0.3$, GM (1,1) model can be used for medium and long-term prediction; when $0.3 < -a < 0.5$, GM (1,1) model can be used for short-term prediction, medium and long-term prediction with caution; when $0.5 < -a < 1$, should use GM (1,1) Improve model, including GM (1, 1) residual correction model; when $-a > 1$, GM (1, 1) model should not be used, other prediction methods can be considered. In this paper, the average relative error of the number of scientific and technological talents predicted by formula (4) is 0.0163. Therefore, the model is used for medium and long-term prediction.

(2) Relevance tested

The correlation test is performed by examining the similarity between the model value curve and the modeling sequence curve.

$$R = \frac{1}{k} \sum_{i=1}^k \frac{\Delta_{\min} + \lambda \Delta_{\max}}{\Delta_i(k) + \lambda \Delta_{\max}} \quad (5)$$

Among them, λ is the resolution. Experience shows that when $\lambda = 0.5$, R is greater than 0.9, the model is excellent; R is greater than 0.8, the model is qualified; R is greater than 0.7, the model is barely qualified; R is greater than 0.6, the model is satisfactory, and the correlation test is passed. Taking the resolution $\lambda = 0.5$, using the formula (5) to calculate the correlation degree of the number of scientific and technological talents is $R = 0.6035$, and the correlation degree R is greater than 0.6, so the models are satisfactory.

(3) Post-test difference tested

The post-test difference test is to test the statistical characteristics of the residual distribution.

First, calculate the standard deviation S_1 and S_2 according to $X^{(0)}(k)$ and $\Delta^{(0)}(k)$:

$$S_1 = \sqrt{\frac{\sum [X^{(0)}(k) - \bar{X}^{(0)}]^2}{k-1}}, \quad S_2 = \sqrt{\frac{\sum [\Delta^{(0)}(k) - \bar{\Delta}^{(0)}]^2}{k-1}} \quad (6)$$

Second, calculate the post-test difference ratio C:

$$C = \frac{S_2}{S_1} \quad (7)$$

Third, calculate the small error probability p:

$$p = P\left(\left|\Delta^{(0)}(k) - \bar{\Delta}^{(0)}\right| < 0.6745 S_1\right)$$

According to the formulas (6) and (7), the posterior difference ratio of the number of scientific

and technological talents is $C=0.238$, and the small error probability is $p=1.000$. The prediction model predicts accuracy to a level one standard.

2.3.3 Prediction results

According to the above test, the feasibility of the forecasting model in the prediction of scientific and technological talents is proved. The total demand of Guangxi science and technology talents in 2017-2021 is calculated by formula (1), as shown in Table 5 below.

Table 3 Forecast results of Guangxi science and technology talents based on GM(1,1) gray forecasting model (unit: person)

Years	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Predictive value	137162	146853	157229	168339	180233	192967	206602	221110	236829	253563

As can be seen from Table 3, by 2021, the total number of scientific and technical personnel is about 180,233, an increase of 59,424 from 2016, a year-on-year growth rate of 49.2%; in the next decade, by 2026, the total number of scientific and technical personnel is about 253,563. It has increased by 132,754 people compared with 2016, with a year-on-year growth rate of 110%. In the next 5 to 10 years, the demand for the total number of scientific and technological talents for Guangxi will increase rapidly. The reasons for the increasing demand for scientific and technological talents are, on the one hand, the country's overall scientific and technological progress, the proportion of total scientific and technological production to the national or regional GDP, and the demand for the quantity and quality of science and technology talents. On the other hand, the economic development of Guangxi Zhuang autonomous region needs a large number of scientific and technological talents to realize the economic transformation and upgrading, and the government's fiscal and policy preferences are relatively strong, which is bound to bring about a higher demand for scientific and technological talents.

3. Conclusion

In order to move towards an innovation-oriented society, improve the ability of scientific and technological innovation, accelerate the transformation from factor-driven and investment-driven to innovation-driven, and realize the transformation and upgrading of Guangxi's industrial structure and sustainable and healthy economic development through innovation, it needs enterprises as the main body, as well as the joint efforts of local governments, universities and research institutes. At the macro level, the government should grasp the formulation of policies for scientific and technological talents and supervise the effective implementation of these policies. At the same time, the government should increase financial investment in science and technology to provide financial and policy support for enterprises, universities and scientific research institutions to carry out scientific and technological innovation and introduce and train scientific and technological talents. Universities, enterprises, scientific research institutions and government departments need to cooperate closely, according to the needs of the talent market, to explore a high quality, solid foundation, strong practice of science and technology innovative talent training mode, the situation of talent training to track and summarize the promotion, in order to promote the construction of innovative Guangxi.

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