Team Number:	**80313**

Problem Chosen:	**B**

2018 APMCM summary sheet

Talent is the motivity of urban development. This paper based on grey model and log-linear regression model makes a quantitative analysis of current talent demand and future development strategies.

For question 1, employment demand fluctuates seasonally. From 2015 to 2018, the demand for Sales, Sales management, marketing positions in A-city is largest, accounting for 42.04%. Technical work (15.12%) is in the hottest demand in the talent market, which is 5.33% higher than the Sales management element (the second place). "Junior college" degree is the main expectations education background in A-city's labor market, which has been kept above 40% with an increasing trend year by year.

For question 2, since the talent demand of A-city fluctuates seasonally, two moving average methods are adopted to obtain the corresponding seasonal indexes of 12 months in city A: [0.117, 2.007, 2.783,0.825, 1.101, 0.944, 0.762, 1.009, 0.797, 0.81, 0.483, 0.363]. Calculating monthly talent demand of A City after eliminating seasonal trends, it is recorded as $x^{(0)}(k)$, k = 1, ..., 36. Grey model GM (1,1) is established. The correlation degree between predictive value and the original data from 2015 to 2018 is 0.7, 0.8 and 0.75, reaching the three-level accuracy. Using the grey model, the total demand for talents in A-city in the next three years is predicted, which are respectively 30603, 24604 and 19782.

For question 3, based on the model established by the second question and comparing with the national average level, it is concluded that A-city is the provincial capital cities in the central and eastern region, and is in the industrial transformation period in recent years, the development of high-tech industry is still relatively backward.

For question 4, the level of Job Satisfaction of College Students(JS) is taken to reflect whether the region can retain talents. The explanatory variables are job hunting expenses (JSC), graduate starting salary (GSS), work matching status (WMS) and the diversification index of students' career preferences(d_i). Models obtained by logarithmic regression is as follows:

$$\ln JS = 0.263 - 0.071ln JSC + 0.161 \ln GSS + 0.433 \ln d_i + \varepsilon$$

The results show that for every 1% increase in GSS and d_i, the job satisfaction of college students will increase by 0.16% and 0.43%, respectively. For every 1% increase in JSC, the job satisfaction of college students decreases by 0.07%, which has a negative impact on talent introduction and urban development. Based on above analysis, the urban development and talent introduction strategies for A-city are listed.

Finally, for question 5, according to the prediction results of the established grey model and the factors encouraging talent introduction (GSS and d_i), a specific recommendation letter was wrote to the relevant departments of the university.

Keywords: Gray Scale Prediction; Log-linear Regression; Seasonal Index; Coefficient of Variation

Contents

1. Introduction

Talents play a leading and supporting role for a city's development. Under the current mode of rapid urban development, the urban demand for talent is very urgent, so talents become an important resource for urban development. As a key factor in promoting the development of various undertakings in the city, talents strive to create tens of thousands of high-quality laborers, tens of thousands of specialized talents and many top-notch innovative talents, with a large scale, reasonable structure and high quality. The talent team, giving full play to the enthusiasm, initiative and creativity of all kinds of talents, creating a new situation of talented people and making the best use of their talents, and effectively improving the city's core competitiveness and comprehensive strength, is an important guarantee for the sustainable development of urban economy and the coordinated development of social groups.

In recent years, many cities have begun to focus on attracting talents as the emphasis of urban work. Some cities are competing for talent through various attractive policies, such as Beijing, Shanghai, Wuhan, Chengdu, Xi'an and Shenzhen. The development of cities requires talents as their driving force, because people can quickly learn skills and make better products, so that they can better promote urban development. By attracting talents to drive the development of urban innovation and diffusion, cities promote the development of new technologies and technologies in the city. At present, the ways to attract talents in cities are as follows: local talent market, interconnection, campus recruitment fairs and open recruitment activities.

Different urban development zones have different needs for different types of talents in different periods, such as junior high school, high school, secondary school, junior college, bachelor's degree, master's degree, doctoral degree, MBA, unrestricted talents, etc. In the process of urban development, there is a certain difference in the number of talents in these categories, and different types of talents contribute differently to urban development. In order to promote the better development of cities, it is necessary to analyze the needs of various types of talents in different periods and different regions of the city, and analyze the relationship between them to find better ways of urban management, thus promoting the better and faster development of cities.

2. Analysis

In order to analyze the relationship between urban talent demand and urban development, and to determine the main factors affecting the city to attract talents, it is more convenient to provide strategies for urban development and talent introduction, and explore talent and urban development on the following issues.

Question 1: We need analyze the “job market of A-City” employment, expected occupations, and expected educational backgrounds, and establishes mathematical models for employment market and talent attraction.

Question 2: We need to build a model of the actual talent demand of A-City with from the perspectives of the talent demand of the "job market of A-City" and the employment status of

Chinese students based on the data attached and other necessary data available, and predict and analyze the potential talent demand of A-City in the next three years to come.

Question 3: According to the data used in Question 2 and the conclusions drawn, we need to use the model established by it, infer the administrative scope, possible geographical area, economic status and high-tech industry development of A-City.

Question 4: We need to quantify some new career preferences of college students: participate in village official examinations, participate in civil service examinations, entrepreneurship, employment in different places, study abroad, and establish corresponding models to provide A-City's urban development and talent introduction strategies.

Question 5: According to the talent training program of a major we know well, covering the curriculum construction, the training of applicative talents, the individualization of college students, and the corresponding quality guarantee measures within the framework of our university and that major, according to the current market demand for talents. We need to write a letter to the school authorities about our suggestions and opinions.

3. Assumptions

There are many factors that affect security check. Our model is setting up and implemented in a relatively ideal environment. Thus, we make some assumptions as follows:

- Assume that there are no other factors affecting employment demand except seasonal factors.
- It can be predicted that the seasonal volatility presented by the classification of talent needs in different educational backgrounds is the same as the volatility of total labor demand in a city.
- Assume that other unlisted occupations will not affect the prediction of talent demand in A-City.
- Assume A-City does not have major events affecting its talent needs in the next three years.
- For the labor market of A city, the seasonal fluctuation of occupational demand in its sub-industries is basically consistent with the seasonal fluctuation of total demand.

4. Symbol Description

In the section, we use some symbols for constructing the model as follows.

Symbol	Description
θ（k）	Stage ratio
R_i	Relative proportion
$x^{(0)}(i)$	Demand for labor

λ	Adjustment coefficient
α	Development coefficient
β	Gray value
ω	Correlation degree
SD_i	Variance standard deviation
d_i	Diversity Index of Career Preferences

P.s: Other symbols instructions will be given in the text.

5. Problem analysis and Model building

5.1 Data preprocessing

We observed the data given by the topic and found that the occupational fields recruited each month were not identical. This article first removes the domain data that does not exist in all months for each month's data, and keeps the other fields sorted unchanged. As a result, we have a career field that will be recruited monthly, for a total of 49. Then we use MATLAB to fill all the employment fields into the employment information of each month in the corresponding order, and get the talent demand situation in different employment fields every month.

In addition, we found that in April 2016 and beyond, there was a job without a name. According to question 4 given by the title, we infer that the field is a new career preference for graduates in recent years, such as taking part in the village official examination, taking civil service examinations, starting a business, finding a job, and studying abroad, etc. We do not consider this column of data in the first three questions.

5.2 Question 1: Analysis of talent demand in a city

In order to solve the problem, this paper analyzes the talent demand of "job market of A-City"，and analyzes it from three aspects: employment demand, expected career and expected education background.

5.2.1 Employment demand

In terms of employment demand, this paper analyzes from two dimensions of time and employment.

5.2.1.1 Analysis from the time dimension

For the analysis of the time dimension, we draw the graph shown in Figure 1.

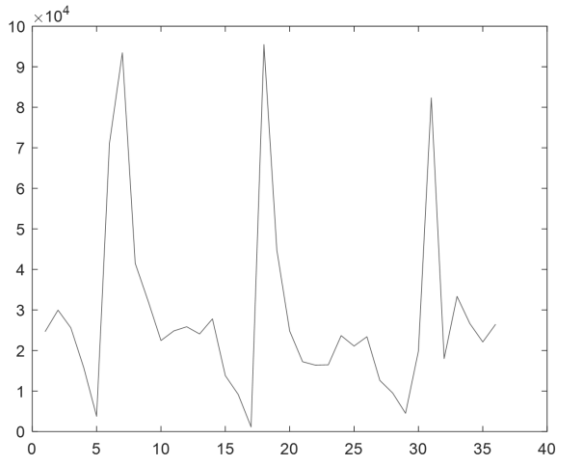

Figure 1：Relationship between the number of applicants and time

Analysis of the graph shown in Figure 1 we can get, around January each year, the employment demand reached the lowest value of the year. The reason for the analysis is because the employers in this period are more cautious and the demand for market positions is declining, resulting in the lowest employment demand. In the February-March period of each year, the highest peak of employment in the whole year is reached. Since the Spring Festival, it is the period of returning migrant workers and returning college students to find work. Currently, employment demand is at its highest value. It can be seen from the changing trend that the employment market is affected by seasonal, phased and cyclical fluctuations.

5.2.1.2 Analysis from the dimension of employment

From the perspective of the employment sector, we can get the total employment demand in various fields from September 2015 to August 2018. Here, only list the data for the top five and bottom five areas of employment needs. (All data is in Appendix 1.)

Table 1：Data on the top five areas of total employment demand

S/N	sector	Total demand (Pers.)	proportion
4	Sales	228408	23.26%
2	Sales management	94588	9.63%
3	market/marketing	89798	9.15%
32	Technical work	61507	6.26%
27	Customer service and technical support	40666	4.14%

As can be seen from Table 1, the total employment demand in the field of Sales, Sales management, market/marketing, Technical work, Customer service and technical support is relatively high, especially in the Sales field, accounting for 23.26%, which is higher than the second place Sales 9.63% of management.

Table 2：Data on the last five areas of total employment demand

S/N	sector	Total demand (Pers.)	proportion
17	Science & Technology	792	0.08%
38	PRs and news media	712	0.07%
33	Fashion/textile/furs	555	0.06%
18	Legal profession/law	497	0.05%
23	Translation	323	0.03%

As can be seen from Table 2, the total employment demand in the fields of Science & Technology, PRs and news media, Fashion/textile/furs, Legal profession/law, Translation is lower about 0.1%.

According to Table 1 and Table 2, we can get a large gap in employment demand in different fields, and sales positions still rank first in demand with absolute advantage.

5.2.2 Expectational career analysis

For the desired career, this article first analyzes the total number of recruits from September 2015 to August 2018, and then calculates the proportion of recruits in various fields to the total number of recruits. Here is a list of the top five and bottom five areas of total demand. (All data is in Appendix 2.)

Table 3：Data on the top five areas of total demand

S/N	sector	requirements	proportion
32	Technical work	21919	15.12%
2	Sales management	14191	9.79%
20	Hospital/medical/care	11956	8.25%
3	market/marketing	11367	7.84%
24	Construction/infrastructure/gardening	6996	4.83%

As can be seen from Table 3, the total employment demand in the field of Technical work, Sales management, Hospital/medical/care, market/marketing, Construction/industry/gardening is relatively high, especially in the field of technical work, accounting for 15.12%.

Table 4：Data on the last five areas of total demand

S/N	sector	requirements	proportion
45	Beauty and personal care	178	0.12%
25	Banking	156	0.11%
10	Electronics/appliances/semiconductor/instrumentation	153	0.11%
19	Education	136	0.09%
36	Biology/chemicals/pharmaceuticals/medical equipment	70	0.05%

As can be seen from Table 4, the total number of recruits in the field of Beauty and personal care, Banking, Electronics/appliances/semiconductor/instrumentation, Education,

Biology/chemicals/pharmaceuticals/medical equipment is relatively low, accounting for about 0.1%.

According to Table 3 and Table 4, we can get a large gap in the number of recruits in different fields.

5.2.3 Expectational education background analysis

5.2.3.1 Analysis from the time dimension

For the time dimension, according to the data given in the question, the employment ratio of each degree in each quarter from 2015 to 2018 is obtained, as shown in Table 5.

Table 5: Employment ratio of different academic qualifications in each quarter

Quarterly time	Junior middle school	Senior middle school	Technical secondary school	Junior college	Bachelor's degree	Master's degree	Doctor's degree	MBA	Unlimited
201504	1.84	7.52	9.09	38.66	3.64	0.05	0.000	0	39.19
201601	2.14	7.50	6.97	39.42	4.98	0.11	0.000	0	38.88
201602	2.33	7.98	5.23	41.36	5.74	0.07	0.008	0	37.28
201603	2.29	8.48	4.77	43.08	5.82	0.08	0.007	0	35.46
201604	2.27	8.76	4.68	43.07	5.73	0.09	0.006	0	35.39
201701	2.09	9.57	4.75	43.83	5.70	0.07	0.007	0	33.98
201702	1.47	10.64	4.83	44.63	5.67	0.08	0.000	0	32.68
201703	1.49	10.80	5.15	43.35	5.87	0.05	0.000	0	33.29
201704	1.41	10.70	5.57	43.98	6.45	0.04	0.000	0	31.86
201801	1.66	10.10	5.26	43.07	7.56	0.29	0.150	0	31.91
201802	2.12	9.29	5.76	42.12	7.66	0.36	0.171	0	32.51

According to the table, the proportion of unemployed graduates has dropped significantly, accounting for 39.19% in the fourth quarter of 2015 and 32.51% in the second quarter of 2018. This indicates that the city expects a certain improvement in the educational background.

The proportion of the employment population in the secondary school has been decreasing quarter by quarter, while the proportion of the employed population above the college has increased significantly. From the fourth quarter of 2015 to the second quarter of 2018, the employment of junior high school in the city was basically flat, and the employment of high school students showed a slow rise. The proportion of unemployed people is still relatively large, and the employment market with a high level of education is relatively low. In the second quarter of 2018, the employment of undergraduates and above only accounted for 8.19%.

5.2.3.2 Analysis from the dimension of employment

For the dimension of employment, there are certain differences in the employment fields entered by employed people with different educational backgrounds. As the job market is affected by seasonal, phased and cyclical fluctuations, here is the employment of 2017.

The number of people who have the expected educational background for 2017 is shown in Figure 2.

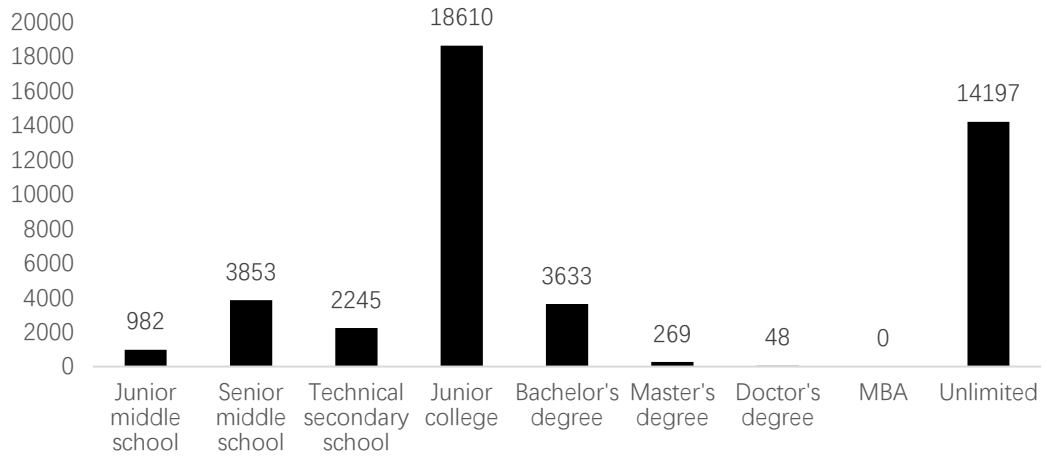

Figure 2: Number of employed people in the expected education background in 2017

It can be obtained from the image: The college degree is as high as 42.63%, which is lower than 16.25% the junior college degree. It indicates that some industries have a minimum education level for workers.

The junior high school graduates account for a large proportion of Technical work, Other, Restaurants and recreation, Transportation service, Logistics/warehousing (technical work, other, catering, entertainment, transportation services, logistics and warehousing), especially in the field of technical work, accounting up to 25.66%, ahead of the second place: Other 12.73%, so it can be judged that the junior high school graduates are mainly concentrated in the service industry.

The high school and secondary school graduates have great similarities in the employment field. The top six employment areas include: Sales, market/marketing, Sales management, Logistics/warehousing, Office administration/logistics, Customer service and technical support. Therefore, it can be judged that the employment of high school and secondary school education is mainly concentrated in the field of sales. For the three sales areas of Sales, market/marketing and Sales management, the recruitment rate of high school education is higher than that of 6.02% of secondary school education. The employment field of high school education is also richer than that of secondary school and junior high school.

Different from the above three academic qualifications, the employment of college graduates has a strong universality, and employers in the field of college education are recruited in various fields. The employment of college graduates is relatively high in the financial industry and the sales industry, while it is significantly lower in other industries, especially in the service industry.

The proportion of undergraduate, master's, doctoral and MBA graduates in the employment market is low, and even the expected level of education is 0, which is related to the low proportion of the total number in the job market. For industries with higher requirements for the overall quality of employment, such as finance, education, and scientific research, the proportion of employed people with higher education is larger.

In summary, the overall education level of the employed people in the city is generally low, and most of the labor force is concentrated in the sales, manufacturing, and service industries.

5.3 Question 2: Grayscale prediction model

We observe that the demand for talents in the labor market shows a certain periodicity with seasonal characteristics. Therefore, this paper considers moving the average method to smooth the data as much as possible. The seasonal index is obtained by calculation, thereby eliminating the seasonal factors existing in the data, removing the historical data with large fluctuations and easily generating large errors, and further gray prediction of the changed data. Then we multiply the result of the gray prediction by the previously obtained monthly index, which is the forecast of the talent demand in the coming months.

5.3.1 Level test

We first need to test the market demand data to determine the smoothness of the data and its availability. Here we find the sequence ratio by establishing a time series of labor market demand data. We then compare the sequence-level ratio with the allowable coverage interval, and observe whether the data all fall within the interval, that is, whether the stability of the data meets the basic requirements for establishing a gray-scale prediction system.

We establish a time series of labor market demand data as follows:

$$x^{(0)} = (x^{(0)}(1), x^{(0)}(2), ..., x^{(0)}(36)) = (24641, 29957, ..., 26470)$$

Then we find the level ratio of market demand according to the following formula：

$$\theta(k) = \frac{x^{(0)}(k-1)}{x^{(0)}(k)}$$

We calculate the grade ratio results:

$$\theta(k) = (\theta(2), \theta(3), ..., \theta(36)) = (0.822546, 1.171064, ..., 0.835059)$$

According to our judgment: If all the ratios fall within the acceptable coverage $X = (e^{-\frac{2}{n+1}}, e^{\frac{2}{n+1}})$ ， Then the $x^{(0)}$ can establish the GM(1,1) model and can perform gray prediction.

Based on the data in this question, we can calculate a tolerable coverage：

$$X = (0.947381, 1.055542)$$

We compare the market demand time series data with the interval to get the figure 3.

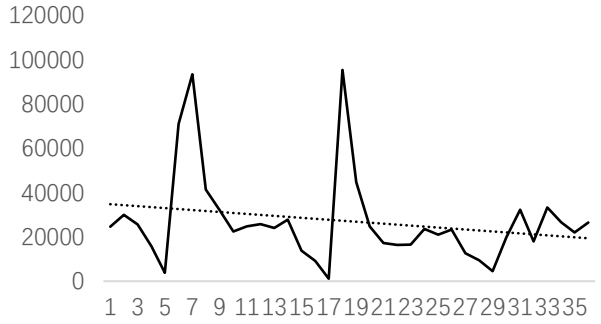

Figure 3: Comparison of market demand time series data and interval

After the comparison, we found that most of the data is not in this interval. Therefore, the stability of the original data does not meet the basic requirements of GM (1, 1), and the original data needs to be processed.

5.3.2 Eliminate seasonal factors

We first calculate the 12-month moving average for each month. Since the moving average period is even, we continue with a moving average with a step size of 2 after a moving average of 12 steps.

We get the labor demand for each month after the mobile average correction $x^{(0)}(i)'(i=13,14,.....,36$, where N_1 represents the labor demand of the labor market in September 2015 after two moving averages, And so on). The raw data demand for the original data per month is $x^{(0)}(i)'(i=1,2,.....,36)$.

In this paper, in order to obtain the weight ratio of each month, in other words, its importance in the seasonal trend, this paper use the magnitude and direction of the data to change both times. We further calculate the relative ratio R_i, which is calculated as follows:

$$R_i = \frac{x^{(0)}(i)}{x^{(0)}(i)'}(i=13,14,.....,36)$$

Based on the above calculation formula, 24 data R_i are obtained, and then we average the monthly value to obtain the pre-adjustment season index from January to December：

$W=[w_1,w_2,.....,w_{12}]$. After calculation, we get $\sum_{k=1}^{12} w_k = 11.4141 \neq 12$.

Therefore, this paper considers the introduction of the adjustment factor λ , which is calculated as follows：

$$\lambda = \frac{12}{\sum_{k=1}^{12} w_k}$$

We obtain the new monthly seasonal index by multiplying the adjustment coefficient by the original seasonal index matrix：

$$W' = \left[w_1, w_2, ..., w_{12}\right] \begin{bmatrix} \lambda \\ \lambda \\ ... \\ \lambda \end{bmatrix}$$

The new seasonal index is $W' = [0.117279, 2.006749, 2.783069, 0.82495799, 1.10054, 0.944417, 0.762245212, 1.009, 0.797, 0.81, 0.483, 0.363]$.

Based on the calculated new seasonal index, we calculate the time series of market talent demand after eliminating the seasonal factors, as shown in Figure 4.

Figure 4: Time series of market talent demand after eliminating seasonal factors

5.3.3 Grayscale prediction model

After processing, the $x^{(0)}(i)'$（$i = 13，14，……，36$） is calculated in the tolerable coverage, and the sequence is $x^{(0)}(i)'$. The establishment of the GM (1, 1) model is valid and can be gray predicted. Firstly, GM (1,1) model is established by using $x^{(0)}(i)'$ as the data column, the specific form is as follows:

$$x^{(0)}(i)' + \alpha z^{(1)}(i) = \beta$$

Here, $z^{(1)}(i)$ is the whitened background value, β is the gray value reflecting the changing relationship of data and α is the development coefficient reflecting the development trend.

We put $i = 2，3，……，36$ into the above formula to get the following expression：

$$\begin{cases} x^{(0)}(2)' + \alpha z^{(1)}(2) = \beta \\ x^{(0)}(3)' + \alpha z^{(1)}(3) = \beta \\ \quad\quad ... ... \\ x^{(0)}(36)' + \alpha z^{(1)}(36) = \beta \end{cases}$$

Then we express the Parameter vector to be estimated:

$$u=\begin{bmatrix}\alpha\\ \beta\end{bmatrix}, Y=\begin{bmatrix}x^{(0)}(2)'\\ .....\\ x^{(0)}(36)'\end{bmatrix}, B=\begin{bmatrix}-z^{(1)}(2)\\ .....\\ -z^{(1)}(n)\end{bmatrix}$$

Therefore, we can represent the GM (1,1) model as $Y=uB$, and then use the least squares method to calculate the values of α and β respectively. The corresponding whitening model is as follows:

$$\frac{d\mathrm{x}^{(1)}(i)'}{di}+\alpha\mathrm{x}^{(1)}(i)=\beta$$

We reduced it to a solution model of $\mathrm{x}^{(1)}(i)$:

$$\mathrm{x}^{(1)}(i)=\left(\mathrm{x}^{(0)}(1)-\frac{\beta}{\alpha}\right)e^{-\alpha(i-1)}+\frac{\beta}{\alpha}$$

According to the expression of this whitening model, we can get the gray prediction equation:

$$\mathrm{x}^{(1)}(k+1)^{e}=\left(\mathrm{x}^{(0)}(1)-\frac{\beta}{\alpha}\right)e^{-\alpha k}+\frac{\beta}{\alpha},\ \mathrm{k}=1,\ 2,\ \ldots\ldots,\ \mathrm{i}-1$$

We then convert this expression into a mathematical expression of the predicted value as follows：

$$\mathrm{x}^{(0)}(k+1)^{e}=\mathrm{x}^{(1)}(k+1)^{e}-\mathrm{x}^{(1)}(k)^{e}, k=1,2,\ldots\ldots,i-1$$

Finally, we use MATLAB to calculate the data according to the problem and get the mathematical expression of the predicted value: (Detailed procedures are in Appendix 3.)

$$\mathrm{x}^{(1)}(k+1)=\left(\mathrm{x}^{(0)}(1)\right)e^{-\alpha k}+\frac{\beta}{\alpha}=-308787e^{-0.01817\mathrm{k}}+313461$$

The gray prediction model has a certain scope of application, and the development coefficient α has the following restrictions:

(1) When $-\alpha\leq 0.3$, the GM (1,1) model can make more accurate medium and long-term predictions.

(2) When $0.3<-\alpha\leq 0.5$, the GM (1,1) model can make more accurate short-term predictions, and should be cautious when making medium-term forecasts.

(3) When $0.5<-\alpha\leq 0.8$, the GM(1,1) model should be used for prediction.

(4) When $0.8<-\alpha\leq 1.0$, when applying the GM(1,1) model for prediction, it must be corrected after necessary.

(5) When $-\alpha>1.0$, the GM(1,1) model cannot be used for prediction.

Since $-\alpha=0.01817\leq 0.3$ in this problem, the model is also suitable for short-term predictions.

Next, we take the data from September 2017 to August 2018 as an example to perform reliability test on the calculated values of the prediction expressions. The results are shown in Table 6.

Table 6: Reliability test results of predicted values

Month number	Actual value	Improve grayscale predictions	Absolute error	Relative error
25	2899	2813.469848	-85.5302	-0.029503329
26	3424	2806.596929	-617.403	-0.180316318
27	1752	1644.421016	-107.579	-0.06140353
28	1399	1212.990477	-186.01	-0.132958915
29	661	385.0717034	-275.928	-0.417440691
30	3079	6470.252293	3391.252	1.101413541
31	11307	8811.652361	-2495.35	-0.220690514
32	2588	2564.900263	-23.0997	-0.00892571
33	4380	3360.084543	-1019.92	-0.23285741
34	3884	2831.475544	-1052.52	-0.270989819
35	3288	2244.136356	-1043.86	-0.317476777
36	3627	2916.558662	-710.441	-0.195875748
Total	42288	38061.60999	-4226.39	-0.09994301

It can be seen from the above table that the prediction relative difference is about 9.99%, we need to further test the validity of the grey model using the degree of association.

5.3.4 Correlation analysis

In order to test the reliability of the grey prediction system prediction results, we consider the gray process based on the gray system to compare the time series between the factors, focusing on the dynamic process of the system. The main steps are as follows:

(1) It is known that the original total talent demand is $\mathrm{x}^{(0)}(i)$ and the demand for talents obtained through gray prediction is $\mathrm{x}^{(0)}(i)^e$, and we assume:

$$\Delta_{min}x = \min[|\mathrm{x}^{(0)}(i)^e - \mathrm{x}^{(0)}(i)|]$$
$$\Delta_{max}x = \max[|\mathrm{x}^{(0)}(i)^e - \mathrm{x}^{(0)}(i)|]$$
$$\Delta x_i = |\mathrm{x}^{(0)}(i)^e - \mathrm{x}^{(0)}(i)|$$
$$i = 1,2,\dots\dots,36$$

(2) We need to calculate the correlation between the calculated prediction curve and the original curve:

$$\omega = \frac{1}{36}\sum_{i=1}^{36}\frac{\Delta_{min}x + \rho\Delta_{max}x}{\Delta x_i + \rho\Delta_{max}x}$$

Based on the data from September 2015 to August 2018, the correlation data between the calculated prediction curve and the original curve is shown in Table 7 below.

Table 7: Correlation between actual demand and forecast demand

Period	Actual demand	Forecast demand	Absolute error	Relative error	Correlation
2015/9/1-2016/8/1	58444	58879	435	0.007443	0.70
2016/9/1-2017/8/1	44225	47339	3114	0.070413	0.80
2017/9/1-2018/8/1	42288	38062	-4226	-0.09993	0.75
2015/9/1-2018/8/1	144957	144280	-677	-0.00467	0.80

According to the above table, the correlation degree of each year is greater than 0.70 in each year, and the associated value reaches the third-level precision.

At the same time, the overall relevance of the model is 0.80. According to Yuan Xiaohong and Li Jiping's research on the talent demand forecasting model based on relevance and minimum variance [1], the model can objectively reflect the development trend of the original data. Therefore, the model achieves the simulation effect and can ideally reflect the trend of talent demand in the talent demand market with time. The figure 5 can directly reflect the fitting of the prediction result and the real result. (Note: The solid line in the figure indicates the actual demand, and the dotted line indicates the forecast demand.)

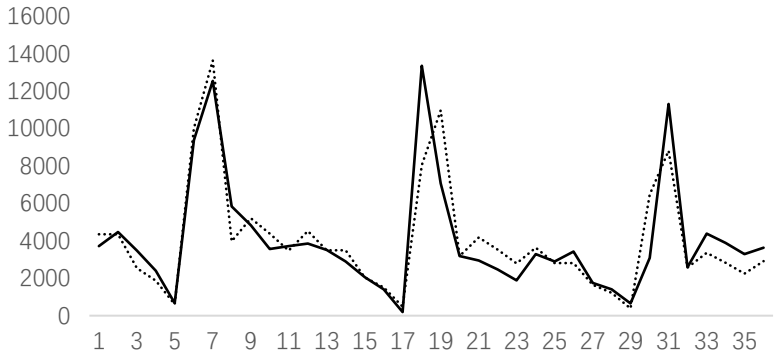

Figure 5: Fit curve between actual demand and forecast demand

This paper uses the above grayscale prediction model to predict the labor market talent demand from September to September 2018, and obtains $x^{(0)}(k+1)^e$ $(k = 36,37,\ldots\ldots,71)$ The data is recorded as $E = [x^{(0)}(37)^e, x^{(0)}(38)^e, \ldots\ldots, x^{(0)}(72)^e]$.

Then we multiply E with the adjusted seasonal index for each month to get the demand E' for talent of each month in the next three years. The prediction expression of E' is as follows:

$$E' = \left[x^{(0)}(37)^e, x^{(0)}(38)^e, \ldots\ldots, x^{(0)}(72)^e \right] \begin{bmatrix} w_1 \\ w_2 \\ \ldots \\ w_{12} \end{bmatrix}$$

We use the predictive expression of E' to calculate the talent demand for each month in the next three years according to the data given in the title. The data obtained are shown in Table 8.

Table 8: Forecast of talent demand for each month in the next three years

Date	Forecasting talent demand	Date	Forecasting talent demand
201809	2262	202003	5696
201810	2257	202004	1658.
201811	1322	202005	2172
201812	975	202006	1830
201901	310	202007	1451
201902	5202	202008	1885
201903	7085	202009	1462
201904	2062	202010	1459
201905	2702	202011	855
201906	2277	202012	630
201907	1804	202101	200
201908	2345	202102	3363
201909	1819	202103	4580
201910	1814	202104	1333
201911	1063	202105	1746
201912	784	202106	1472
202001	249	202107	1166
202002	4183	202108	1516

5.3.5 Annual forecast for different educational backgrounds

5.3.5.1 Forecast for each educational background

Then we use the same method to predict the educational background and the number of people in the labor market in the next three years (September 2018 to August 2021).

This paper considers that the demand for the number of doctors in the labor market fluctuates excessively with time. Instead of using the gray model to predict here, a simple regression is used to calculate the demand for the labor market in the next three years. Regression prediction. For the MBA market, there was only a demand phenomenon in May 2018. We ignored it and thought that the MBA had no market in the city and recorded its annual expectation value as zero. The final prediction results are shown in Table 9.

Table 9: Annual forecast for different educational backgrounds

Period	Junior middle school	Senior middle school	Technical secondary school	Junior college	Bachelor's degree	Master's degree	Doctor's degree	MBA	Unlimited
201809-201908	1265	3561	2013	16002	3657	263	78	0	12290
201909-202008	1341	3205	1743	14113	3830	349	104	0	10585
202009-202108	1423	2885	1508	12446	4011	465	130	0	9116

5.3.5.2 Classified forecast of different educational backgrounds

In order to further explore the changes in the talent market requirements of the labor market in the city of A, we will classify the different educational backgrounds in the above table. This article divides it into four categories, namely: Bachelor's degree, Master's degree, Doctor's degree (recorded as: Above Bachelor degree); Technical secondary school, Junior college (recorded as: Secondary school or junior college); Junior middle school, Senior middle school (recorded as: Junior high school); Unlimited classified into one category (recorded as: Unlimited).

Based on the data given by the topic and the gray prediction model we created earlier, we have obtained total forecast data of 6 years and 72 months since September 2015 (recorded as "1" on the timeline) and August 2021 (recorded as "72" on the timeline). We compare it with real data and get the result as shown in Figure 6(Here the solid line represents the true value, and the dotted line represents the grayscale prediction value).

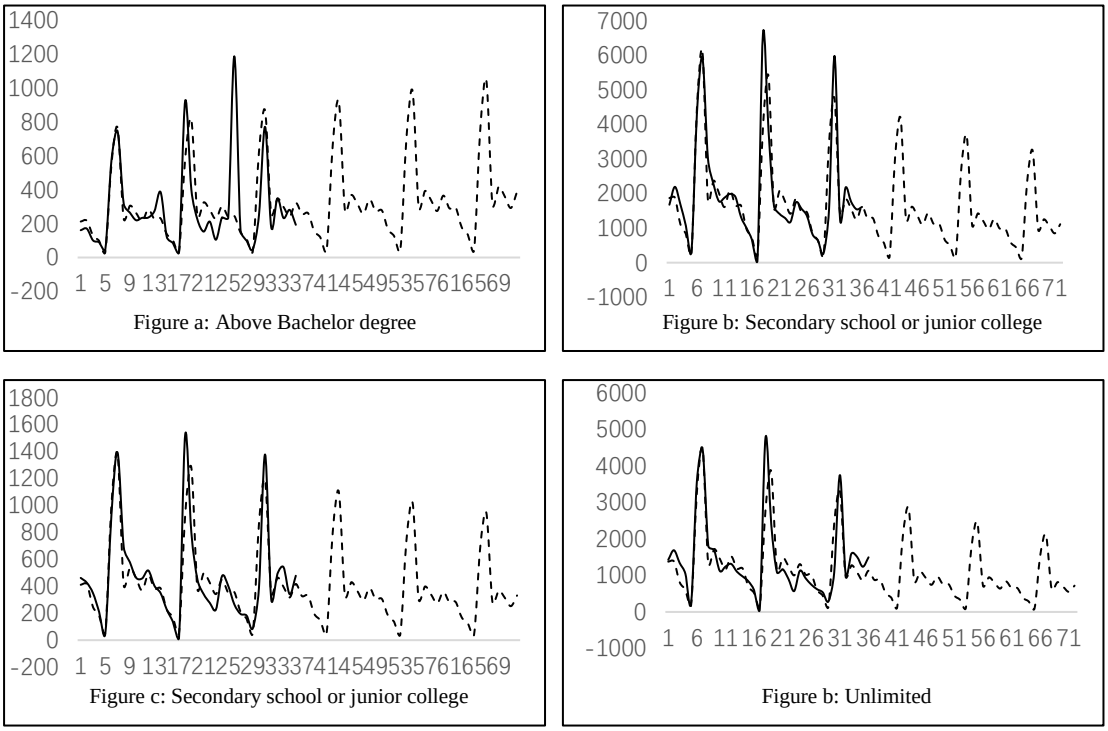

Figure a: Above Bachelor degree

Figure b: Secondary school or junior college

Figure c: Secondary school or junior college

Figure b: Unlimited

Figure 6: Forecast of different types of talent demand

According to the above four graphs, the grayscale prediction value is better than the known data of the previous three years, which also confirms the previous assumptions, and the model can effectively predict the market demand of different academic talents in the future.

Figure a reflects the changing demand for talents of "Above Bachelor degree" in the labor market of A-City over time. The demand and the total demand of the labor market show similar fluctuations with the change of the month, that is, the demand will have peaks and troughs in a fixed period. It can be seen from the image that the peaks of the peaks change with time, and the troughs remain basically stable without significant decline. Therefore, it is believed that the

demand for high-quality talents of “undergraduate and above” in A-City is increasing year by year. According to Yue Changjun and others [2], the increase in demand for high-quality talents proves that the economic development of the place is in a period of rapid growth, and the talent market has not yet Saturated, there is a phenomenon of talent vacancies in high-tech positions.

Figures b, c, and d respectively reflect the changes in the labor market for Secondary school or junior college, Junior high school, and Unlimited talents over time. The changes in the three are basically the same, that is, the periodic occurrence of peaks and troughs, and over time the value of the crest shows a significant downward trend. This phenomenon indicates that the demand for relatively low-quality talents in the labor market in the A-City has been saturated, and no more labor is needed to promote economic development.

5.3.6 Annual forecast for different occupation types

In order to explore the changes of the demand for different professional talents in the labor market over time, this paper predicts the talent demand based on the occupational classification. First, we classify the 49 occupational references given in the title by Zhou Lijun and others in the "China University Graduates Employment Trend Analysis: 2013-2017"[3], and divide them into six categories. The classification results are shown in Appendix 4.

According to the results of occupational classification, combined with the data given by the topic, we obtained the change rule of the demand for talents in different categories of occupations over time from September 2015 to August 2018, as shown in Figure 7.

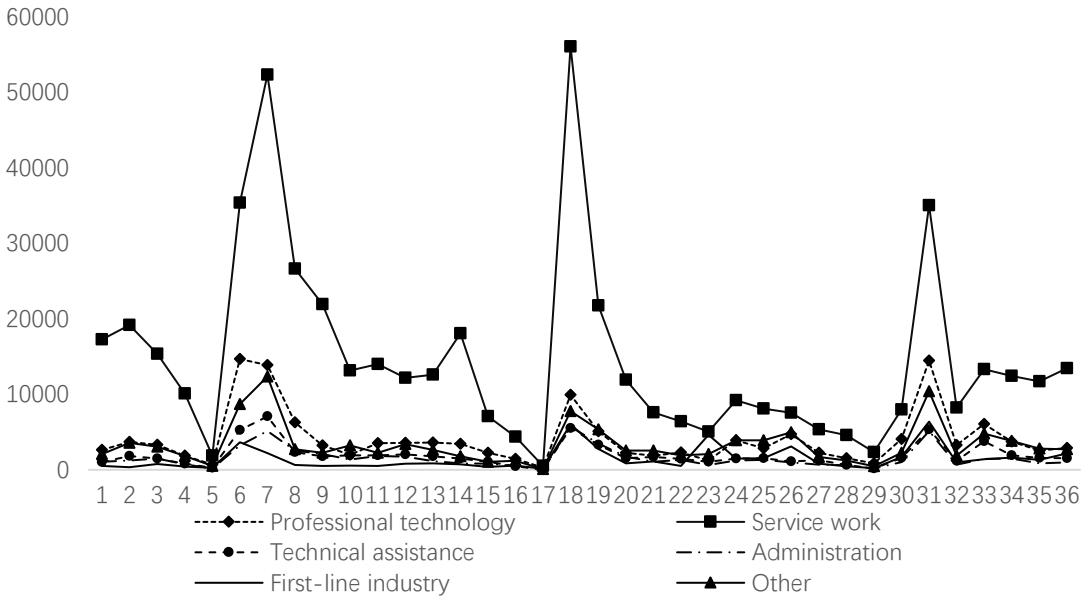

Figure 7: Changes in the demand for talent over time in different occupational categories

As can be seen from the above figure, the service work has occupied a dominant position in the A city, and has shown certain fluctuations in the past three years, indicating that the service industry is likely to be the pillar industry of the city A. Contrary to this, the demand for talents in the first-line industry is relatively cold, and the demand among the six categories of professional talents is the least, indicating that the city A may have been transformed from a

labor-intensive enterprise to a capital-intensive enterprise. Other categories of work did not show a clear trend in the past three years.

Then we use the grey forecasting model to predict the demand for talent in different occupational categories in A city in the next three years. The predicted results are shown in Table 10.

Table 10: Forecast of talent demand for various occupations

Period	Professional technology	Service work	Technical assistance	Administration	First-line industry	Other
2018/09-2019/08	38205	91446	18872	13784	32516	35826
2019/09-2020/08	34065	68495	17009	11914	43069	33925
2020/09-2021/08	30373	51305	15331	10297	57048	32126

According to the data released by the Institute of Educational Economics of Peking University, we draw a trend graph of the proportion of graduates entering different types of industries over time, as shown in Figure 8 below.

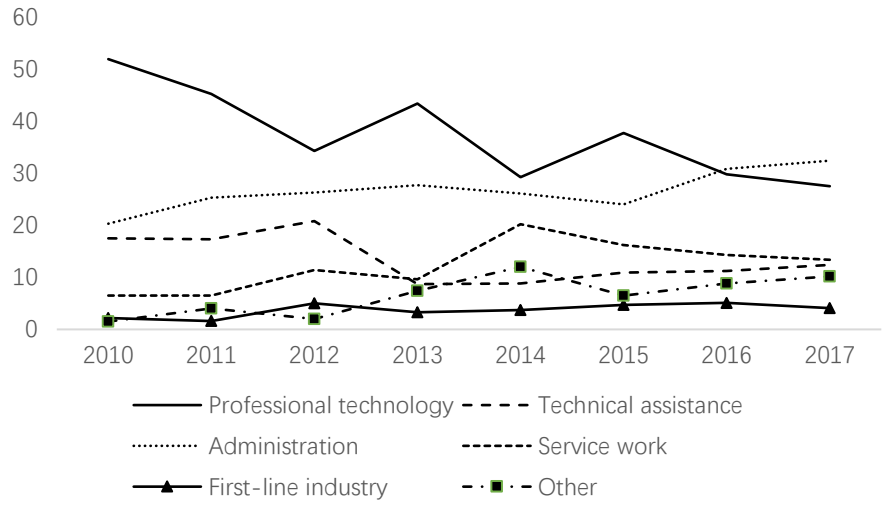

Figure 8: Trends in the proportion of people in different types of industries

According to the trend chart, we can see that the proportion of people engaged in "Professional technology" at the national level is the highest, basically maintaining above 30%, but the proportion has decreased in recent years, and entered the stage bottom in 2017. The proportion of the number of people engaged in "Technical assistance" has also declined to some extent over time, which is also consistent with China's current development: the transformation of manufacturing development has led to a decline in the demand for professionals in the market. Talent quality requirements are rising. The proportion of people engaged in "Administration" is on the rise, rising from 20.3% in 2010 to 32.4% in 2017, reaching a new high. The proportion of people engaged in "Service work" is relatively small. In 2010, it only accounted for 6.5% of the total number of employees. However, in recent years (especially in 2014), the proportion of employees has increased significantly, and the growth in 2014 has reached a quarter-on-quarter.

110%. The proportion of people engaged in “first-line industry” and “Other” types of occupations has not shown a strong trend with time, and the ratio is basically around 8%.

5.4 Question 3: The inferred result of A-City

The labor demand in A-City tends to be stable, and there has been a certain degree of decline, indicating that A-City is experiencing the stage of economic transformation and development. The revised grey model predicts that the number of labor demand in the city will be 30603 from September 2018 to August 2019, and the number of labor demand in the city from September 2019 to August 2020 will be 24604. From September 2018 to August 2019, the labor demand of the city was 19782. This shows that the labor demand of the city has gradually stabilized in recent years, and there has been a slow decline. This is basically consistent with the overall trend of China in recent years, labor costs. The rise has led to a certain decline in the demand for labor.

The demand for talents has changed from “quantity to quality”. High-quality talents have gradually occupied the market for labor demand, indicating that the industry in A-City is gradually changed from “labor-intensive” to “technical or capital-intensive”. According to the improved gray model, the expected background of the labor market expectation of talents and the corresponding number of people, the demand for undergraduate and above in the region is increasing year by year. Among them, the estimated labor demand for undergraduates gradually increased from 3657 in the first year (from September 2018 to August 2019) to 4011 in the third year (from September 2020 to August 2021), with an increase of 9.68%; the estimated labor demand of master students rose from 263 in the first year to 465 in the third year, with an increase of 76.8%; the demand for doctoral students rose from 78 in the first year to 130 in the third year. The increase rate was 66.7%. With the increasing demand for high-quality talents in the market, those relatively low-quality laborers (specialties and below) are gradually abandoned by the labor market of A-City, and their market demand is declining year by year.

High-tech talents are still relatively short, and the enterprise entry barrier is still relatively low. The development of high-tech in A-City is still relatively backward. According to the predicted data, in the next three years, the demand for education of talents in the A-City labor market is still almost 30% as “Unlimited”, and the number of people with academic qualifications of “Below Bachelor degree” is the total. About 58% of the demand for talents exceeds half of the market demand, indicating that although A-City is currently in the stage of economic development and transformation, due to the backward development of the basic development, the market still needs many relatively low-quality labors to maintain economic development.

The industrial structure of A-City is better than the national average and is still in the process of continuous optimization. In the second question, the distribution ratio of the national labor force in different industries was compared with that of the A-City. It was found that the level of the service industry in the A-City was significantly higher than the average level of the national service industry development. According to Zou Yu and Fu Yazhou’s view in the “Empirical Analysis of the Grey Correlation between Industrial Structure and Employment Structure in Hunan Province” [4], the greater the proportion of the tertiary industry (mainly

service industry) in economic development, proves that the region's economy is developed. The higher the degree is, the more reasonable industry results are.

Based on the above analysis, we make a basic inference about the administrative category, possible geographical area, economic status and high-tech industry development of A-City: A-City's economic development is significantly higher than the national average, so it should be a provincial capital. In recent years, especially with the acceleration of industrial transformation since 2016, but the demand for high-quality talents such as graduate students and doctors in A-City is not much higher than the national average. Therefore, we judge that A-City is in the central and eastern regions, where the economy is more developed, but the development of high-tech industries is still relatively backward.

5.5 Question 4: Log-linear regression model

5.5.1 Selection of the variables

5.5.1.1 Selection of the interpreted variables

Chen Liying [5] believes that in recent years, especially after the new generation of employees entered the workplace, the turnover rate of employees in the advanced manufacturing industry ranks among the best in all industries in China. The reason is that the new generation of employees did not achieve the pursuit of employee happiness, and did not make employees satisfied with their employment status. Therefore, we choice the labor satisfaction as an evaluation index to measure the employment status of college graduates.

The higher the job satisfaction, the more talents tend to stay in the current position to provide labor, which means that the region can better retain talents; on the contrary, if the employment satisfaction is lower, the labor is not for the current occupation. Recognizing that this "no recognition" will lead to the outflow of labor in the region to a certain extent.

According to the data of the 2003-2017 college students' employment quality survey report [3], this paper is empowered according to the satisfaction degree of employment status. "Very satisfied" is recorded as 5, "Satisfied" is recorded as 4, "General" is recorded as 3, "Not satisfied" is recorded as 2, "Very dissatisfied" is recorded as 1, and the satisfaction index is among graduates of each year. The proportion of different labor satisfaction numbers is multiplied by the weight coefficient, and the labor employment satisfaction index change table is compiled, as shown in Table 11.

Table 11: Change in Labor Employment Satisfaction Index

Satisfaction Index	2003	2005	2007	2009	2011	2013	2015	2017
Very satisfied	6.3	4.6	12	16.4	11.1	13.7	26.3	28.5
Satisfied	38.4	32.8	41.1	43.1	43.6	51.1	54.5	50.7
General	46.4	50	40.1	34.3	40	32.4	17.8	17.8
Not satisfied	7.3	10.3	6	5.5	4.7	2.5	1.2	2.7
Very dissatisfied	1.6	2.3	0.9	0.8	0.7	0.4	0.5	0.8
Satisfaction index	3.405	3.271	3.576	3.691	3.6	3.755	4.058	4.059

5.5.1.2 Selection of the explanatory variables

According to the 2003-2017 Peking University Institute of Educational Economics published the survey report on the employment quality of college students [3], we have some social and economic data that will have an impact on the employment opportunities of college students. Here are the following data for analysis.

Occupational diversification

In recent years, the employment choices of college students have been diversified, which also means the increase in employment opportunities for college students. Using the 2003-2017 Peking University Institute of Educational Economics published the survey report on the employment quality of college students [3], we have compiled the situation and proportion of college graduates' employment choices after graduation in recent years, as shown in Table 12.

Table 12: Basic Status of Employment of College Graduates

Basic Status	2003	2005	2007	2009	2011	2013	2015	2017
Company has been determined	40.7	47.2	40.4	34.5	43.3	43.5	33.3	38.8
Domestic study	15.1	16.8	14.1	18.3	13.7	14	18.6	20.4
Going abroad	1.9	2.3	2.7	3.2	2.6	2.8	5.8	5.9
Freelance	0.3	1.2	4.1	3.3	4.3	2.6	4.7	5
Self-employment	1.3	1.2	3.2	2.4	3.2	2.1	4.6	4.7
Other flexible employment	0.5	1.2	6.6	5.4	5.1	7	16.1	9.7
Waiting for employment	35.8	22.4	22.6	26.4	21.9	23.4	12.8	10.1
Unemployment	0.8	2.4	2.9	3.1	2.4	2	2.2	3
Other temporarily not employed	0.9	2.4	2.4	2.2	2.1	1.8	1.3	1.4
Others	2.7	3	1.1	1.2	1.5	0.9	0.7	0.9

It can be seen from Table 12 that in recent years, the proportion of “Company has been determined” of college graduates has shown a significant downward trend, while the proportion of “Domestic study l”, “Going abroad” and engaging in “Freelance” has increased year by year, and the diversity of college students’ choice has increased significantly.

Job Search Fee (JSC)

Job Search Fee refer to the cost of submitting resumes, commuting, communication, and personal reasons for graduates seeking their ideal positions. In recent years, with the increase in the number of graduates and the intensification of competition in the labor market, the cost of job hunting for graduates has become higher and higher. Some graduates even think that the more Job Search Fee, the greater the probability of success in job hunting, which is for those who are from poverty. The job hunting of family graduates is undoubtedly worse, creating new inequities related to employment. The changes in Job Search Fee for 2003-2017 are shown in Table 13 below.

Table 13: Job Search Fees for 2003-2017

Year	2003	2005	2007	2009	2011	2013	2015	2017
Job Search Fee	819	1100	1132	1159	1110	1766	2029	2207

Graduate starting salary (GSS)

Graduate starting salary is the average salary that the unit is willing to pay when recruiting new graduates. The higher the starting salary of a graduate, the higher the level of economic development. It also means that graduates may prefer not to change their work. Look for higher paying jobs. The changes in the Graduate starting salary in 2003-2017 are shown in Table 14 below.

Table 14: Graduate starting salary for 2003-2017

Year	2003	2005	2007	2009	2011	2013	2015	2017
Graduate starting salary	1569	1659	1798	2331	2394	3378	4307	4812

Work Matching Status Index (WMS)

Work Matching Status Index reflects the effective utilization of the labor force in a certain period. The better the job matching status, the greater the investment return rate of the society for talents, which means that the talents are willing to work in this position and better display themselves. Talent. The changes in the graduate job matching Work Matching Status Index for 2003-2017 are shown in Table 15 below.

Table 15: Work Matching Status Index for 2003-2017

Year	2003	2005	2007	2009	2011	2013	2015	2017
Work Matching Status Index	2.889	2.679	2.6	2.608	2.517	2.682	2.663	2.736

Occupational preference diversification index

We calculate the data in Table 12 and come up with an index that reflects the degree of diversification of college students' occupational preferences in each year d_i.

Frist, we record the data in Table 12 as a matrix W:

$$W=\begin{bmatrix} w_{11} & \cdots & w_{18} \\ \cdots & w_{ij} & \cdots \\ w_{10,1} & \cdots & w_{10,8} \end{bmatrix}$$

Then we proceed as follows:

(1) We calculate the standard deviation of the proportion of different types of college graduates each year, and use it to reflect the degree of absolute variation.

In order to indicate the degree of diversification of college graduates' employment choices, this paper first calculates the standard deviation of the variance of college graduates for different types of choices each year SD_i:

$$SD_i = \sum_{j=1}^{10} \frac{(w_{ij} - \bar{w}_{ij})^2}{10-1} \qquad i = 1,2,\ldots\ldots,8$$

$$\bar{w}_{ij} = \sum_{j=1}^{10} w_{ij} \qquad i = 1,2,\ldots\ldots,8$$

(2) We need to calculate the coefficient of variation for each year CV_i.

This step is not only to eliminate the small errors caused by the statistical caliber, but also to reduce the error caused by the difference in the order of magnitude of the data. The calculation formula of the coefficient of variation is as follows:

$$CV_i = \frac{SD_i}{\bar{w}_{ij}}$$

(3) We need to calculate the index d_i that reflects the degree of diversification of college students' occupational preferences in each year.

The market requires that the degree of diversification of occupational preferences is higher, and the specific meaning of the index is greater. According to the definition of coefficient of variation, when the proportion of graduates in different occupational choices is similar (The greater the diversification of occupational preferences), the smaller the coefficient of variation, which is obviously contrary to the requirement, so the coefficient of variation is Countdown processing:

$$d_i = \frac{1}{CV_i}$$

After the above steps, we finally get the index d_i of the degree of diversification of college students' occupational preferences in each year, as shown in the following table 16.

Table 16: Occupational Preferences Diversification Index

	2003	2005	2007	2009	2011	2013	2015	2017
CV_i	0.940	0.919	0.822	0.798	0.852	0.867	0.737	0.784
d_i	1.064	1.089	1.217	1.253	1.174	1.153	1.356	1.275

5.5.2 Logarithmic linear regression model

Based on the above analysis, we use the index d_i of Job Search Fee (JSC), Graduate starting salary (GSS), Work Matching Status Index (WMS) and student occupational preference diversification as explanatory variables, and Job satisfaction as the explain the variable establishment model, considering that the model needs to weaken the heteroscedasticity as much as possible, and in reality, there is often no strict linear relationship between the explanatory variable and the interpreted variable, and establish a log-linear regression model with the following form to reflect the relative change of the variable:

$$\ln\mathrm{JS} = \ln\rho_0 + \rho_1 ln\mathrm{JSC} + \rho_2 \ln\mathrm{GSS} + \rho_3 \ln\mathrm{WMS} + \rho_4 \ln d_i + \varepsilon$$

Here, $\ln\rho_0$ represents a constant term, and ε represents a random error term outside the model. $\rho_1, \rho_2, \rho_3, \rho_4$ respectively represent the elasticity of the corresponding explanatory variable.

5.5.3 Model test

5.5.3.1 Significant test

We conducted a significant test on the regression results of college students' employment satisfaction. The results are shown in Table 17.

Table 17: Significance test results

Statistics	R^2	Adjusted R^2	Estimated standard error	Prob(F-statistic)
Numerical value	0.977	0.947	0.017	0.008

It can be seen from the above table that the goodness of fit R^2 of the logarithmic model is 0.977, which indicates that there is a strong linear relationship between the employment satisfaction of college students and the interpretation variables after legitimizations. The R^2 of model adjustment is 0.937, which indicates that 95% of the changes in college students' employment satisfaction can be explained by explanatory variables, and the model has a good goodness of fit. At the same time, the significance test value of the model is Prob(F-statistic) =0.008, which is less than 0.01, so we can obviously reject the null hypothesis that the overall regression coefficient is 0.

5.5.3.2 Colinearity test

We calculated the covariance test of the regression model by calculating the variance expansion factor. The calculation results are shown in Table 18.

Table 18: VIF calculation results

Characteristic variable	**Tolerance**	**VIF**
JSC	0.109	9.196
GSS	0.266	3.757
WMS	0.749	1.334
d_i	0.334	2.992

The smallest VIF is the work matching condition of 0.875. The maximum VIF is the job-seeking fee of 9.196, so the range of VIF can be expressed as $0.875 \leq VIF \leq 9.196$. The VIFs are all less than 10, indicating that the collinearity assumption between the explanatory variables entering the model does not hold, that is, there is no serious collinearity problem between the explanatory variables.

According to the above test results, the logarithmic model has good fitting degree and high degree of interpretation, so the model has strong statistical significance, which is of great significance for further discussing the relationship between employment satisfaction and explanatory variables of college students.

5.5.4 Result analysis

5.5.4.1 Empirical analysis

We selected a significant level of 10%, and there are three main factors that have a significant impact on college students' job satisfaction: job search expenses, graduate starting salary, and employment diversification index. In this paper, the significance level of each explanatory variable passed the test is calculated. The specific data are shown in the following table 19.

Table 19: Tests for the significance level of each variable

Characteristic variable	B	Standard error	t	Sig
Constant	0.263	0.223	1.178	0.324
JSC	-0.071	0.746	-0.095	0.036
GSS	0.161	0.057	2.857	0.065
WMS	0.208	0.187	1.113	0.347
d_i	0.433	0.14	3.096	0.053

Observing the results, we found that the level of significance of job matching is greater than 10%, which will not have a significant impact on the employment satisfaction of college students, so they can be excluded.

In addition, according to the sign of the regression coefficient, it can be qualitatively judged that the explanatory variable has a positive or negative influence on the explanatory variable (college student employment satisfaction). The results show that graduates' starting salary and diversification index will have a positive impact, and job-seeking expenses will have a negative impact on college students' employment satisfaction, which is consistent with our previous predictions, and proves that the economic significance of explanatory variables is reasonable. So, we get the final expression of the model:

$$\ln JS = 0.263 - 0.071 ln JSC + 0.161 \ln GSS + 0.433 \ln d_i + \varepsilon$$
$$\text{（-0.10）} \qquad \text{（2.88）} \qquad \text{（3.10）}$$

5.5.4.2 Descriptive analysis

According to the data published by Peking University Institute of Educational Economics, in recent years, the employment selection structure of university graduates has undergone major changes in the past, and the proportion of “Company has been determined” has decreased significantly. Graduates tend to study further or go abroad for further study. In the employment group, more and more people choose those relatively free careers. The number of people to be employed fell from 35.8% in 2004 to 10.1% in 2017, and the utilization efficiency of labor resources has been significantly improved.

Then the article uses the index d_i, which is the JSC, GSS, WMS and the degree of diversification of the student's occupational preference as the explanatory variable, and the job satisfaction as the explanatory variable to establish the multivariate linear logarithm model.

The model shows that job-seeking expenses, graduates' starting salary, and reflecting the diversification of students' professional preferences all have a significant impact on the satisfaction of college students' employment, while job matching does not significantly affect college students' employment satisfaction. Among them, the occupational preference diversification index d_i has the most important impact on college students' employment satisfaction. For every 1% increase in d_i, the employment satisfaction of college students will increase by 0.43%, which means that the city has a greater possibility of retaining talents. The job-seeking expenses will significantly reduce the employment satisfaction of college students. For every 1% reduction in job-seeking expenses, the employment satisfaction of college students will drop by 0.07%, and talents may be outflowed.

5.5.5 Strategies for the urban development and talent introduction for A-City

In response to the conclusions drawn from the above phenomena, we hope to make the following recommendations for the development of A-City:

(1) To open a “green channel” for talent recruitment, A-City needs to reduce the total cost of job hunting.

The data shows that the cost of finding a job for college students is on the rise in recent years. According to the logarithm model we have established, the increase in job-seeking expenses leads to a decrease in the employment satisfaction of college students, which may lead to the phenomenon of brain drain. Therefore, reducing job-seeking expenses and improving job satisfaction is conducive to the free flow of talents and thus better serve the development of A-City.

(2) A-City can set minimum wage guarantee according to the graduates' academic qualifications, and use the policy to raise the salary for graduates and retain talents.

Due to the lack of necessary work experience for recent graduates, the market gives wages to fresh graduates often low. A-City should introduce corresponding policies to increase the income of graduates and increase the employment satisfaction of graduates in order to better introduce and retain talents.

(3) A-City can further encourage college students to start their own businesses and promote the diversified development of talents.

In recent years, the data shows that with the proposal of “mass entrepreneurship and innovation”, the career choices of graduates are gradually “liberalized” and “diversified”. We have found through analysis that this diversity of employment options can also increase job satisfaction. Therefore, the establishment of corresponding entrepreneurial support mechanisms and the introduction of relevant support policies is conducive to the introduction of talents in A-City and the development of the city.

5.6 Question 5: Suggestion letter for the mathematics major

25th November, 2018

Dear Sir:

We are a few ordinary undergraduates at school. During the period of studying at school, we are very grateful to our school for all aspects of our education, so that we can get a certain

improvement in different skills. Schools are places to educate talent, and universities are especially. Therefore, our team hopes to provide some meager suggestions for the construction of talents in the school in combination with the market talent needs of this city.

Our group has recently studied the market demand for talents in this city, and found that with the development of economy and society, the market demand for talents has changed greatly in structure. Especially for the traditional basic theoretical disciplines, the form of demand for talents has changed substantially. This change has promoted the tradition. Reform of personnel training in basic theoretical disciplines. We find that the demand for talents in A market presents the following basic characteristics:

1. The total demand for talents in the market has declined and the quality has risen.

In the three years from 2015 to 2018, the total demand for talents in A city is 58 444, 44 225 and 42 288, respectively. The forecast results show that this number will fall to 30 603, 24 604 and 19782 in the next three years, indicating that the actual demand for talents in A city will decline. The level of education requirements for talents is divided into four categories: unlimited, junior and senior high schools, secondary and tertiary colleges and undergraduates and above. The data show that in the past three years, the demand for undergraduates and above in A city is 3158, 3155 and 3987 respectively, showing an upward trend year by year, while the proportion of recruitment requiring "junior high school", "junior high school" and "junior college" and not requiring academic qualifications decreases year by year.

2. The total demand for service-oriented talents in finance, commerce and sales industry is large, and the proportion of demand exceeds 50% of the total market demand. The demand will decline in the future.

We divide the occupational types given by A city into six categories according to the national standards: professional technology, service work, technical assistance, administrative management, frontline industry and others. Data show that in the next three years, market demand for "professional technology" will decrease from 3825 in 2019 to 30373, while demand for "service work" will also decrease from 91446 in 2019 to 5135 in 2021, a decline of 43.8%. The market demand for talents engaged in "front-line industry" shows an upward trend year by year, which indicates that the city's industrial development potential is huge, and the demand is expected to rise from 32516 in 2019 to 57048 in 2021.

3. The market demand for top talent is still relatively inadequate. Data show that in the past three years, the total demand for MBA in the talent market of A city is only 1, and the demand for doctoral students is relatively small, indicating that the development of high-end industries in the region may be relatively backward.

Based on the above analysis of the characteristics of talent demand, combined with their own experience, put forward some corresponding suggestions and suggestions on talent training plan:

1. Maintaining the stability of talent supply and improving the quality of talent supply

Chinese universities are often criticized for "strict access and lenient access". Schools can improve the quality of students'training requirements, add some courses, and regularly inspect the study of these courses, requiring those who fail to pass the course, and persuading those who fail to pass many courses to retreat.

2. Continue to cultivate talents in business, finance, sales and other fields, offer practical courses, and help students in this field contact internships to improve their employment

competitiveness. At present, there is still no hot demand in the A market, such as business, finance, sales and other industries. Therefore, schools need to continue to cultivate professionals in this field. At the same time, the demand of the market has shown a certain downward trend and the pressure of employment competition has increased. Therefore, the school can add some practical courses to help students to be familiar with the work they are going to do. At the same time, it can contact some enterprises for students'internship, so as to improve the employment competitiveness of students majoring in this field.

3. Strengthen the cultivation of high-end talents and strengthen the construction of mathematics. The total demand for first-line industrial talents in A city keeps increasing, while the market demand for high-end talents seems tepid, which also means that the high-tech industry in A city has great potential for development. The Strategic Research Report on the development of Mathematics Specialty points out that in the next five years and five years, the level of mathematics talents required by the society will be mostly above master's degree, and with the expansion of postgraduate enrollment, postgraduate study will be an important direction for graduates of mathematics undergraduate course in the next five years. Therefore, in order to do a good job in curriculum construction, we must strengthen the establishment of basic theory courses of mathematics, help students better grasp the core content of basic courses, and strengthen the understanding and application of mathematical thinking.Applied mathematics talents are talents who cultivate mathematics and science, and mathematical techniques are used to implement mathematical techniques. Mathematical modeling is of great significance for cultivating applied mathematics talents. Mathematical modeling is to build a mathematical model based on actual problems, solve the mathematical model, and then solve the actual problem according to the results. It not only requires students to fully exert their subjective initiative and creativity, but also requires students to cooperate closely, learn from each other's strengths, and cultivate students' innovative spirit. Encourage students to participate in mathematical modeling competitions, build a better team of instructors, and better develop applied mathematics talents.

The cultivation of talents in universities should be closer to comprehensive. This comprehensiveness is not only aimed at the comprehensiveness of the professional development of the school, but also covers the diversification of professional training. The school can adopt the talent training mode of simultaneous selection and minor minors. While studying the compulsory courses of the majors, it can choose other minors' courses according to their own interests and conditions, such as computer science and technology, electronic information engineering, management science and engineering.

How to ensure and improve the quality of teaching has always been a hot issue for leaders and teachers. Here are some suggestions. First, the construction of the master's capital will create a good teaching environment and play a supporting role in improving the development of teaching quality. Second, explore the teaching methods of mathematics courses, adapt to the new forms of current education in teaching, combine mathematics courses with mathematics experiment classes, mathematical modeling, and apply mathematical theory methods to numerical calculations, signal processing, and images through experiments. Processing and other aspects. Third, to strengthen the reform of teaching evaluation, a reasonable classroom teaching evaluation system should be established, which not only regards the students' test scores as the evaluation standard of teachers' teaching quality.

We appreciate your sincere consideration of my suggestions and hope that our school will train more talents.

Yours faithfully,
APMCM team

6. Strength and Weakness

6.1 Strength

From the two dimensions of time and space, the talent demand of a city is modeled and analyzed, which makes the analysis results comprehensive. Using the grey prediction model after eliminating seasonal trend, the seasonal fluctuation of data is effectively eliminated, and the employment demand in the next three years is predicted. The prediction accuracy is high. Logarithmic linear regression model can weaken the heteroscedasticity of data and describe more accurately the imprecise linear relationship between interpreted variables and interpreted variables.

6.2 Weakness

Grey forecasting model has high requirements for basic data. This model is suitable for forecasting exponential growth sequence and can only describe the monotonous change process.

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Appendix

Appendix 1: Total employment demand in various fields from September 2015 to August 2018

S/N	sector	Total demand (Pers.)	proportion
1	Computer software	7014	0.714399936
2	Sales management	94588	9.634111935
3	market/marketing	89798	9.14623402
4	Sales	228408	23.26413751
5	Computer hardware	1335	0.135974325
6	Internet development and application	7235	0.736909543
7	IT-Management	864	0.088001361
8	IT-QM, technical support and more	3977	0.405071078
9	Communications technology	2964	0.301893557
10	Electronics/appliances/semiconductor/instrumentation	16624	1.693211367
11	Finance/auditing/tax	13504	1.375428676
12	Engineering/machinery/energy	21275	2.166931655
13	HR	14378	1.464448571
14	Senior management	1316	0.13403911
15	Logistics/warehousing	18313	1.865241805
16	Art/graphics/Animation design	10903	1.110507912
17	Science & Technology	792	0.080667914
18	Legal profession/law	497	0.050621153
19	Education	11071	1.127619288
20	Hospital/medical/care	8526	0.868402317
21	Counsel/consulting	17722	1.80504643
22	Transportation service	5932	0.604194528
23	Translation	323	0.032898657
24	Construction/infrastructure/gardening	21242	2.163570492
25	Banking	1993	0.20299388
26	Office administration/logistics	32292	3.289050858
27	Customer service and technical support	40666	4.141971455
28	Securities/finance/investment	17366	1.76878661
29	Insurance	12165	1.239046937
30	Production/operation	14573	1.484309989
31	QMS/safety/environmental protection	11930	1.215111382
32	Technical work	61507	6.264698723
33	Fashion/textile/furs	555	0.056528652
34	Procurement	2366	0.240985208
35	Trade	2988	0.304338039
36	Biology/chemicals/pharmaceuticals/medical equipment	4698	0.478507399
37	Advertising	1261	0.128437171
38	PRs and news media	712	0.07251964

39	Movies, TV and recreation	1650	0.168058154
40	Literature/screenwriting/writing	1267	0.129048292
41	Real property	39202	3.992858038
42	Property management	7694	0.783660266
43	Restaurants & recreation	33730	3.435516086
44	Hotels/tourism	4976	0.506822652
45	Beauty and personal care	10392	1.058460811
46	General merchandise/chains/retail	18191	1.852815687
47	Security/housekeeping/other	6884	0.70115899
48	Graduates	21018	2.140755325
49	Other	33126	3.373996616

Appendix 2: Total number of recruits in various fields from September 2015 to August 2018

S/N	sector	requirements	proportion
1	Computer software	1119	0.771953062
2	Sales management	14191	9.789799734
3	market/marketing	11367	7.841635795
4	Sales	1223	0.843698476
5	Computer hardware	512	0.353208193
6	Internet development and application	1290	0.889919079
7	IT-Management	1178	0.812654787
8	IT-QM, technical support and more	1005	0.69330905
9	Communications technology	1015	0.700207648
10	Electronics/appliances/semiconductor/instrumentation	153	0.105548542
11	Finance/auditing/tax	863	0.595348966
12	Engineering/machinery/energy	1743	1.202425547
13	HR	1986	1.370061467
14	Senior management	2180	1.503894258
15	Logistics/warehousing	5575	3.845968115
16	Art/graphics/Animation design	4068	2.806349469
17	Science & Technology	891	0.614665039
18	Legal profession/law	2198	1.516311734
19	Education	136	0.093820926
20	Hospital/medical/care	11956	8.247963189
21	Counsel/consulting	4372	3.016066834
22	Transportation service	1518	1.047207103
23	Translation	6246	4.308864008
24	Construction/infrastructure/gardening	6996	4.826258822
25	Banking	156	0.107618121
26	Office administration/logistics	342	0.235932035
27	Customer service and technical support	309	0.213166663

28	Securities/finance/investment	3343	2.306201149
29	Insurance	2014	1.38937754
30	Production/operation	241	0.1662562
31	QMS/safety/environmental protection	1463	1.009264816
32	Technical work	21919	15.12103589
33	Fashion/textile/furs	1018	0.702277227
34	Procurement	519	0.358037211
35	Trade	593	0.409086833
36	Biology/chemicals/pharmaceuticals/medical equipment	70	0.048290183
37	Advertising	4257	2.936732962
38	PRs and news media	1993	1.374890485
39	Movies, TV and recreation	298	0.205578206
40	Literature/screenwriting/writing	1508	1.040308505
41	Real property	1916	1.321771284
42	Property management	5313	3.66522486
43	Restaurants & recreation	261	0.180053395
44	Hotels/tourism	6019	4.152265844
45	Beauty and personal care	178	0.122795036
46	General merchandise/chains/retail	636	0.438750802
47	Security/housekeeping/other	2166	1.494236222
48	Graduates	3723	2.568347855
49	Other	921	0.635360831

Appendix 3: Grayscale prediction

```
clc
clear
x0=[71.1 72.4 72.4 72.1 71.4 72.0 71.6]';% Note here is the column vector
n=length(x0);
lamda=x0(1:n-1)./x0(2:n); % Computational ratio
range=minmax(lamda'); % Calculate the range of the ratio
x1=cumsum(x0); % Accumulation operation
B=[-0.5*(x1(1:n-1)+x1(2:n)),ones(n-1,1)];
Y=x0(2:n);
u=B\Y
syms x(t)
x=dsolve(diff(x)+u(1)*x==u(2),x(0)==x0(1));% Find the symbolic solution of differential equation
xt=vpa(x,6)% Display the solution of differential equations in fractional format
yuce1=subs(x,t,[0:n-1]);% In order to improve the prediction accuracy, the predicted value is calculated first, and then the solution of the differential equation is displayed
yuce1=double(yuce1);% The number of symbols is converted to a numeric type, otherwise the difference operation cannot be performed
yuce=[x0(1),diff(yuce1)]; % Differential operation, restoring data
```

```
epsilon=x0'-yuce; % Calculating residuals
delta=abs(epsilon./x0'); % Calculating relative error
rho=1-(1-0.5*u(1))/(1+0.5*u(1))*lamda';% Calculate the ratio deviation
```

Appendix 4: Career classification

Type	Career	Type	Career
Professional technology	Computer software	Technical assistance	Internet development and application
	Computer hardware		IT-QM, technical support and more
	Communications technology		Logistics/warehousing
	Finance/auditing/tax		Customer service and technical support
	Engineering/machinery/energy	Administration	Senior management
	Science & Technology		IT-Management
	Translation		HR
	Banking		Office administration/logistics
	Securities/finance/investment		Property management
	Insurance	First-line industry	Electronics/appliances/semiconductor/instrumentation
	Technical work		Construction/infrastructure/gardening
	Biology/chemicals/pharmaceuticals/ medical equipment		Production/operation
	Advertising		Fashion/textile/furs
Service work	Sales management	Other	Art/graphics/Animation design
	market/marketing		
	Sales		
	Legal profession/law		
	Education		
	Legal profession/law		
	Education		
	Hospital/medical/care		
	Counsel/consulting		
	Procurement		
	Trade		
	Restaurants & recreation		
	Hotels/tourism		
	Beauty and personal care		
	General merchandise/chains/retail		
	Security/housekeeping/other		