Time Measurement of People's Cultural Life Quality in China 's Provinces Based on Grey Prediction

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Abstract. In order to better counter the quality of people's cultural life in various regions of China, based on the scientific and effective principles of data, this paper collects 33 secondary indicators for evaluating the quality of people 's cultural life from 31 provinces in China from 2014 to 2022. Then, the box plot and mean interpolation method are used to deal with outliers and missing values, and then the heat map is used to evaluate and screen the index system. In order to more accurately reflect the quality of cultural life, this paper uses the entropy weight method to integrate the second-level indicators into a more comprehensive first-level indicator, and obtains the specific scores of 31 provinces in ' cultural participation', 'cultural industrialization', 'cultural creativity', 'cultural richness' and 'cultural resources 'from 2014 to 2022, so as to do basic work for subsequent prediction and comprehensive evaluation. Finally, in order to enhance the innovation of the model, this paper studies the quality of cultural life of Chinese people in each province by 2025 under the grey prediction model from the time dimension, taking into account the scientific and effective. This method is conducive to China 's full understanding of the differences and convergence of the quality of cultural life in various provinces, providing a scientific basis for the cultural construction of the world 's people, and promoting social progress and civilization development.

Keywords: Cultural Life, Entropy Weight, Dimension Reduction, Grey Prediction.

1. Introduction

Based on the existing research, this paper relies on objective data to establish a time measurement standard for the quality of people 's cultural life in China 's provinces from multi-dimensional and multi-angle qualitative and quantitative analysis, and fully understands the differences and convergence of the quality of cultural life in each province. It provides a scientific basis for the construction of people’s culture and promotes social progress and civilization development.

Hu [1]and others put forward the SEM structural equation, from the construction of public spiritual and cultural facilities, the degree of public spiritual and cultural activities, the investment of public spiritual and cultural activities, the richness of public spiritual and cultural types, and the openness of public cultural places. From the five perspectives, the influencing factors of the quality of spiritual and cultural life of migrant workers are verified. Zheng [2] proposed a cultural life construction plan based on excellent literary and artistic works and public culture, from literary and artistic evenings to stage plays; from TV series to movies, cultural self-confidence is established through classic stage images. At the same time, we should actively build public cultural facilities such as libraries and cultural stations, and steadily promote the equalization of public cultural services.

Based on the entropy weight method, this paper innovatively integrates the secondary indicators into the first-level indicators, and then calculates the values of the five first-level indicators of each province based on the grey prediction model, thus completing the time and space of the quality of cultural life of the people in each province of China.

2. Model construction

2.1. Entropy weight method

Entropy is a concept in information theory and a measure of uncertainty. The greater the amount of information, the smaller the uncertainty, the smaller the entropy; the smaller the amount of information, the greater the uncertainty, the greater the entropy [3]. According to the definition of information entropy, the entropy value can be used to judge the dispersion degree of an index. The smaller the entropy value is, the greater the dispersion degree of the index is, and the greater the influence of the index on the comprehensive evaluation (i.e. weight) is. The entropy weight method is a multi-index decision-making method, which can transform the weights of different indicators into entropy values, so as to realize the quantification and comparison of index weights [4].

$$w_{ij} = \frac{d_j}{\sum_{j=1}^{m} d_j}, j = 1, K, m \tag{1}$$

2.2. Grey prediction model

The grey prediction model is a prediction method that establishes a mathematical model through a small amount of incomplete information [5]. Gray here means that the information of the system is only part of the incomplete. Usually, the prediction object requires the data to have a quasi-exponential law and the data is non-negative. The grey prediction model is usually suitable for the prediction of year data and the number of periods is small [6].

$$\widehat{x^{(0)}}(m+1) = \quad (1 - e^{\hat{a}})[x^{(0)} - \frac{\hat{b}}{\hat{a}}] - e^{-\hat{a}m} \tag{2}$$

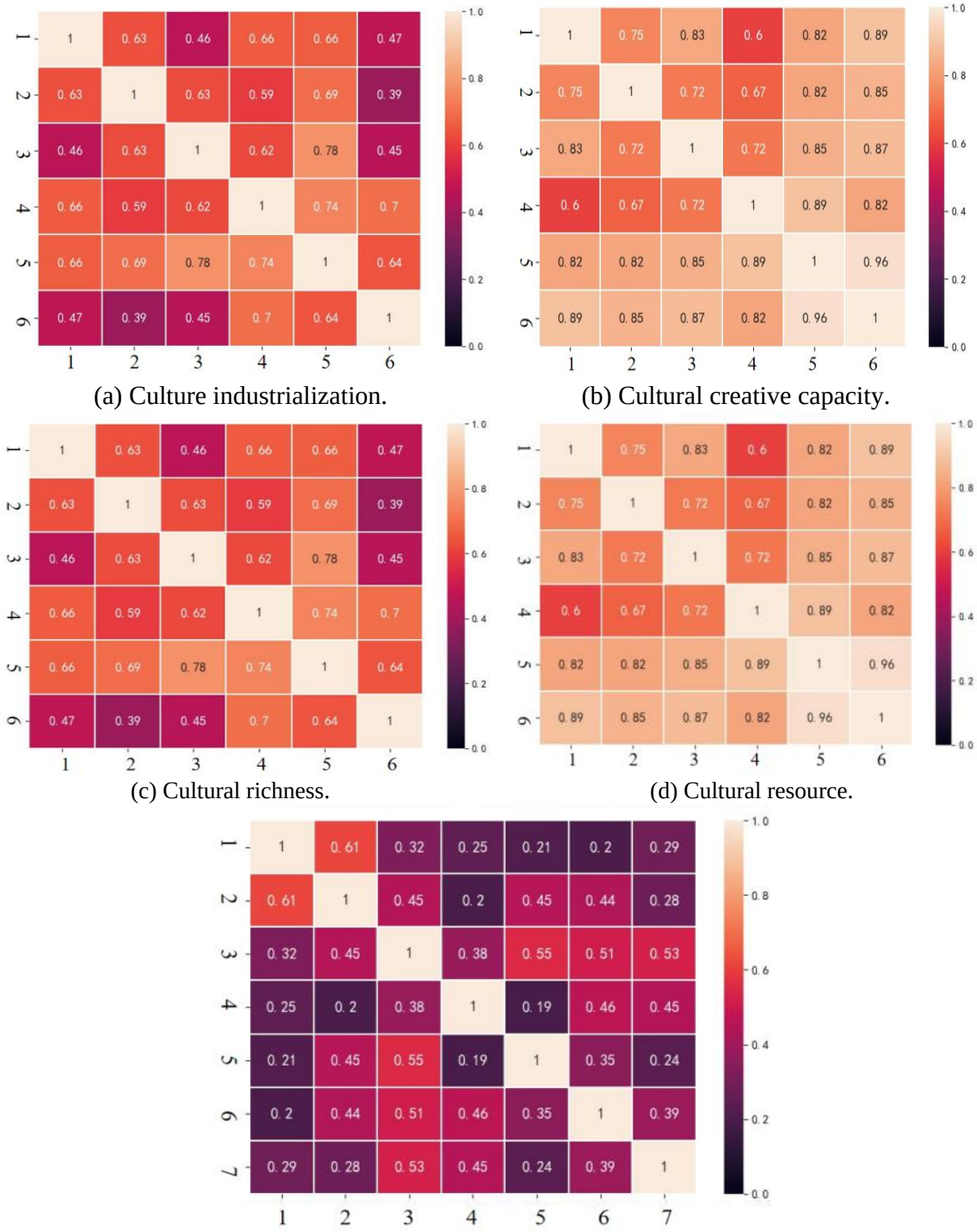
3. Construction and dimension reduction of index system

3.1. Selection of indicators

Based on the quantifiable principle, multi-dimensional principle and reliability principle [7], this paper obtains relevant data from the National Bureau of Statistics (http://www.stats.gov.cn/)), and preliminarily determines 33 second-level indicators including museum visits and 5 first-level indicators including cultural participation. Subsequently, a box plot based on normal distribution was used to remove the more obvious outliers. And the mean interpolation scheme is adopted to deal with the missing values. Considering that the research object of this paper is the remaining 31 provincial-level administrative regions in mainland China except Hong Kong, Macao and Taiwan, and the objects are more and more complicated, this paper selects the representative provinces of the four regions: Jiangsu Province, Xinjiang Uygur Autonomous Region (hereinafter referred to as Xinjiang), Guangdong Province, Liaoning Province, as the main display objects in the follow-up papers.

Based on the five provinces, this paper conducts spearman correlation analysis on the 33 initially selected indicators and obtains the mean value, and obtains the spearman correlation analysis results of each secondary indicator under the five first-level indicators. As shown in Figure 1 below. It can be seen from the figure that the correlation coefficients of 22 secondary indicators including the number of museum visitors and other indicators are less than 0.85, which are the first outstanding feature indicators to be retained.

In the first-level indicator of cultural creativity, the number of new product projects (items) and the number of patent applications (pieces) of industrial enterprises above designated size should be eliminated, but the two indicators belong to the field of industrial technology, so the number of patent applications (pieces) of industrial enterprises above designated size should be retained. In the first-level index of cultural resources, according to the heat map, the total collection of museum cultural relics and public libraries should be eliminated, but because the index can well reflect the quality of people's cultural life, it should be retained.



(a) Culture industrialization. (b) Cultural creative capacity.

(c) Cultural richness. (d) Cultural resource.

(e) Cultural participation.

Fig 1. Correlation analysis result diagram

3.2. Data dimensionality reduction based on entropy weight method

In order to process the data more conveniently, this paper compresses all the second-level indicators under the first-level indicators. The method used is the entropy weight method. Firstly, the values of all the second-level indicators of each province and city from 2014 to 2022 under each first-level indicator are collected. Then, in order to improve the versatility of the algorithm, the data of all provinces and cities under each second-level indicator are averaged, so as to obtain the average value of each province and city under the second-level indicator from 2014 to 2022 under each first-level

indicator. Then, each first-level indicator is used as a calculation unit to obtain the weight of all second-level indicators under the first-level indicator. Therefore, the data dimension reduction can be realized, and then the scores of different provinces and cities in 2014 ~ 2022 under the first-level index can be obtained.

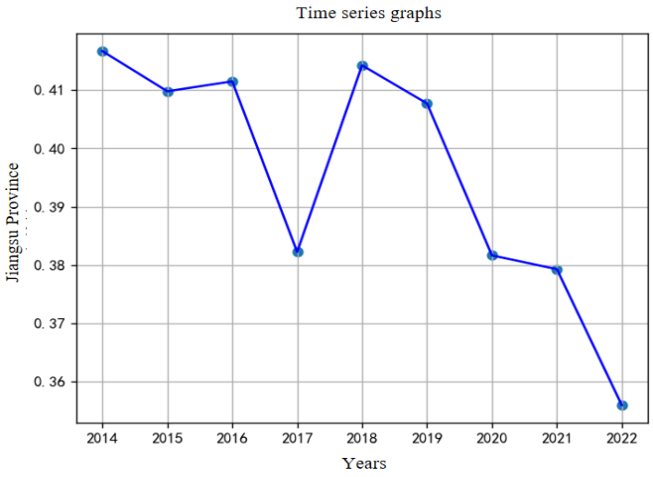
Based on SPSSPRO, this paper finally obtains the index system and its entropy weight results as shown in Table 1:

Table 1. The results of second-level index entropy weight.

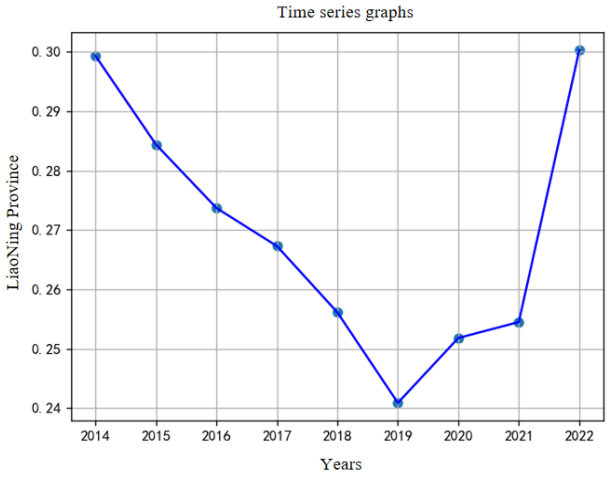
Target	First index	Second index	Weight
Comprehensive evaluation system of people 's cultural life quality in China 's provinces	Cultural participation	Art performance audience attendances	0.154713068
		Museum visits	0.159726763
		Total circulation of public libraries	0.180680972
		Number of digital TV users	0.160811602
		Art Performance Group Audiences number	0.151901295
		Art performance venues audience number	0.1108685
		Lectures attended by public libraries	0.0812978
	Cultural creativity	Higher education	0.215127137
		Enrolment in institutions of higher learning	0.178326332
		Total number of faculty and staff in institutions of higher learning	0.120151712
		Full-time equivalent of R&D personnel in industrial enterprises above designated size	0.282044854
		Number of patent applications for industrial enterprises above designated size	0.204349965
	Cultural resource	Number of museum institutions	0.105973808
		Museum Collections	0.168002106
		Number of public library institutions	0.101212884
		The total collection of public libraries	0.302403787
		Number of art performance venues	0.081197529
		Number of art performance organizations	0.159376007
		Number of parks	0.08183388
	Cultural richness	The number of electronic publishing items published	0.139539598
		Number of publications of sound recordings	0.099188624
		Number of publications of video products	0.211916618
		Books-publishing bibliocount	0.170158933
		Number of periodicals published	0.115413078
		Number of newspapers published	0.083314639
		Number of public television programmes	0.180468509
	Culture industrialization	Number of publishing and printing enterprises	0.153218329
		Local financial culture sports and media expenditure	0.121659
		Welfare lottery sales	0.073086239
		The number of employees of Xinhua Bookstore System Publishing House	0.167031963
		Educational fund	0.186505642
		Number of collective individual retail	0.298498826

4. The prediction of the quality of cultural life in 2025 based on grey prediction

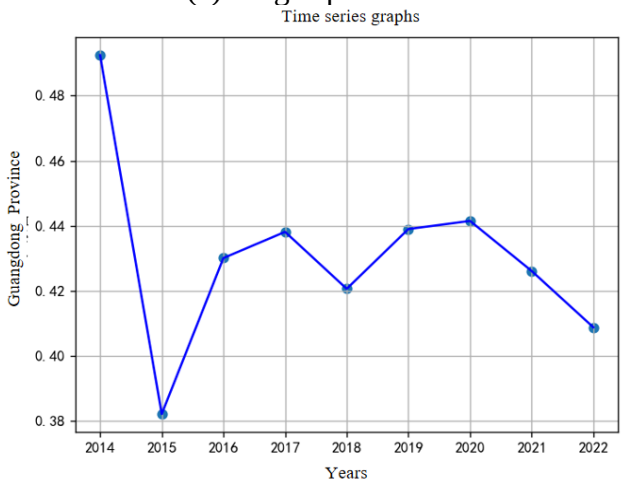
Time series diagram is a method for visual analysis of cultural life quality data. By drawing the time series diagram of the cultural life quality of the people in each province, the trend and change rule of the data can be observed, so as to provide the basis for the subsequent prediction modeling. Figure 2 is the time series of cultural resources in four provinces.



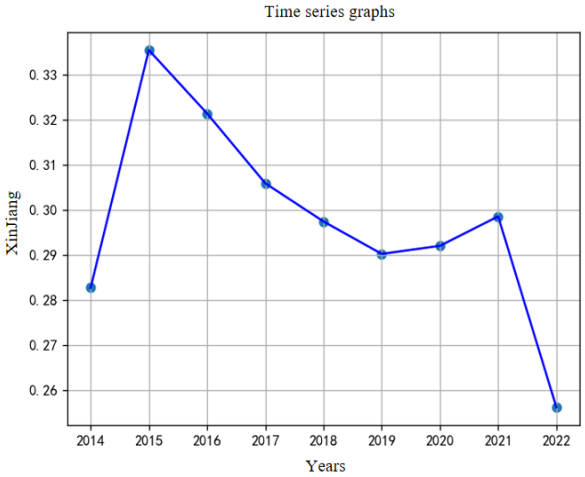
(a)Jiangsu province.



(b)Liaoning province.



(c)Guangdong province.



(d)Xinjiang.

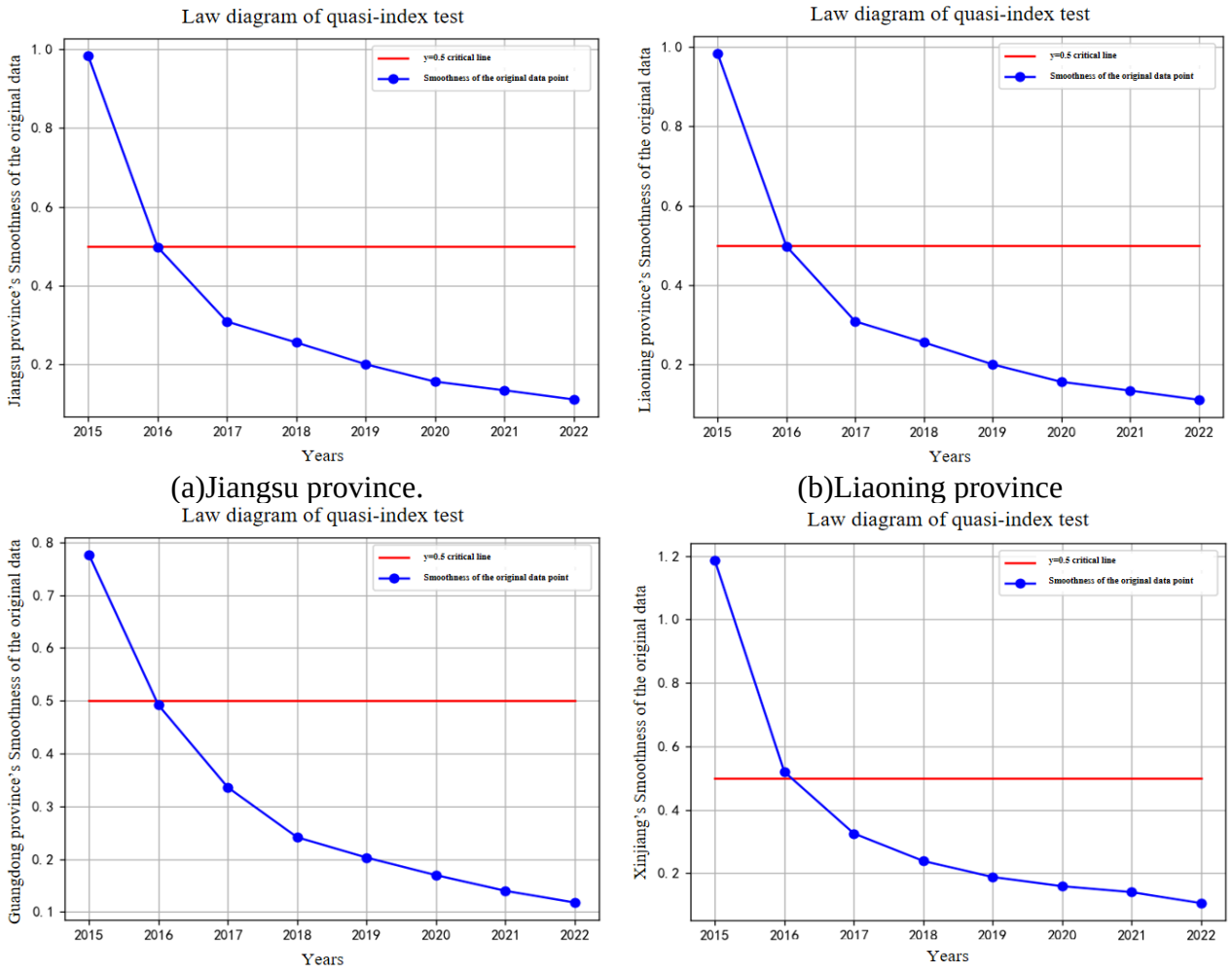
Figure 2. Four provinces time prediction results figure.

The quasi-exponential test in the model is a method to evaluate the accuracy and reliability of the model prediction results [8]. We calculate the smoothness p value of the original data in different years and compare it with the critical line of y = 0.5. The reference method is shown in Table 2.

Table 2. Quasi-index test reference table.

Inspection object	Reference value
Proportion of data with a smoothness ratio of less than 0.5 when the first two metrics are not removed	>60%
The proportion of data with a smoothness ratio less than 0.5 when the first two indicators are removed.	>90%

The results are shown in Figure 3. It can be found that the proportion of data with a smoothness ratio of less than 0.5 when removing the first two indicators in the four provinces is greater than 60 % of the reference. When the first two indicators are removed, the proportion of data with a smoothness ratio less than 0.5 is even 100 %. It shows that the data series are suitable for grey prediction.



(a)Jiangsu province. (b)Liaoning province

(c)Guangdong province. (d)Xinjiang.

Fig 3. Four provinces quasi index test results.

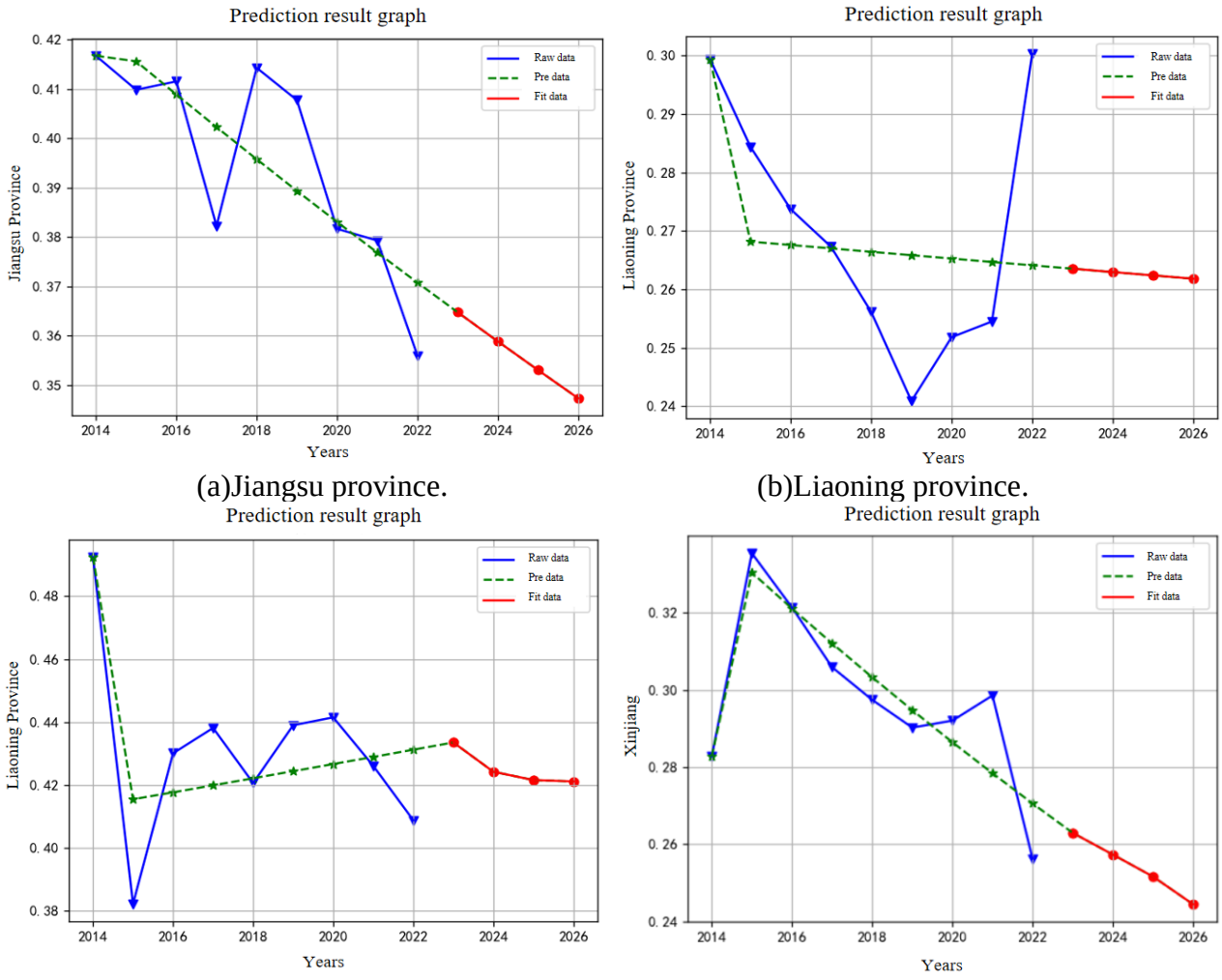
At present, the grey prediction model is usually applied in the three models of full data, new information and metabolism [9-10]. Therefore, we calculate the sum of error squares under different models, and select the most suitable model according to the one with the smallest sum of error squares. The model selection of the four provinces is shown in Table 3:

Table 3. Grey prediction model selection of cultural industrialization in four provinces.

Province	Scripture	New information	Metabolism	Model selection
Ln.P	6.385e-05	6.325e-05	0.0001188	New information
Js.P	0.003789	0.003783	0.003802	New information
Gd.p	0.0183955	0.0183953	0.0139185	Metabolism
Xinjiang	0.0009225	0.0009228	0.0004095	Metabolism

Under the condition that the data meet the application conditions of the grey prediction model and the model is selected appropriately, this paper obtains the prediction of the quality of cultural life of the people in each province in 2025. The prediction results are shown in figure 4 below:

According to the forecast results, it can be found that the quality of people's cultural life in most provinces has decreased in a sense, which provides effective evidence for subsequent suggestions and improvements.



(a)Jiangsu province. (b)Liaoning province.

(c)Guangdong province. (d)Xinjiang.

Fig 4. Grey prediction results of four provinces.

For model evaluation, this paper judges from two perspectives: model average relative residual error and model average stage ratio deviation. The relative residual refers to the absolute value of the difference between the predicted fitting value and the residual value divided by the original value. The average relative residual error of the model is the value obtained by averaging the relative residuals of multiple models. The average relative residual error of the smaller model indicates that the fitting effect of the model is better, indicating that the model can predict the data more accurately. The grade ratio deviation is an index used to measure the deviation between the model fitting and the actual situation. The average ratio deviation of model is the average value of the ratio deviation of multiple models. The smaller average level ratio deviation of the model indicates that the fitting effect of the model is better, indicating that the model can predict the data more accurately.

In summary, we get the evaluation results as shown in table 4 below:

Table 4. Evaluation results.

Province	Average relative residual	Average ratio deviation	Effect
Ln.P	0.07491279786645794	0.09236543656218765	Excellent
Js.P	0.05665241211820978	0.07989247981539703	Excellent
Gd.p	0.01820109867086741	0.029118625550504415	Excellent
Xinjiang	0.0387927484328797	0.05044081204792662	Excellent

5. Conclusions

The quality of people's cultural life in different provinces of China presents obvious differences in time. From the perspective of time dimension, the quality of people's cultural life in most provinces has an upward trend, but the growth rate is different. The main factors that cause the differences in the quality of people's cultural life in China's provinces include: cultural participation and cultural industrialization level. The differences in these factors are also related to the level of local economic development and education. In the future, it is also necessary to increase investment in cultural resources in underdeveloped areas, improve the construction of public cultural facilities, and increase people's cultural participation. Improve the cultural management system, strengthen the overall planning and allocation of cultural resources, promote cultural exchanges and mutual learning between different regions, and promote the overall improvement of the quality of people's cultural life. In short, promoting the improvement of the quality of cultural life of the Chinese people requires the joint efforts of the whole society and the cooperation of the government, enterprises and the broad masses of the people.

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