

## The prediction model of the new-type industrialized process and its application to the evaluation index system of the county \*

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**Abstract.** Making reference to relevant industrialized theories and historical experiences, in this research, we analyze the county area characteristics and set up the new-type industrialized process evaluation index system which is feasible for a county of Sichuan Province. Through this index system we can objectively judge the county's present new-type industrialized stage according to historical statistics. At the same time, development trend to the future of each index is predicted through the scientific prediction model by WinQSB operations research software. Therefore the reference of formulation and adjustment to local industry's development policies will be more convincingly offered.

**Keywords:** prediction model, new-type industrialization, index system, WinQSB

### 1 Introduction

New-type industrialization and traditional industrialization are essentially different from the view of developing and growth ways. The traditional industrialization one-sidedly pursues the economic growth rate and scale, relying on the extensive development mode to increasing the quantity. Therefore this course of industrialization causes high input, excessive consumption and seriously polluted environment. Otherwise the new-type industrialization pursues economy developed with the society, resource, ecological environment in harmony, depending on the scientific innovation and technological progress to reduce resource consumption and environmental pollution<sup>[14]</sup>. Moreover the improvement of people's quality and full play of the human resources advantage promotes innovational ability. In this paper, we will conduct the research of the new-type industrialized process of the county by the evaluation index system and the prediction model.

At present, the theoretical research of dividing industrialized stage has already become progressively ripe in the world<sup>[2]</sup>, but these international standards in common use only are a judgement to stage of traditional industrialization. Many domestic scholars have carried on theoretical research to connotation<sup>[6]</sup>, essence, characteristic<sup>[1]</sup> of new-type industrialization and the relationship with traditional industrialization<sup>[23]</sup>. Some have tentatively set up the new-type industrialized index systems and evaluation criterion<sup>[6, 8, 22]</sup>. But after all the conception of the new-type industrialization as an important strategy of economic development of our country was put forward a few years ago, and the economic development foundations and environmental conditions of different areas are not the same, so these index systems and evaluation criteria can not be in common use. In this paper, we will design the new-type industrialized process evaluation index system which reflects the county area characteristic.

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Some scholars have applied all kinds of predicting method in this field, including neural network model<sup>[21]</sup>, two stage least square method<sup>[15]</sup>, grey forecast GM model<sup>[24]</sup> and so on. In this paper, we adopt the time series prediction model to predict the index data relying on WinQSB operations research software. This method can improve data fit degree and more convenient to utilize limited historical data to predict future development curve. According to the characteristics of the data collected, we concretely use the weighted moving average of the linear trend method, exponential smoothing with trend method, time linear return predict method and Holt-Winters multiplication algorithm methods to predict index trend<sup>[18]</sup>.

The rest of the paper is organized as follows. In section 2, we design the new-type industrialized process evaluation index system which is suitable for the county. In section 3, we introduce the formulae of 4 kinds of prediction methods concretely. Next, in section 4, we appraise the new-type industrialized historical process of a county of Sichuan Province, at the same time predict index data of the future process. At last, the conclusions have been drawn in section 5.

## 2 Index systems

Setting up the new-type industrialized process evaluation index system of a county in Sichuan Province and connecting local economy, society, resource and environment influence, we can find out process, the degree of realizing and the development trend of new-type industrialization, can carry on dynamic analysis and horizontal contrast to the development level, and can offer scientific basis for carrying on decision to local relevant departments to guide new-type industrialized development better. This operation also has important meaning to the whole historical process of the well-off society in their place.

### 2.1 Design principle

The index system according to the scientific, systemic, feasible and comparable principle<sup>[1]</sup>.

**scientific principle:** It means the index systems scientific designed to accurate objectively reflect connotation, goal, main characteristic and basic demand of new-type industrialization. “New-type” should fully be reflected in the index system, at the same time, the current statistics index is strictly avoided gathering briefly or repeating up.

**systemic principle:** Systematic principle means that the system for statistical indices should be a unified organic whole. There should be certain logic relations between every index within the system. This system not only contains main characteristic and local current developing situation, but also reflects the inner link of various fields in new-type industrialized connotation with a clear level.

**feasible principle:** Taking into account scientific and objective aspect index system gives more consideration to the practicability and effectiveness of each index. The choosing of the index should base on the current situation and increase the effectiveness to benefit the collection and calculation of the data because the appraisal work is extraordinary practicality.

**comparable principle:** The number value of index in the system can be compared vertically (with historical state) and be compared horizontally (with other regions) with comprehensive considered, in order to carry on deep analysis and appraisal to new-type industrialized horizontal difference and development process.

### 2.2 Concrete index

The evaluation index system of the new-type industrialized process regards education of science and technology as support, informationization and economic globalization as the opportunity, changing the growth way and improving the quality as the center and improving the industrialized level as the goal. We can set up new-type industrialized process evaluation index system according to the industrialized level, intensify competence level, information-based level and education of science and technology level. Every aspect is formed by several relatively independent indexes.

**industrialized level:** According to domestic and international historical experience and theoretical research about industrialized aspect, choose 8 indexes to reflect the industrialized level of this county. These 8

indexes are: per capita GDP; agricultural GDP takes total GDP proportion; tertiary industry GDP takes total GDP proportion; agricultural employed population takes total employed population proportion; urbanization rate (urban population takes total people's proportion); industry's profit rate of increase; urban residents per capita disposable income; rural residents per capita net income.

**intensify competence level:** Intensify competence level is expressed with 6 following indexes: labor productivity of the whole society; energy consumption per ten thousand yuan GDP; contribution rate of large-scale corporation; eligibility rate of waste water; forest coverage rate; investment for pollution rate of increase.

**information-based level:** Choose 3 indexes to appraise the social information-based level: information industry GDP takes total GDP proportion; contribution rate of technological progress; urban residents computer owning rate.

**education of science and technology level:** This level is expressed with 2 following indexes: education funds take GDP proportion; average year of receiving education.

## 2.3 Appraising method

We adopt comprehensive method to appraise new-type industrialized process.

### 2.3.1 Standard value

The standard value of the new-type industrialized evaluation index is to judge the degree of realizing the new-type industrialization. In this research, the main basis of confirming is as follows: (1) The strategic objective that China will realize industrialization basically in the first 20 years of this century confirmed by the 16th National Congress of Communist Party of China; (2) outline of sustainable development of the beginning of 21st century of China, the medium-term and long-term plans of national economic and social development and relevant development goal put forward in key sub-plan; (3) The average level of the medium-sized developed country or the area in the world at present; (4) Influential industrialized evaluation criterion which the domestic and international scholar puts forward.

### 2.3.2 Index weights

The new-type industrialized evaluation index system is the comprehensive multi- subsystem appraisal systems. The influence degree of every subsystem and index to effect new-type industrialized level are not the same. According this condition, we need to give different weights to each index.

At present, there are a lot of domestic and international methods to confirm relevant weights which can roughly be divided into two kinds: One is subjective method, for instance level analytic approach, Delphi method, comparative method, etc. Its disadvantage lies in that the weight is tend to affect by policymaker's knowledge structure with strong subjectivity; The other is objective method, for instance main composition analytic approach, factor analytic approach, etc. It confirms the weight according to relevant relations among every index, having avoided the deviation of subjective factor. But the weight confirmed may be contrary to reality, such as the most important index might not have the greatest weight.

So, in order to overcome the both deficiency, we adopt subjective and objective integrative weight method. Integrative weight method is usually divided into two classes, the synthetical unitary multiplication method and the linear weighting combination method.

(1) The calculation formula of the synthetical unitary multiplication method is:

$$W_j = (\alpha_j \cdot \beta_j) / \left( \sum_{i=1}^m \alpha_i \cdot \beta_i \right),$$

where  $m$  expresses the number of index,  $\alpha_j$  shows the objective weight,  $\beta_j$  shows the subjective weight,  $W_j$  is the integrative weight.

(2) The calculation formula of the linear weighting combination method is:

$$W_j = \sum_{i=1}^g (\alpha_i \cdot \beta_{ij}) (j = 1, 2, \dots, m),$$

where  $\alpha_i$  is the right coefficient of  $i$  method,  $\beta_{ij}$  confirms  $j$  pieces of index weight,  $m$  expresses index number and  $g$  shows numbers of definite method.

**Table 1.** new-type industrialized process evaluation of the county index system form

index	unit	weight	standard value		
			initial	middle	later
per capita GDP	ten thousand yuan/person	10	1.5 ↓	1.5-4.0	4.0 ↑
agricultural GDP takes total GDP proportion	percentage	7	15 ↑	8-15	8 ↓
tertiary industry GDP takes total GDP proportion	percentage	5	30 ↓	30-50	50 ↑
agricultural employed population rate	percentage	6	20 ↑	15-20	15 ↑
urbanization rate	percentage	8	40 ↓	40-60	60 ↑
industry's profit rate of increase	percentage	4	15 ↓	15-20	20 ↑
urban residents per capita disposable income	ten thousand yuan	4	1.5 ↓	1.5-2	2 ↑
rural residents per capita net income	ten thousand yuan	4	0.5 ↓	0.5-1	1 ↑
labor productivity of the whole society	ten thousand yuan/person	7	8 ↓	8-15	15 ↑
energy consumption per ten thousand yuan GDP	ton	5	0.5 ↑	0.2-0.5	0.2 ↓
contribution rate of large-scale corporation	percentage	4	10 ↓	10-15	15 ↑
eligibility rate of waste water	percentage	5	90 ↓	90-98	98 ↑
forest coverage rate	percentage	5	30 ↓	30-40	40 ↑
investment for pollution rate of increase	percentage	4	15 ↓	15-20	20 ↑
information industry GDP takes total GDP proportion	percentage	5	7 ↓	7-15	15 ↑
contribution rate of technological progress	percentage	4	50 ↓	50-70	70 ↑
urban residents computer owning rate	percentage	3	60 ↓	60-80	80 ↑
education funds take GDP proportion	percentage	4	3 ↓	3-5	5 ↑
average year of receiving education	year	6	7 ↓	7-11	11 ↑

Note: upward arrow representatives greater than the figure, downward arrow representatives smaller than the figure

Through analyzing, we can know the linear weighting combination method need to confirm each kind of weight of method. So we select the synthetical unitary multiplication method to synthesize the subjective and objective weight. Concretes standard value and weight of the index see Tab. 1.

### 2.3.3 Appraise formula

Taking into consider the new-type industrialization is an aggregate in many aspects such as economy, society, science and technology, information and life quality. The development level of a certain respect can not substitute the level of another. Therefore standard value is maximum and so long as an index can not reach standard value, the industrialized integrated value will be lower than 100% when grading, which just reflects that the new-type industrialized level of this area has weak points. The concrete formula is

$$S_i = \begin{cases} \frac{p}{m} \times q, & \text{when the index is a positive index} \\ \frac{m}{p} \times q, & \text{when the index is a negative index} \end{cases}$$

Among them,  $S_i$  is each index score,  $p$  is the actual value of the index,  $m$  is the standard value of evaluation,  $q$  is index weight. Conditional restriction is  $\frac{p}{m}$  (or  $\frac{m}{p}$ )  $\leq 1$ .

The total score formula is:  $S = \sum S_i$ .

The result is calculated out, and we can judge the stage in according to the following standard:  $S \geq 85$ , define it for the best level at stage by corresponding standard value, we can carry on the appraisal at next stage;  $50 \leq S < 85$ , proves that is at the corresponding right stage of standard value;  $S < 50$ , shows that has not reached this stage level at present and should appraise by standard value of former stage.

## 2.4 Predicting method

While predicting the new-type industrialized evaluation index in the county, which kind of method is very suitable on definitely situation, depending on the stability degree of the time array to a great extent. The definition of steady and unstable is: probability distribution keeping the same when period changed, the time arrays is steady at that time Probability distribution changing frequently and greatly when period changed, the time array is unstable.

This research has used four kinds of prediction methods to appraise future process of county.

**The weighted moving average of the linear trend method:** It is suitable for the medium-sized steady time array. There is dependence in predicting the next value. The number of the data included in moving average has reflected the steady degree of the time array.

The corresponding formula is

$$F(t) = \frac{\sum_{i=t-m+1}^t x(i)}{m}$$

$$F'(t) = F'(t-1) + a[(m-1)x(t) + (m+1)x(t-m) - 2mF(t-1)]$$

$$f(t+h) = F(t) + F'(t) \left[ \frac{m-1}{2} + h \right]$$

Among them,  $a = \frac{6}{m(m^2-1)}$ ,  $m$  is the period number of moving average.

**Exponential smoothing with trend method:** This method uses the latest data in time array to estimate upwards or downward trend of future. It is suitable for the time array which has upwards or downward change trend of mean value of the probability distribution. The definition of the trend is: If present way keeps on, trend is an average change from a time array value to another time array value. The formula is

$$F(t) = \alpha x(t) + (1-\alpha)[F(t-1) + T(t-1)]$$

$$T(t) = \beta[F(t) - F(t-1)] + (1-\beta)T(t-1)$$

$$f(t+h) = F(t) + hT(t)$$

Among them,  $\alpha$  and  $\beta$  is smooth constant  $0 \leq \alpha \leq 1$ ,  $0 \leq \beta \leq 1$ ; usually  $F(0) = x(1)$ ,  $T(0) = 0$ .

Make two initial estimations to the state of the time array before beginning to predict. One is an initial estimation of the average of the time array when the environment is without variation tendency; the other is an initial estimation of the trend of the time array. The predicted value of the first period is the initial estimation of the average adding the initial estimation of the trend the second predicted value can be got from the formula of the above. Analogizing in proper order, we can obtain a series of predicted values directly. The calculation of this method is interrelated and usually finished by the computer.

**Time linear return predict method:** The formula is

$$\mu = \frac{\sum_{i=1}^n x(i)}{n}, \quad \theta = \sum_{i=1}^n ix(i), \quad \sigma^2 = \sum_{i=1}^n (x(i))^2$$

$$b = \frac{\theta - n\mu \frac{n+1}{2}}{\frac{\theta^2 - n(n+1)^2}{4}}, \quad a = \mu - b \frac{n+1}{2}$$

$$f(t+h) = a + bt$$

**Holt-Winters multiplication algorithm method:** The formula is

$$F(t) = \alpha x(t)/S(t-c) + (1-\alpha)[F(t-1) + T(t-1)]$$

$$T(t) = \beta[F(t) - F(t-1)] + (1-\beta)T(t-1)$$

$$\begin{aligned}
 S(t) &= \gamma x(t)/F(t) + (1 - \gamma)S(t - c) \\
 f(t + h) &= F(t) + hT(t) + S(t + h - c) \quad h = 1, 2, \dots, c \\
 f(t + h) &= F(t) + hT(t) + S(t + h - 2c) \quad h = c + 1, c + 2, \dots, 2c \\
 f(t + h) &= F(t) + hT(t) + S(t + h - 3c) \quad h = 2c + 1, 2c + 2, \dots, 3c \\
 &\vdots
 \end{aligned}$$

Among them  $c$  is Season length of circulation;  $\alpha, \beta, \gamma$  is smooth constant,  $0 \leq \alpha \leq 1, 0 \leq \beta \leq 1, 0 \leq \gamma \leq 1$ .  $\mu$  is the average of the first circulation,  $t = 1$  till  $c$ . The common initial establishment is:  $F(0) = \mu, T(0) = 0, S(t) = x(t)/\mu$  for  $t = 1$  till  $c$  come into existence.

### 2.5 Process appraising

We appraise the new-type industrialized historical process in a county of Sichuan Province with above-mentioned methods, and predict the index that has important influence to the local industrialization development.

**Table 2.** Form of the appraisal data in 2004 about the historical process

index	unit	weight	initial	data
per capita GDP	ten thousand yuan/person	10	1.5 ↓	0.62
agricultural GDP takes total GDP proportion	percentage	7	15 ↑	25.99
tertiary industry GDP takes total GDP proportion	percentage	5	30 ↓	25.27
agricultural employed population rate	percentage	6	20 ↑	76.93
urbanization rate	percentage	8	40 ↓	10.65
industry's profit rate of increase	percentage	4	15 ↓	62.61
urban residents per capita disposable income	ten thousand yuan	4	1.5 ↓	1.41
rural residents per capita net income	ten thousand yuan	4	0.5 ↓	0.26
labor productivity of the whole society	ten thousand yuan/person	7	8 ↓	8.01
energy consumption per ten thousand yuan GDP	ton	5	0.5 ↑	0.47
contribution rate of large-scale corporation	percentage	4	10 ↓	24.99
eligibility rate of waste water	percentage	5	90 ↓	85.83
forest coverage rate	percentage	5	30 ↓	35.50
investment for pollution rate of increase	percentage	4	15 ↓	15.24
information industry GDP takes total GDP proportion	percentage	5	7 ↓	6.32
contribution rate of technological progress	percentage	4	50 ↓	40
urban residents computer owning rate	percentage	3	60 ↓	3.29
education funds take GDP proportion	percentage	4	3 ↓	3.1
average year of receiving education	year	6	7 ↓	6.74

note:upward arrow representatives greater than the figure, downward arrow representatives smaller than the figure

#### 2.5.1 Historical process

Making reference to the national economic and social development plan and medium or long-term development goal of a county in Sichuan Province, at the same time, according to the lately ten years historical data in the statistical yearbook that the local government's statistics bureau offered, appraise to the new-type industrialized current situation of the development of this county with the above-mentioned new-type industrialized evaluation indexes system.

The data of new-type industrialized historical process are shown in the Tab. 2.

Calculate the current situation data of the industrial development with the above-mentioned appraisal formula, bringing into the standard value of initial stage of new-type industrialization, and receive  $S_i = 63$ . The result proved the county at the new-type industrialized initial stage in 2004.

### 2.5.2 Future process

To make the scientific prospect with development trend to the future of new-type industrialized road of the county, by predicting each index in the system we can find blocking factor and promoting factor on the development path, and offer better reference to the formulation and adjustment of the regional industry's development policies. We use several kinds of prediction methods as above-stated in WinQSB operations research software to carry on the prediction to the data of new-type industrialized process evaluation index in the following 15 years.

Trend picture predicted in Future process development of some important indexes is shown in Fig. 1 to Fig. 8.

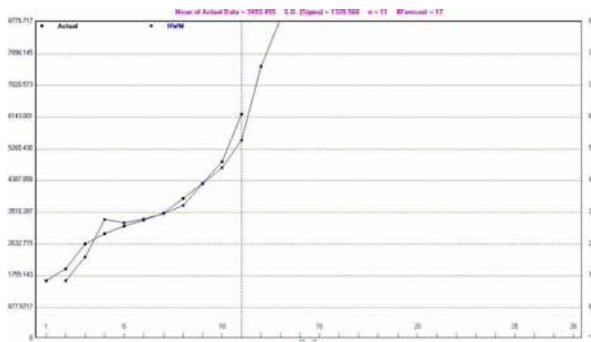


Fig. 1. per capita GDP

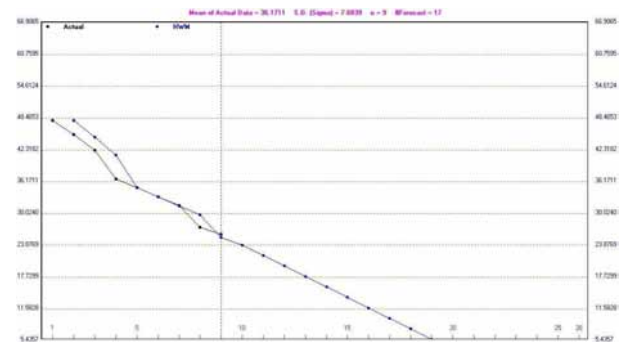


Fig. 2. agricultural GDP takes total GDP proportion

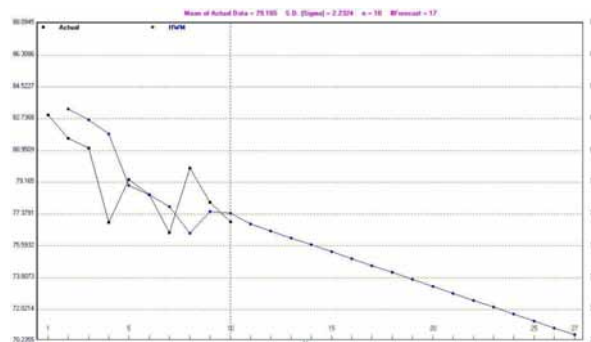


Fig. 3. agricultural employed population rate

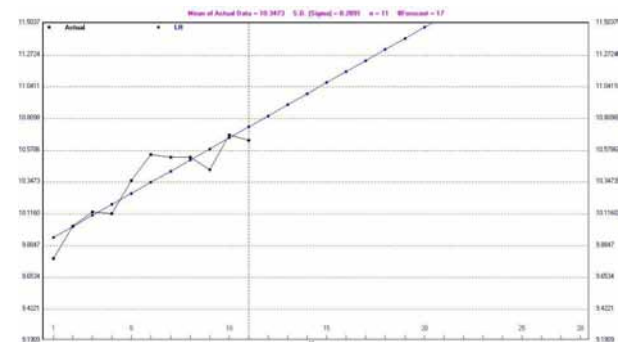


Fig. 4. urbanization rate

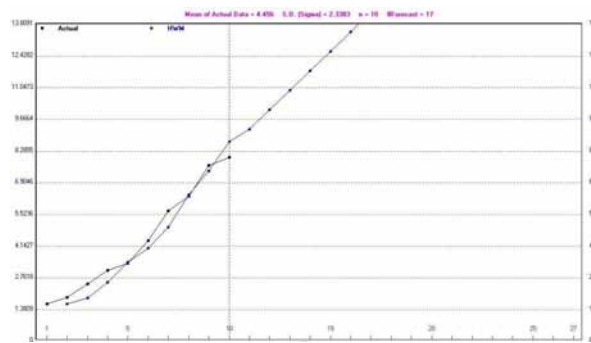


Fig. 5. labor productivity of the whole society

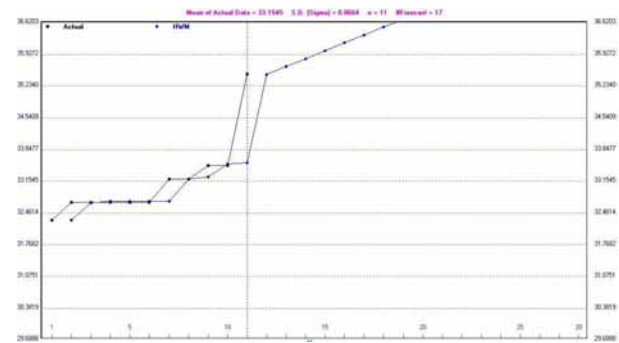


Fig. 6. forest coverage rate

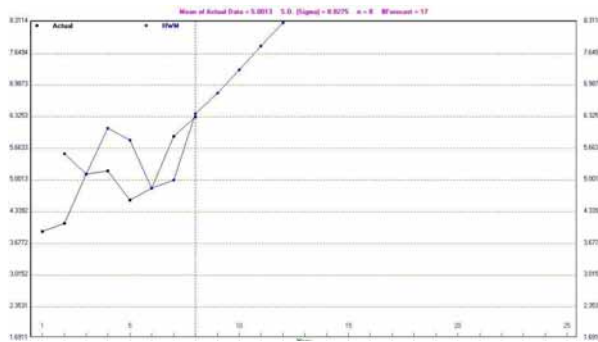


Fig. 7. information industry GDP rate

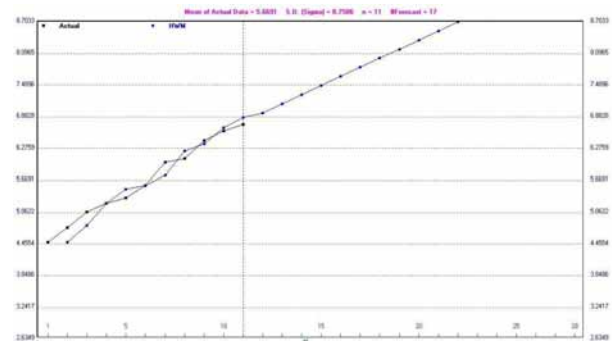


Fig. 8. average year of receiving education

## 2.6 Conclusion

In this paper, we set up the new-type industrialized process evaluation index system which is feasible for a county of Sichuan Province. In index system, we depend on 4 aspects to establish standard value and adopt integrative weight method to calculate weight of each index. In real example, we use appraise formula to evaluate a county's new-type industrialized history process according to local historical statistical data, and predict development trend to the future of each index rely on WinQSB operations research software.

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