

## **The relationship between population and industrial structure on economic development based on exponential smoothing method**

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**Abstract:** In recent years, China's economy has been in a state of medium-high speed growth, and great changes have taken place in the population and industrial structure. The influence of population and the industrial organization on the economy has always been an important basis for the country to make economic policies. Therefore, it is of great practical significance to study the relationship between population and industrial structure for economic development. Firstly, this paper using SPSS to conduct a linear regression analysis on the collected data. The results show that the natural growth rate, population quantity and the GDP of the secondary industry have a strong correlation with economic progress. Secondly, the natural growth rate, the population and GDP of the secondary industry are predicted by the exponential smoothing method and then analyze to put forward reasonable suggestions for the future economic development.

### **1. Introduction**

#### **1.1 Research Background**

Economic construction is the basis for China to gradually become a strong country. It is a direct result of the quality of life of the people and is a necessary condition for people to carry out daily life. It also provides monetary support for the country's development and construction in all aspects, and is a strong guarantee for the country to secure its international status. Now that the global economy is in a downturn and economic growth is at a low ebb. It is important to think about how to maintain rapid economic development in the future and put China at the forefront of international development. The population and industrial structure have a direct impact on economic development. It is reasonable and effective to analyze the future economic development of these two aspects and put forward Suggestions.

In 2018, there will be changes in the global economic market. The primary and secondary markets will be suspended upside down. The demographic dividend will disappear substantially, and the labor cost will rise. The public will lose confidence in the monetary market. Taking economic development as the research point, this paper chooses two aspects of population and industrial structure for specific analysis, and puts forward measures and Suggestions for this, which is helpful for the adjustment of economic and market policies, the establishment of public confidence, and the realization of steady economic growth in the future.

#### **1.2 Research Status**

The GDP of the three major industries is a component of GDP. The increase of the GDP of each industry will directly promote the development of the national economy. The gross product is closely linked to the human capital brought by the labor force. The more the social labor supply is, the greater the social value will be created. In economic development, the change of population and industrial structure will bring about the change of economic effect.

Scholars at home and abroad have made in-depth analysis of the relationship between population factors and economic development. In 2018, H. Zhou in the population structure change of China's economic growth impact study, based on the perspective of population quantity and population

quality, put forward not only in the present stage of the demographic dividend and the aging of the population on the basis of exploring the impact of population change on economic growth, but also explore the latter demographic dividend from human capital's impact on economic growth. In her research on the impact of population aging on China's economic growth, X. Wu also combined population aging and human capital together into the slow economic growth model to analyze the economic effects of population aging. Get reasonable utilization old age population, increase collective labor supply to be able to bring stimulative effect to economic development. With the increasingly serious aging problem, China's low fertility rate has become a major problem<sup>[2]</sup>.

At present, most foreign researches focus on whether China should further relax the birth policy and increase the population by increasing the birth rate, so as to promote economic progress. Belgium's evening news believes that China's decision to allow a second child at the start of the 13th five-year plan will promote comprehensive and balanced development in all sectors of society. The recent fertility policy confronts the reality of a rapidly aging population, especially a low birth rate. Archom Lukin, deputy dean of the school of regional and international studies at the federal university of the Russian far east, said that population aging will lead to the weakening of the country's economic and geopolitical status, and raising the fertility rate will largely alleviate the aging trend. At present, China's economic development has not been directly analyzed from the perspective of data, and the population and industrial structure have not been included in the research scope.

This article will analyze from this Angle and discuss the relationship among the three. The influence of population size and industrial structure on economic development can be studied by analyzing the correlation between population size, industrial structure and economic development. Therefore, this paper adopts the linear regression analysis and time series method to find the factors with high correlation through the multiple linear regression analysis of SPSS, and then USES the exponential smoothing method to predict these factors, and finally obtains the influence of each factor on the future economic development.

### 1.3 Innovation in this paper

- Introduce mathematical linear regression to determine the influencing factors in the impact of population and industrial structure on economic progress, and intuitively reflect the aspects that can be improved through data.
- In the analysis of future economic development, the exponential smoothing method is adopted to predict with the help of existing data, and the exact GDP forecast value is obtained, which is more intuitive to reflect the trend of economic progress.

## 2. Method

### 2.1 Linear regression analyses

Linear regression analysis is to look for a linear function between the dependent variable and (one or more) independent variables based on a set of data from a number of related variables, so that the function fits well with that set of data.

Multiple linear regression

The regression equation is:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_n x_n + \varepsilon$$

Type in the  $\beta_0, \beta_1 \dots \beta_n$  are all with  $x_1, x_2 \dots x_n$

Extraneous unknown parameters, where  $\beta_0, \beta_1 \dots \beta_n$  this is called the regression coefficient.

### 2.2 Exponential Smoothing Method

Exponential smoothing method is a kind of time series analysis and prediction method developed on the basis of moving average method. It can predict the future of the phenomenon by calculating the exponential smoothing value and combining a certain time series prediction model. The principle

is that the exponential smoothing values in anyone period are the weighted average of the observed values in the current period and the exponential smoothing values in the previous period. It is compatible with the advantages of the whole-period average and the moving average, and does not discard the past data. However, it gives the gradually decreasing influence degree, that is, with the data moving away, it gives the weight that gradually converges to zero.

(1) Primary exponential smoothing method

Let's call the time series  $y_1, y_2, \dots, y_t$ ,  $\alpha$  Where, is the weighting coefficient,  $0 < \alpha < 1$ , and the formula of the first exponential smoothing is:

$$y_{t+1} = \alpha * y_t + (1-\alpha) * y_t$$

$y_{t+1}$ -- the predicted value of t+1 period, that is, the smoothing value  $S_t$  of the current period (t period);

$y_t$ -- the actual value of t period;

$y_t$ -- the predicted value of t period, namely the smoothing value  $S$  of the previous period<sup>t-1</sup>.

In other words, the exponential smoothing value at the t stage was used as the predicted value at the 1 +t stage.

(2) Quadratic exponential smoothing method

When there is a linear trend in the change of time series, there is still a significant lag deviation in the prediction by using the exponential smoothing method. Therefore, it must also be amended. The correction method is the same as the trend moving average method, that is, quadratic exponential smoothing is made again, and the linear trend model is established by using the law of lag deviation. That's quadratic exponential smoothing. The calculation formula is as follows:

$$S_t^{(1)} = \alpha y_t + (1 - \alpha) S_{t-1}^{(1)}$$

$$S_t^{(2)} = \alpha S_t^{(1)} + (1 - \alpha) S_{t-1}^{(2)}$$

Type in the  $S_t^{(1)}$  Is the smoothing value of the first exponential;  $S_t^{(2)}$  Is smoothing value of the quadratic exponent.

(3) Cubic exponential smoothing method

When the change of the time series shows a conic trend, the cubic exponential smoothing method is needed.

The calculation formula is as follows:

$$S_t^{(1)} = \alpha y_t + (1 - \alpha) S_{t-1}^{(1)}$$

$$S_t^{(2)} = \alpha S_t^{(1)} + (1 - \alpha) S_{t-1}^{(2)}$$

$$S_t^{(3)} = \alpha S_t^{(2)} + (1 - \alpha) S_{t-1}^{(3)}$$

Type in the  $S_t^{(3)}$  Is the exponential smoothing cubic value.

### 3. Model

#### 3.1 Introduction of related concepts

(1) GDP: A measure of economic development is gross domestic product (GDP), which refers to the total value of all final products and services produced in a country (or region) within a certain range within a certain period. GDP reflects the overall economic performance of a country.

The statistical range of GDP data is from 1978 to 2018.

(2) Population: Population quantity refers to the prescriptive nature of population quantity. It is the quantity that indicates the existence and degree of change of population.

The demographic data range from 1978 to 2018.

(3) Industrial structure: Industrial structure refers to the proportion of agriculture, industry and

service industry in a country's economic structure. GDP of each part directly shows the impact of different industries on GDP, and the adjustment of industrial structure will largely affect the national economic trend. The theory of industrial structure explains the relationship between industrial structure and economic development more closely: the high transformation rate of industrial structure will lead to the high growth rate of economic aggregate, and the growth rate of economic aggregate will lead to the high transformation rate of industrial structure.

Statistics on the gross domestic product of the primary industry, the gross domestic product of the secondary industry and the gross domestic product of the tertiary industry in the industrial structure range from 1978 to 2018.

### 3.2 Model assumptions

- It is assumed that the influence of other policy factors on industrial structure will not be considered during the forecast period
- Assume that all death factors have the same impact on the population, and all are natural deaths
- It is assumed that no population flow and migration will occur during the forecast period
- It is assumed that during the forecast period, there will be no major natural disasters affecting the population

### 3.3 Symbol descriptions

y : gross domestic product

$x_1$ : natural growth rate

$x_2$ : population

$x_3$ : GDP of the secondary industry

### 3.4 Model calculations and analysis.

(1) Influence of population and industrial structure on economic development

In terms of population, it is not only the performance of the total number of people, but also the birth rate, death rate and natural growth rate. For the industrial structure, the gross domestic product of the primary industry, the gross domestic product of the secondary industry and the gross domestic product of the tertiary industry are all components of GDP. Therefore, this paper searched and summarized the data in these aspects.

(2) Data preprocessing

If there is missing data, SPSS is adopted to fill the data

(3) Establish multiple linear regression equation

The GDP is set as the dependent variable, and the population, birth rate, death rate, natural growth rate and the respective GDP of the three industries are set as independent variables. The formula is as follows:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_n x_n + \varepsilon$$

SPSS was used for regression analysis, as shown in Table 1, Table 2.

Table 1: Variable selection

Variable entered/removed			
Model	Variable entered	Variable removed	Methods
1	Natural growth rate	.	Step by step (rule: the probability of f-to-enter $\leq .050$ , the probability of f-to-remove $\geq .100$ ).
2	population	.	Step by step (rule: the probability of f-to-enter $\leq .050$ , the probability of f-to-remove $\geq .100$ ).
3	SMEAN(secondary industry)	.	Step by step (rule: the probability of f-to-enter $\leq .050$ , the probability of f-to-remove $\geq .100$ ).

Table 2: Variable correlation

model		Nonnormalized coefficient	Standardized coefficient		T	significant	Collinear statistics	
		B	The standard error	Beta			tolerance	<sup>2</sup> VIF is based
1	(constant)	659509.07	188.		35.163	000.		
	Natural growth rate	- 38667.	018.	- 960.	21.219	000.	1.000	1.000
2	(constant)	566003.34	1.205		- 719.	477.		
	Natural growth rate	- 23763.	027.	- 589.	8.717	000.	225.	4.453
	population	. 005-4 e	000.	421.	6.232	000.	225.	4.453
3	(constant)	443046.57	1.061		- 587.	561.		
	Natural growth rate	- 10974.	025.	- 519.	8.276	000.	201.	4.971
	population	3.922 e-4	000.	372.	6.093	000.	212.	4.709
	SMEAN(secondary industry)	2.827	000.	151.	3.451	001.	414.	2.413

Through the establishment of the model, it can be seen that among the numerous factors selected, the natural growth rate, the number of population and the gross domestic product of the secondary industry have the largest impact on economic development, thus obtaining the linear regression equation:

$$y = -443046.57 - 10974x_1 + (0.00039)x_2 + 2.827x_3$$

#### (4) Predictive analysis

In the problem study, SPSS regression analysis shows that the natural growth rate, population quantity and the GDP of the secondary industry should be considered in order to predict the GDP in the next few years.

In this paper, the exponential smoothing method is used to predict the three and the GDP from 2015 to 2023 respectively, as shown in Figure Table 3.

Table 3: Predicted value

year	Secondary industry (100 million yuan)	Population (person)	GDP (billion yuan)	Natural growth rate (%)
2015	336038.00	1372742307.00	676463	4.76
2016	229415.00	1379825657.00	755873.4375	5.56
2017	238109.00	1390080000.00	771438.3376	5.39
2018	268880.97	1402260794.23	832069.9460	5.37
2019	278493.40	1415900784.92	882701.5544	5.40
2020	288105.83	1420351093.14	913080.5194	5.42
2021	297718.27	1429086583.24	968268.9726	5.45
2022	307330.70	1437822073.16	1023457.426	5.47
2023	316943.13	1446557563.24	1078645.879	5.49

Through the comparison between the existing data from 2015 to 2018 and the predicted data, it is found that the results are basically consistent, and it can be thought that the exponential smoothing method is feasible for the prediction.

Finally, the results are drawn as shown in Figure Fig.1.

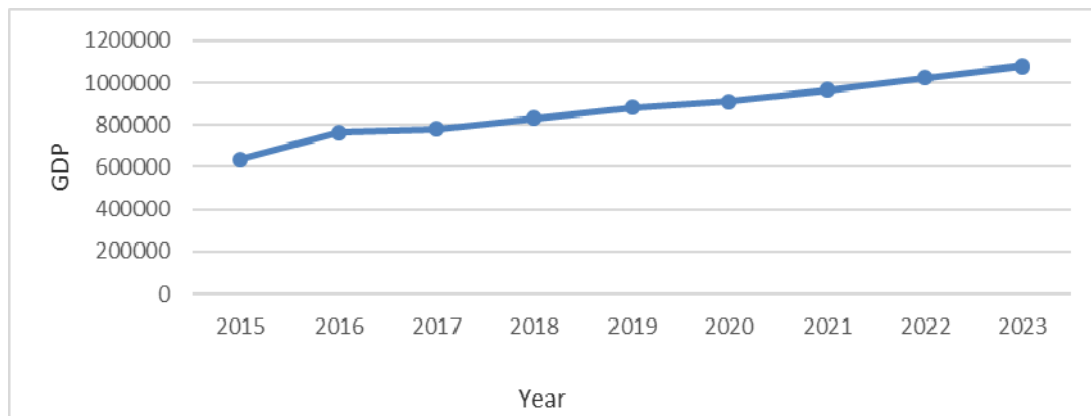


Fig.1: GDP in the coming years

#### 4. Conclusions

Through the establishment and solution of the prediction model, the natural growth rate, population quantity, GDP of the second industry and GDP of the next five years are calculated. It can be seen that under the influence of three factors, the GDP will still increase steadily in the next five years. From this point of view, in the next five years, the country's economic development is still good. In view of the economic downturn in 2018, the national economic regulation and control should be well handled in terms of economic development.

In the model, the natural growth rate, population quantity and the GDP of the secondary industry have great impact on economic development. In the future policies, from the perspective of population, appropriate population policies should be formulated to provide guarantee for the "second child", further improve the education and medical system, increase the construction of social public resources, make preparations for relevant services and directly increase the population.

From the perspective of industrial structure, the adjustment of industrial internal structure and the increase of investment in product research and development make the secondary industry still become the pillar force of the country's current industrial development. Second, stabilize agricultural growth, consolidate the basic position of the primary industry, and third, promote the development of the tertiary industry as the focus of future economic development. In the process of optimizing the industrial structure, the primary and tertiary industries should be gradually improved, the secondary industry should continue to maintain its advantages, and the three major industries should jointly promote economic development.

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