Research on the influencing factors of GDP in Guangdong Province based on grey relational analysis

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Abstract: *As the most economically developed region in China, Guangdong Province has important guiding significance for the study of the influencing factors of Guangdong Province's economic development. This paper uses the grey correlation method to study the GDP data of Guangdong Province from 2010 to 2020, and conducts an empirical analysis on the relationship between it and the index system composed of indicators such as environment, investment and education. The research shows that the total social fixed asset investment in the indicator system has the highest correlation with the GDP of Guangdong Province, but the correlations corresponding to different indicators are different. According to its conclusion, this paper puts forward corresponding policy suggestions to provide theoretical support and thinking perspective for the economic development of Guangdong Province.*

Keywords: *Grey relation, Guangdong Province, GDP*

1. Introduction

GDP comprehensively reflects a country's economic development and the ups and downs of the macro economy. It is one of the most important indicators to measure the economic development of a region. In 2020, the new crown epidemic is raging around the world, which has caused great pressure on the global economy. However, in this invisible gunpowder, China's prevention and control measures are strict and effective, all provinces have made full efforts, and the economy has gradually recovered to lead the world. China has also become a global leader. The only country in the world's major economies to achieve positive growth. Economic growth is the year-on-year growth rate of GDP, which is of great significance to the study of GDP. Since 1978, Guangdong, riding the east wind of reform and opening up, has ushered in rapid development. The total GDP has increased by multiples. It has transformed from a backward border province to a world-class manufacturing base. Its development model can be regarded as a typical example of China's economic development.

Guangdong is backed by the vast hinterland of the motherland and faces Southeast Asia. It is located at the hub of the Pacific Ocean, Indian Ocean, and Atlantic Ocean shipping. It is close to Hong Kong and Macao. It has natural connections with the rest of the world, especially with Europe and the United States. There are convenient transportation conditions for trade exchanges in various places; in terms of technological innovation, Guangdong has formed pillar industries based on information technology, advanced manufacturing, automobile manufacturing, smart home appliances, advanced materials, and biomedicine; located in the East Asian monsoon region, it is It is the place with the most abundant solar thermal resources and water resources in the whole of China. At the same time, Guangdong has a profound history and culture, and its education and scientific and technological development are among the best in the country and the world. Major universities have trained and delivered a large number of talents for the country's development, and also attracted people from all over the country to come to Guangdong to seek development opportunities. Guangdong's economic aggregate is in a leading position in the country, and its GDP has ranked first for many years, which plays a huge role in China's economic growth. Therefore, it is of great significance to study Guangdong's GDP growth.

China has achieved remarkable results in coordinating epidemic prevention and control and social and economic development. Compared with most countries in the world, the economic development is more optimistic. However, with the repeated epidemics, the global economy is unknown, and the development of China's economy will also be affected by changes in the global economy. Guangdong

has a relatively large GDP in China, so we should study the factors that affect Guangdong's GDP. This paper uses the grey correlation method to analyze from a diversified perspective, and explores the total investment in industrial pollution control, education expenditure, total import and export, general public budget expenditure, medical and health institutions, original insurance premium income, urban per capita disposable income, urban per capita consumption expenditure , the relationship between the electricity consumption of the whole society, the investment in fixed assets of the whole society and the total GDP of Guangdong Province. Compared with the previous research results, the data studied in this paper are more extensive and the influencing factors considered are more comprehensive. The purpose is to discover the internal correlation of the influencing factors of GDP in Guangdong Province and promote the economic growth of Guangdong.

2. Literature review

In recent years, many scholars have been continuously researching and analyzing the influencing factors of Guangdong Province's economy. Chen Youyu used the grey relational analysis method to conduct research from different aspects. The structural analysis shows that the industrial structure has a greater impact on China's economy, and the impact of urban and rural structure is not prominent. China's economic growth mode is in a transition period from extensive to intensive. The analysis of income level shows that the improvement of consumption capacity has made a great contribution to China's economic growth, and it is necessary to constantly change the consumption concept of residents. Wang Shuyao studied the data on changes in the age structure of the population in the past 40 years from 1978 to 2017, and found that the population dependency ratio was negatively correlated with economic growth, and the proportion of the working-age population was positively correlated with economic growth. Zhou Xiaodan used the grey correlation analysis method to quantitatively analyze the correlation between China's primary, secondary and tertiary industries and the overall economic growth from 2007 to 2012, and found that the secondary and tertiary industries surpassed the primary industry to become the decisive factor for China's economic growth.

Liang Liping's analysis by grey correlation method shows that rural financial development plays a positive role in promoting rural economic growth, but the correlation between rural financial development scale indicators and rural growth is weak. Qi Shuyu et al. conducted an empirical analysis by establishing a grey system correlation analysis model between education development and economic growth, indicating that strengthening the continuing education and training of Chinese labor force is the main way to promote economic growth, strengthening secondary education and vocational education, and accelerating the knowledge update of laborers. It is an important measure to promote economic growth.

At the economic level of Guangdong, the following scholars have conducted empirical analysis on its influencing factors. Liao Huiling used inductive and deductive methods to examine the impact of changes in the proportion of the working-age population and the composition of the internal working-age population on the economic growth of Guangdong Province, and found that the changes in the age structure of the population in Guangdong Province were mainly promoted through the increase of total factor productivity and the increase of human capital. Economic Growth. Wang Wei analyzed the main source of regional economic development differences in Guangdong Province through the single index method is the difference between the Pearl River Delta and the east, west and north of Guangdong, and then through the construction of a comprehensive index system of regional economic development, analyzed the main reasons for the differences in economic development in Guangdong Province. Differences in science and technology and basic public services Finally, based on the results of spatial panel regression, it is found that the influencing factors of regional economic development differences in Guangdong Province are urbanization level, industrial structure, transportation infrastructure, government intervention and capital factors. By building an ADL-ECM model, Yi Ying et al. showed that there is a long-term equilibrium cointegration relationship between fiscal revenue and GDP in Guangdong Province, and there is a strong positive correlation. Ju Zhanjie et al. obtained the grey correlation coefficient through various sets of data and formulas, proving that the traditional fishery, which mainly relies on fishery production and fishing, and the increase of fishermen's investment, has gradually transformed into a new type of fishery, and the application of science and technology in the proportion of fishery output value continues. rising.

To sum up, there are many scholars who have done many and wide-ranging studies on economic influencing factors, and their research results have been shown through model analysis and theoretical analysis, which are of great significance. By reading the literature of scholars, we found the following

three deficiencies. First, the influencing factors studied by scholars are few and not comprehensive enough, because the economic development of a region is complex, and at the same time, many aspects are interrelated and inseparable. Second, the selection of indicators is not reasonably classified and the number of indicators selected is small, so it is difficult to form a comprehensive indicator system. Third, scholars have analyzed factors such as population age structure, industrial structure, fiscal revenue, and technological investment, ignoring factors such as environment and trade. Therefore, on the basis of the original literature, this paper selects indicators from multiple perspectives to construct an indicator system, conducts an in-depth study of the correlation between Guangdong's economy and each indicator system through the grey correlation method, and analyzes the results according to the results, and puts forward reasonable suggestions.

3. Data selection

In this paper, the total GDP of Guangdong Province from 2010 to 2020 is selected as the indicator reflecting the economic development of Guangdong Province, the total investment in industrial pollution control is selected as the indicator of the environmental situation in Guangdong Province, the total education expenditure is selected as the indicator of the education situation in Guangdong Province, and the total import and export volume is selected. As an indicator of Guangdong's foreign trade situation, the general public budget expenditure is selected as an indicator of Guangdong's financial situation, the number of medical and health institutions is selected as an indicator of Guangdong's health situation, and the original insurance premium income is selected as an indicator of Guangdong's financial industry. The urban per capita disposable income and urban per capita consumption expenditure are the most important indicators of the living conditions of the people in Guangdong Province. The above nine influencing factors constitute the index system, as shown in Table 1. The following data are all from China Statistical Yearbook and Guangdong Statistical Yearbook. The total investment in industrial pollution control reflects Guangdong's support for environmental protection; the total education expenditure reflects the emphasis on talent training; the total import and export reflects the The total scale of local foreign trade; the general public budget expenditure reflects the financial strength of the local government; the number of medical and health institutions reflects whether people's health is guaranteed; the original insurance premium income reflects the development prospects of the financial industry; urban per capita Disposable income and urban per capita consumption expenditure reflect the differences in residents' income levels; the electricity consumption of the whole society reflects the level of regional economic development; the investment in fixed assets of the whole society reflects the development of Guangdong's industrial structure.

Table 1: Indicator system of Guangdong Province

target layer	feature layer	Indicator layer
	surroundings	Total investment in industrial pollution control (million yuan)
	educate	Education expenditure (100 million yuan)
	foreign trade	Total import and export (100 million yuan)
	financial	General public budget expenditure (100 million yuan)
Guangdong Province Economy	health	Number of medical and health institutions (number)
	financial industry	Original insurance premium income (100 million yuan)
	Citizens' lives	Urban per capita disposable income (yuan)
		Urban per capita consumption expenditure (yuan)
	energy	Electricity consumption of the whole society (100 million kilowatt hours)
	invest	Fixed asset investment of the whole society (100 million yuan)

As shown in Figure 1, from 2010 to 2022, the index values of Guangdong Province showed an overall upward trend. Among them, the total GDP of Guangdong Province has increased steadily year by year, indicating that the economy of Guangdong Province has been in a state of growth. The increase in the total investment in industrial pollution control indicates that Guangdong Province's awareness of environmental protection has increased, and the government has strengthened its efforts in environmental protection. The increase in education funding year by year shows that Guangdong Province attaches great importance to talent training and builds strength for scientific and technological innovation and development. The total value of imports and exports rose steadily from 2010 to 2013, but surged from 2014 to 2020, indicating that international trade has continuously powered Guangdong's economic growth. The general public budget spending has increased year by year, indicating that government spending has increased as the economy has grown. The increase of medical and health institutions shows that the medical conditions in Guangdong Province are getting better and better, and the sanitary conditions are also continuously improved. The premium income of the original insurance has increased

year by year, indicating that the financial industry in Guangdong Province is developing continuously. The urban per capita disposable income and per capita consumption expenditure have continued to increase, indicating that the quality of life of the people in Guangdong Province has continued to improve. The power consumption of the whole society has been increasing year by year, which indicates that the economic and industrial structure of Guangdong Province has been improved, and the energy utilization rate has also been continuously improved. The investment in fixed assets of the whole society has been increasing year by year, indicating that the scale of investment by enterprises and governments is increasing.
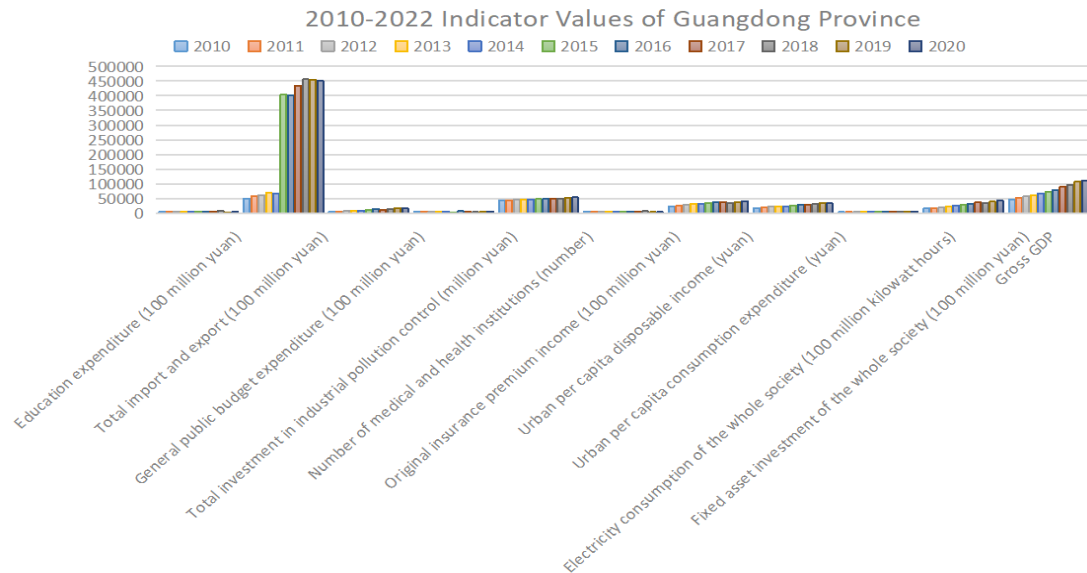

Figure 1: Indicator System of Guangdong Province

4. Model selection

This paper studies the correlation between Guangdong's economy and the index system composed of factors such as urban environment, educational investment, and foreign trade through the grey correlation analysis method. Grey relational analysis refers to a method of quantitative description and comparison of the development and change of a system. degree of correlation between. In the process of system development, if the trends of the two factors are consistent, that is, the degree of synchronous change is high, the degree of correlation between the two is high; otherwise, it is low. Therefore, the grey relational analysis method is based on the degree of similarity or dissimilarity of the development trends among the factors, that is, the "grey relational degree", as a method to measure the degree of correlation between the factors.

The steps of grey relational analysis are as follows:

(1) Determine the analysis sequence: determine the reference sequence that reflects the characteristics of the system behavior and the comparison sequence that affects the behavior of the system. Let the reference sequence (also known as the mother sequence) $Y = \{Y(k) \mid k = 1, 2, \Lambda, n\}$; the comparison sequence (also known as the subsequence) $Xi = \{Xi(k) \mid k = 1, 2, \Lambda, n\}, i = 1, 2, \Lambda, m \cdot$

(2) Normalize the value: ①Initialization: As the name implies, the data of this sequence is divided uniformly by the initial value. Since the magnitude of the sequence of the same factor is not very different, it can be divided by the initial value. These values are sorted around the order of magnitude 1.

Formula: $x\_i(k)' = x\_i(k) / x\_i(1) \ i = 1,...,m, \ k = 1,...,n$

②Meanization: As the name implies, it is to divide the data of this series by the mean value. Since the mean value of the sequence with a large order of magnitude is relatively large, it can be normalized to the order of 1 after removal.

Formula: $x\_i(k)' = x\_i(k) / (mean(x\_i))$

(3) Calculate the correlation coefficient:

$$\xi_i(k) = \frac{\min\limits_s \min\limits_t |x_0(t) - x_s(t)| + \rho \max\limits_s \max\limits_t |x_0(t) - x_s(t)|}{|x_0(k) - x_i(k)| + \rho \max\limits_s \max\limits_t |x_0(t) - x_s(k)|}$$

(4) Calculate the correlation degree: Because the correlation coefficient is the correlation degree value between the comparison sequence and the reference sequence at each moment (that is, each point in the curve), it has more than one number, and the information is too scattered to facilitate the overall comparison. Therefore, it is necessary to concentrate the correlation coefficients of each moment (ie, each point in the curve) into one value, that is, to obtain the average value, as a quantitative representation of the degree of correlation between the comparison sequence and the reference sequence.

$$r_i = \frac{1}{n} \sum_{k=1}^{n} \xi_i(k), k = 1, 2, \wedge, n$$

(5) Sorting by degree of association: The degree of association is sorted by size, if $r1 < r2$, The reference sequence y is more similar to the comparison sequence $x2$. After calculating the correlation coefficient between series $x_i(k)$ and series $Y(k)$, calculate the average value of various correlation coefficients, and the average value r_i is called the correlation degree between $Y(k)$ and $x_i(k)$.

5. Empirical Analysis

This paper selects the total GDP of Guangdong Province from 2010 to 2020 as the dependent variable X0, selects nine indicators in the same period as the independent variables X1-X10, uses SPSS logarithm to calculate the grey correlation degree and sorts the correlation degree according to the results. The relationship between Guangdong Province's economy and 10 indicators such as urban environment, educational investment, and foreign trade, the greater the correlation, the closer the relationship between variables.

Table 2: Calculation results of grey correlation degree

independent variable	Correlation	ranking
Total investment in industrial pollution control	0.664	8
Education expenditure	0.751	4
Total import and export	0.416	10
General public budget expenditure	0.738	5
Number of medical and health institutions	0.649	9
Original insurance premium income	0.690	7
Urban per capita disposable income	0.720	6
Urban per capita consumption expenditure	0.822	2
Electricity consumption of the whole society	0.781	3
Fixed asset investment of the whole society	0.856	1

The calculation results are shown in Table 2. According to the calculation results, the correlation between the calculated 9 indicators and the economy of Guangdong Province exceeds 60%, indicating that these 9 indicators are closely related to the economy of Guangdong Province. The factors affecting the total GDP of Guangdong Province are ranked according to the degree of correlation: fixed asset investment in the whole society > per capita consumption expenditure in urban areas > electricity consumption in the whole society > education expenditure > general public budget expenditure > urban per capita disposable income > original insurance Premium income > total investment in industrial pollution control > medical and health institutions > total import and export.

The investment in fixed assets of the whole society is an indicator reflecting the investment situation of Guangdong Province, and its correlation is the highest among the 10 indicators, indicating that the economic growth of Guangdong Province is related to the investment situation and investment scale of enterprises and governments. In recent years, Guangdong has shown three different development models. The more economically developed areas such as Guangzhou and Shenzhen have a higher proportion of real estate investment, and a lower proportion of manufacturing investment, resulting in a decrease in employment opportunities and an increase in living expenses, resulting in an increase in labor costs. Foshan, Dongguan and other regions have a relatively high proportion of manufacturing investment, and

employment opportunities have increased. The investment in urbanization infrastructure construction in other regions accounts for a relatively high proportion, but the promotion effect on the commission of production capacity is low, and the dependence of economic growth on investment in fixed assets will become higher.

Secondly, the correlation between urban per capita consumption and urban per capita disposable income is relatively high, indicating that people's life and economic development are closely related. With the rapid development of the economy, people pay more and more attention to the quality of life, but the development of the economy also brings pressure, employment pressure and consumption pressure, the reduction of employment opportunities and the increase of prices all affect the pursuit of high life by human beings. Quality, in view of the inseparability of people's life and economic development, we can pay more attention to people's livelihood and improve the quality of life. The power consumption of the whole society is ranked third. The growth of energy consumption can reflect the trend of economic growth and directly reflect the changes in production scale and output value. The fourth ranking of educational relevance is that education affects the quality and accumulation of human capital, which in turn affects economic development, indicating that education promotes economic development in Guangdong Province. The general public budget expenditure correlation ranks fifth. The fiscal expenditure of Guangdong Province has a very obvious amplifying effect on economic growth, but its regional characteristics are very obvious. Smaller, Guangdong Province should improve the fairness of fiscal expenditures, moderately favor mountainous areas, and ensure sustainable and healthy economic development. The original insurance premium income, total investment in industrial pollution control, medical and health institutions, and total imports and exports have a weak correlation with the GDP of Guangdong Province. This is because the economic growth of other regions in Guangdong Province, except the Pearl River Delta, is relatively slow, and the economic development is relatively unbalanced.

6. Conclusion

This paper uses nine factors of environment, education, foreign trade, finance, health, financial industry, people's life, energy, and investment to form an index system, and then uses the grey relational analysis method to analyze the total investment in industrial pollution control, education expenditure, total import and export, General public budget expenditure, medical and health institutions, original insurance premium income, urban per capita disposable income, urban per capita consumption expenditure, the whole society's electricity consumption, the whole society's investment in fixed assets, the impact of 10 indicators on the GDP of Guangdong Province was analyzed. It is found that each index has different degrees of differences in the economic growth of Guangdong Province. Research shows that the economic growth of Guangdong Province is mainly driven by capital investment and energy consumption. In particular, the fixed asset investment of the whole society has the greatest correlation with the GDP of Guangdong Province. On the other hand, it also shows that the development of various regions in Guangdong Province is uneven, the economic growth of the Pearl River Delta region and cities is less dependent on the investment in fixed assets of the whole society, and the economic growth of other regions is less dependent on the investment in fixed assets of the whole society. The amount of dependence is strong. Secondly, energy consumption is also concentrated in cities in the Pearl River Delta region, and the growth rate of energy consumption in the east and west wings has declined. The economic development of Guangdong Province not only depends on the development of cities in the Pearl River Delta, but also drives the industrial development in backward areas, thereby reducing the differences in regional economic development.

7. Suggestion

Based on the empirical results, the development trend of Guangdong Province and relevant government policies, the following three suggestions are put forward.

First, moderately increase the investment in fixed assets of the whole society and maintain a certain growth rate of fixed investment. According to the analysis of the grey correlation analysis method, the total social fixed asset investment has the greatest correlation with the GDP of Guangdong Province, which can drive the economic development of Guangdong Province; second, adhere to market norms and structural improvement. Make full use of the capital market, expand investment channels, reasonably control the proportion of the three major industries, and optimize the structure of fixed asset investment. The Pearl River Delta region mainly develops capital-intensive industries and technology-intensive industries, northern Guangdong mainly develops agriculture, eastern Guangdong mainly develops light

industry, and western Guangdong mainly develops service industries. Third, improve energy consumption structure and improve energy utilization efficiency. Guangdong Province is a large energy consumption province, and at the same time, energy is relatively scarce and needs to be supplied from other provinces. Therefore, it is necessary to improve energy technology and equipment, improve energy utilization, and develop green energy and high-quality energy.

References

[1] Chen Youyu. The application of the improved grey model in the prediction of rural per capita net income in my country [J]. Journal of Hubei Institute of Economics (Humanities and Social Sciences Edition), 2012, 9(03): 49-50.

[2] Ju Zhanjie, Long Teng. Research on the influencing factors of fishery economic development in Guangdong Province ①——Based on grey relational analysis [J]. China Fishery Economy, 2019, 37(05): 47-54.

[3] Liang Liping. The Grey Correlation Analysis of Rural Finance and Rural Economic Growth [J]. Financial Development Research, 2013, (09): 78-81.

[4] Liao Huiling. Research on the Influence of Population Age Structure on Economic Growth in Guangdong Province [D]. Wuhan University, 2018.

[5] Qi Shuyu, Ji Xiaohun. Grey Correlation Analysis of Educational Development and Economic Growth [J]. China Management Information, 2013, 16(10): 103-106.

[6] Wang Shuyao. An Empirical Analysis of the Impact of Population Age Structure Changes on Economic Growth [J]. Modern Communication, 2019, (13): 50-51.

[7] Wang Wei. An empirical study on the differences in regional economic development and its influencing factors in Guangdong under the new economic normal [D]. Jinan University, 2019.

[8] Yi Ying, Luo Minmin. An empirical study on the relationship between fiscal revenue and economic growth in Guangdong Province based on ADL model [J]. Statistics and Management, 2020, 35(08): 16-20.

[9] Zhou Xiaodan. Grey correlation analysis between industrial structure and economic growth [J]. Modern Marketing (Latest Issue), 2017, (02): 13.