ISSN 2616-5902 Vol. 3, Issue 10: 74-77, DOI: 10.25236/AJBM.2021.031013

Analysis of the gray correlation between GDP growth and the three major industries in Shandong Province

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Abstract: *2021 is the first year for China to implement its 14th Five-Year Plan. Under this background, Shandong province actively plays a pioneering role, scientifically grasps the new stage of development, focuses on promoting the sustainable and healthy development of the province's economy and society, and plans to build a regional development pattern of "one group, two centers and three circles". The purpose is to test the effect of reform and development in Shandong province in recent ten years, and to provide basis for further development planning of Shandong province under the new background. Therefore, GDP is chosen as an important indicator of economic development. This paper studies the relationship between GDP and output value of three major industries in Shandong province by using grey correlation analysis method. Research shows that the tertiary industry has the greatest impact on Shandong's GDP. Finally, some suggestions are put forward for the economic development of Shandong Province.*

Keywords: *Shandong Economy, GDP, Gray Correlation, Policy Recommendations*

1. Introduction

In recent years, China's socialist modernization has entered a new era and embarked on a new journey. Under the background of development in the new era, the Shandong provincial government has actively responded to the national call, implemented the new development concept of innovative, green, open, coordinated and shared development, and issued relevant policies to promote and support high-quality economic development. At the same time, the second Centenary Goal sets higher requirements for economic development and improving people's living standards. To realize the overall layout of the 14th Five-Year Plan, we must give play to the regional leading and leading role of large economic provinces. Shandong province is one of the most developed provinces in China with many favorable economic development factors. Shandong province has a dense population, abundant labor force and high-quality labor talents. Population advantage is of great significance to the economic development of the whole region and even the whole country. Shandong province is located in the North China plain, east of the Yellow Sea and Bohai Sea, has excellent seaports, and adjacent to Korea, Japan and other countries, foreign trade is very convenient. But most importantly, from the perspective of the overall national development strategy, Shandong province is the strategic node of China's expansion of opening-up from south to north and gradient development from east to west, and occupies an important position in the national regional development pattern. It can be seen that the future economic growth of Shandong province is of great significance to national economic development.

2. Literature Review

In recent years, many domestic scholars have analyzed the related factors of regional economic development and predicted its future development. Zhang Li and other scholars modeled The GDP of Shanghai with the grey forecasting model and Logistic model, and analyzed the conclusion that the grey forecasting model is more ideal for GDP change [1]. Geng Liyan et al. analyzed the logistics industry in Hebei Province with grey correlation degree and found that there was a large correlation degree between the logistics industry and all regional economic development indicators except fixed assets, among which heavy industry had the greatest influence [2]. Zhang Ting and other scholars studied the correlation between industrial development and industrial structure layout of Shanghai Lingang Industrial Zone by using the grey correlation degree method, and came to the conclusion that some industrial layout structure

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gradually tended to be reasonable, but the overall development was unbalanced and needed to be optimized [3]. Li xiaohui used grey correlation to analyze the impact of the Expo on Shanghai and concluded that environmental protection and safety work should be strengthened during the Expo [4]. An Jing adopts the grey correlation method, through the comparative study with other cities, analyzes the measurement and influence factors of foshan's financial development level, and draws the conclusion that foshan's financial development level is still low, which needs to be promoted jointly from the aspects of financial demand, financial scale, economic development, scientific and technological innovation, talent training and so on. [5] The results show that industrial energy consumption in Shanghai will continue to increase, but the growth rate will slow down.

To sum up, in the past decade, most of the studies on economic development analysis and prediction focus on a single industry, and there is a lack of studies on the overall regional economic development from a relatively macro perspective. Therefore, based on the background of current economic development and relevant research status, this paper studies the economic development of Shandong Province, analyzes the correlation between GDP and the development of the three major industries in Shandong Province, and provides theoretical reference for formulating economic development policies.

3. Data Selection

This paper selects the GDP and output value of the primary, secondary and tertiary industries of Shandong Province from 2011 to 2020 as research data, which come from the National Bureau of Statistics and Shandong Provincial Bureau of Statistics.

Table 1: The GDP and output value of the three major industries over the ten years

Year	The primary industry(hundred million ¥)	The secondary industry(hundred million ¥)	The tertiary industry(hundred million ¥)	The gross domestic product(hundred million ¥)
2011	3768.55	19926.11	15370.27	39064.93
2012	4047.06	21275.89	17634.36	42957.31
2013	4454.11	22615.89	20274.33	47344.33
2014	4662.81	23588.02	22524.01	50774.84
2015	4902.82	24814.88	25571.09	55288.79
2016	4830.25	25565.04	28367.17	58762.46
2017	4832.71	26925.59	31253.80	63012.10
2018	4950.52	27523.67	34174.68	66648.87
2019	5116.44	28310.92	37640.17	71067.53
2020	5363.76	28612.19	39153.05	73129.00

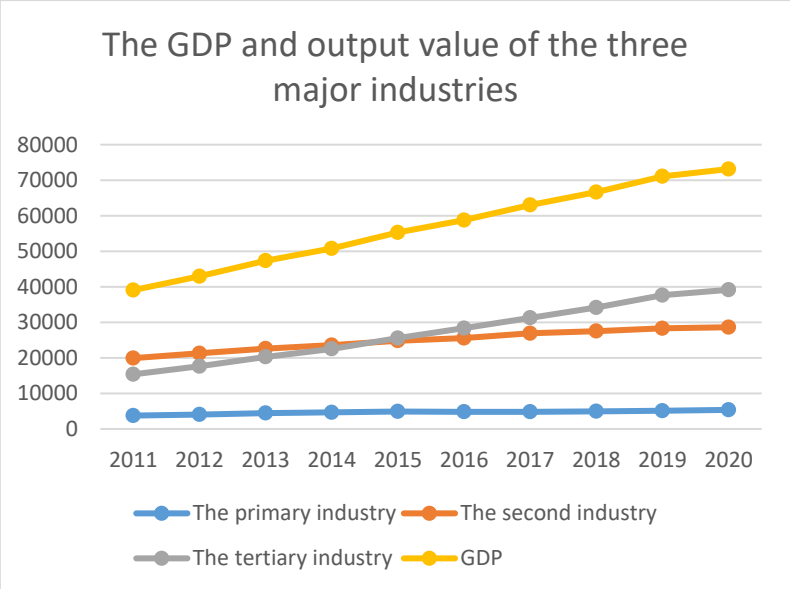

Figure 1: The GDP and output value of the three major industries in the last ten years

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As can be seen from the figure, the output value and GDP of the three major industries showed an overall upward trend in the decade, among which the tertiary industry grew the fastest and became the most important component of GDP, surpassing the secondary industry in 2016. Shandong's GDP has grown over the past decade, reaching 7,312.91 billion yuan for the first time in 2020, a record high. Although growth slowed in 2020 due to the impact of COVID-19.

4. Methodology

The method of gray correlation is as follows.

Firstly, the analysis reference sequence and comparison sequence are determined. The reference sequence is the data sequence reflecting the characteristics of the system behavior, and the comparison sequence is the sequence composed of the factors affecting the system behavior. Let the reference sequence and comparison sequence be respectively.

$$x_0 = \{x_0(k), k = 1,2,\cdots,n\}$$

$$x_i = \{x_k(k), k = 1,2,\cdots, \ n\}, (i = 1,2,\cdots,n)$$

In order to make the data have comparability, the dimensionless processing of the data is adopted here.

$$x_i^{'} = \frac{x_i}{x_{i1}} = (x_{i1}^{'}, x_{i2}^{'}, \cdots x_{in}^{'}), i = 1,2,\cdots,n$$

Calculating correlation coefficient

$$\xi_i(k) = \frac{\min\limits_i \min\limits_k |x_0(k) - x_i(k)| + \rho \max\limits_i \max\limits_k |x_0(k) - x_i(k)|}{|x_0(k) - x_i(k)| + \rho \max\limits_i \max\limits_k |x_0(k) - x_i(k)|}$$

ρ is the resolution coefficient, and its value is 0.5. Then calculate correlation degree.

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

The grey correlation degree of each index to parent sequence is obtained.

5. Result

In order to better reflect the contribution rate of the three industries to GDP growth, the annual increment of each factor is adopted for calculation, the growth of GDP from 2011 to 2020 is selected as the reference sequence (x_0), and the growth of primary industry output value (x_1), the growth of the secondary industry output value (x_2) and the growth of the tertiary industry output value (x_3) are respectively used as the comparison sequence. According to grey correlation analysis, the correlation degree of output value of three major industries to GDP is 0.6426, 0.6488 and 0.6622, respectively. The correlation degrees are all above 0.6, indicating that the three industries all have a great impact on GDP, and there is indeed a correlation.

Table 2: Correlation between GDP and growth of three major industries output value

industry	The correlation degree
The primary industry	0.6426
The secondary industry	0.6488
The tertiary industry	0.6622

According to the rank of correlation degree, the rank of influence degree is ‘tertiary industry > secondary industry > primary industry’. It can be seen that the tertiary industry has the greatest impact on GDP in Shandong Province, followed by the secondary industry and the primary industry.

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6. Conclusion

The GDP development of Shandong Province is closely related to the development of the three major industries, no matter which industry is an important component that cannot be ignored for Shandong Province. But we should focus on the tertiary industry, give consideration to the development of the first and second industries, and jointly promote the economic development of Shandong province.

1) To promote agricultural modernization. Shandong province should make full use of the geographical advantages of regional agricultural development and optimize the agricultural structure and regional distribution. Shandong provincial government should deepen rural reform and introduce relevant policies so that farmers can benefit and become rich. To increase investment in agricultural technology, advancing agriculture technology innovation, improve the efficiency of agricultural production, promote agricultural scale, intensive management on a wider scale. Maintain Shandong province agricultural development advantage, provide more stable convenient foundation for economic development.

2) Change the growth model and promote green development. Actively promote the traditional industry transformation, especially the iron and steel, building materials, petrochemical and other industries layout optimization and structure adjustment. At the same time, expand the supply high quality products, to promote transformation and upgrading of key industry enterprises. Take is advantageous to the scientific and technological innovation of policies and measures to promote innovation provided strong impetus for economic development, creating and releasing new momentum, deepen the digital economy and the real economy. Encourage and support the enterprise application of new technology, the construction of advanced manufacturing.

3) Develop the third industry, promote the depth of the advanced manufacturing and modern service industry. Make full use of the advantages of ecological resources and human resources in Shandong province, vigorously develop natural ecology and historical and cultural tourism services; Accelerate the development of trade logistics industry, promote the large-scale, specialized and intensive development of logistics industry, improve the level of logistics economy; To deepen financial reform, improve the level of financial innovation, and promote the financial better service the real economy.

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