ISSN 2616-5902 Vol. 4, Issue 3: 58-64, DOI: 10.25236/AJBM.2022.040311

Research on the Influencing Factors of Shanghai GDP Based on Principal Component Analysis

Yuqi Yin[1], Jingwen Liang[2]

[1]School of Economics and Management, Shanghai Maritime University, Shanghai, 201306, China
[2]School of Economics and Finance, Zhanjiang University of Science and Technology, Zhanjiang, Guangdong, 524084, China

Abstract: *As one of the most economically developed cities in China, Shanghai is very necessary to study the influencing factors of its economic development. This paper constructs an indicator system from the aspects of economic growth, technological innovation, foreign trade, etc., and selects the principal component analysis method to conduct an empirical analysis of the factors affecting Shanghai's economy. Research shows that technological innovation and environment contribute the most to Shanghai's GDP, followed by per capita disposable income and tertiary industry. Through the analysis of the influencing factors of Shanghai's economy, the corresponding conclusions are drawn, which provides a reference for Shanghai to issue corresponding policies.*

Keywords: *Shanghai, principal component analysis, GDP*

1. Introduction

GDP is the final result of a country or region's production activities within a certain period of time, it is the core indicator of national economic accounting, so it is of great significance to economic research. The arrival of the new crown epidemic has brought a great impact on the economies of all countries. However, China has been able to resume work and production as soon as possible, and promote the economy to run on a normal track. On January 17, 2022, according to the National Bureau of Statistics, China's GDP in 2021 will be 114.367 trillion yuan, an increase of 8.1% over the previous year. No. 1 in the country.

Since the reform and opening up, Shanghai's economic growth rate has always been leading the country, the consumption level of urban and rural residents has been continuously improved, the quality of life has been significantly improved, the city's functions have been improved in an all-round way, and a high-level opening pattern has basically been formed. Significant achievements have been made in many aspects. Today, Shanghai is one of the regions with the most active economic development in my country. It is China's economic and financial center and plays an important role in its contribution to my country's GDP. The economic development of Shanghai is not only a typical representative of my country's economic development, but also provides an example for the development of other cities at home and abroad, and plays an important role in optimizing my country's economic development and enhancing its international influence.

The sea is located at the estuary of the Yangtze River and is adjacent to the East China Sea in the east. It has a unique geographical location and rich natural resources; it has superior transportation conditions, which can realize multimodal transportation by river, sea, land, air and rail; there are many scientific research institutes and universities, There are sufficient human resources and great potential for technological innovation; Shanghai has a high concentration of shipping resources and a complete shipping system, and has basically built a world-leading international shipping center; now benefiting from the three leading industries of biomedicine, integrated circuits, and artificial intelligence layout, and further promote the high-quality development of Shanghai's economy.

Although my country's current economic development situation is relatively optimistic, based on the complex international situation and the uncertainty of the development of the epidemic, it is still unknown whether GDP can maintain the current growth rate in the future. Many scholars also have different opinions. In order to avoid falling into the middle-income trap, promote my country's for the high-quality development of the economy, it is necessary to study the influencing factors of Shanghai's GDP and strengthen the forecast and analysis of Shanghai's GDP. This paper uses the principal component analysis

ISSN 2616-5902 Vol. 4, Issue 3: 58-64, DOI: 10.25236/AJBM.2022.040311

method to analyze the effect of various factors on the GDP growth of Shanghai through the idea of dimensionality reduction.

2. Literature review

Based on GDP as an important indicator reflecting my country's economic development, the research on the influencing factors of GDP has always been the focus of research in the economic field. In recent years, many scholars have carried out research on this, some scholars have used multiple regression analysis to analyze the influencing factors of GDP in individual provinces in my country. Among them, Liang Haonan used the multiple linear regression method to study the total GDP of Anhui Province from 2000 to 2017, and concluded that research and experimental expenditure (R&D expenditure), energy consumption, total import and export trade, and foreign direct investment are the main factors affecting GDP; Guan Yongqian conducted a multiple regression analysis on various factors affecting the GDP growth of Henan Province, and concluded that the three indicators of the primary industry, the secondary industry and the tertiary industry are important indicators to promote the rapid growth of the GDP of Henan Province; Jin Mofei, 1991-2018 The annual data is used as a sample, and the multiple linear regression method is used to establish a model, and it is concluded that the secondary industry, the tertiary industry and consumption have a significant effect on GDP growth. Zhao Haoran takes the statistical data of my country from 2000 to 2018 as the research object, and uses the per capita consumption expenditure of the national residents, the fixed social investment of the whole society, the government budget expenditure, the total export trade, and the total number of employed population as explanatory variables to establish a multiple regression model. and other factors have an important impact on GDP. Bai Yu uses the multiple regression method to take the relevant indicator data in my country from 2000 to 2017 as the research sample, and uses the household consumption level, total import and export trade, foreign direct investment, energy consumption, total retail sales of consumer goods, financial expenditure, employment, R&D expenditure, etc. The 8 indicators establish an indicator system and conclude that the level of household consumption, total import and export trade, foreign direct investment, and R&D expenditure have a very significant impact on GDP.

In terms of factors influencing Shanghai's economy, many scholars have also conducted research on it. Hu Jincheng takes Shanghai GDP as the research goal, selected four indicators, including education expenditure, labor force ratio, primary, secondary and tertiary industry value, geographical location and policy, to construct an index system, and concluded that Shanghai's GDP is closely related to the output value of primary and secondary industries. It is necessary to carry out industrial transformation and stimulate the growth of the tertiary industry. Zhang Yongqing and Zu Xiaomei took the relevant statistical data from 2002 to 2014 as research samples, the purpose of this study is to explore the impact of Shanghai's cultural needs on the economy, established a VAR model, to analyze the cultural needs of Shanghai, the international influence of culture and the degree of influence of human capital level on Shanghai's economic development and its dynamic changes, it is concluded that cultural consumption demand and the impact of cultural international influence have a positive impact on Shanghai's economic development.

To sum up, the above-mentioned scholars have conducted research on the influencing factors of GDP, and the proposal of many influencing factor indicators has provided insights for other scholars and the research of this paper, and the research and prediction results are of great significance at the theoretical and empirical levels. However, on the one hand, most scholars only select one or two indicators when studying the influencing factors of GDP, which cannot fully reflect the influencing factors of GDP; on the other hand, there are many factors affecting GDP, and many factors are uncertain. Multiple linear regression analysis method There is multicollinearity among the lower variables, and the influencing factors of GDP cannot be accurately analyzed. Based on the above reasons, this paper selects the principal component analysis method to study the influencing factors of Shanghai GDP.

3. Data selection

This paper selects the data of Shanghai GDP from 2010 to 2020 as the research object, and refers to Fan Zifu's index system of sustainable development of digital economy, Rui Ziqiu's Nanjing urban development capacity index system, and Guan Yongqian's index system of Henan Province's GDP influencing factors based on multiple linear regression. According to the four principles of scientificity, systematicness, practicability and operability, Select six levels of economic growth, technological innovation, environment, foreign trade, people's livelihood, and infrastructure as the factor level, select

ISSN 2616-5902 Vol. 4, Issue 3: 58-64, DOI: 10.25236/AJBM.2022.040311

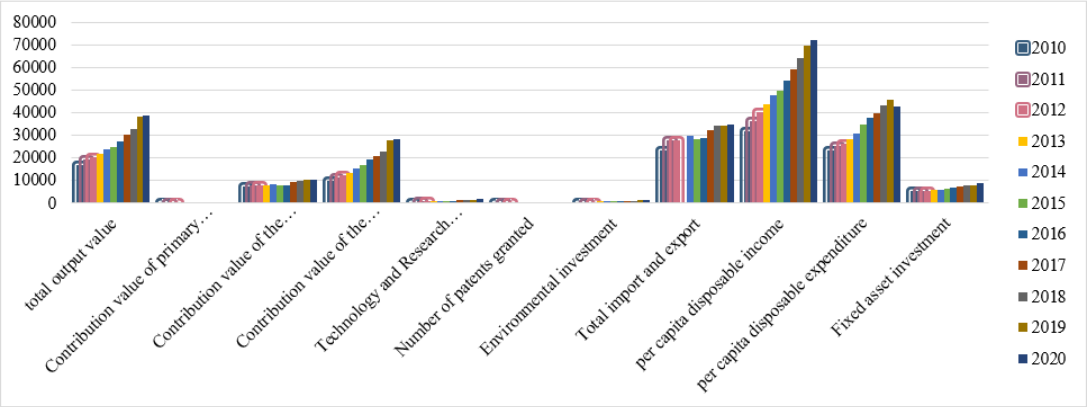
the contribution value of the first, second and third industries, the internal expenditure of R&D project funds, the amount of patent authorization, the total import and export, Nine factors of per capita disposable income, per capita consumption expenditure and fixed asset investment are used as the index layer to construct the index system.

Table 1: Shanghai GDP indicator system

target layer	feature layer	Indicator layer
GDP of Shanghai	Economic Growth	Contribution value of primary industry (100 million yuan)
		Contribution value of the secondary industry (100 million yuan)
		Contribution value of the tertiary industry (100 million yuan)
	Technological innovation	R&D expenditure (ten thousand yuan)
		The number of patents granted (pieces)
	foreign trade	Total import and export (100 million yuan)
	infrastructure	Fixed asset investment (100 million yuan)
	people's livelihood	Per capita disposable income (yuan)
		Per capita consumption expenditure (yuan)
	surroundings	Investment in environmental protection (100 million yuan)

As shown in table 2, in general, the values of each indicator are in a state of steady growth. Among them, Shanghai's GDP was in a steady and progressive growth trend from 2010 to 2019, reflecting that Shanghai's economic situation in the first nine years was good. The contribution value of the primary industry first decreased and then increased, the contribution value of the secondary industry has declined briefly for two years, and is still in a state of growth on the whole, and the contribution value of the tertiary industry is in a state of steady growth, reflecting that with the continuous progress of society, The role of agriculture in economic development is decreasing. R&D expenditures and patent authorizations are both on the rise, which reflects Shanghai's increasing emphasis on science and technology ; the investment in environmental protection is increasing ,which reflects the enhancement of environmental protection awareness and Shanghai's progress towards a resource-friendly society; the total import and export volume is also in a state of growth , reflecting the good situation of Shanghai's foreign trade; per capita disposable income is increasing year by year, and per capita disposable expenditure has only decreased in a small scale from 2019 to 2020, which reflects the continuous improvement of people's living conditions, but the new crown epidemic has a certain impact on consumption. The negative effect of the fixed asset investment is also in a state of growth, which shows that the Shanghai government attaches great importance to infrastructure

Table 2: Data map of various indicators in Shanghai



4. Model establishment

This paper analyzes and studies the influence of three major industries, science and technology, environment, and foreign trade on Shanghai's GDP through principal component analysis.

(1) Normalize the raw data

It is assumed that there are m index variables for principal component analysis: $x_1, x_2, x_3 \ldots x_m$, A total of n evaluation objects; The value of the j-th index of the i-th evaluation object is x_{ij} ,Standardize the data as follows

ISSN 2616-5902 Vol. 4, Issue 3: 58-64, DOI: 10.25236/AJBM.2022.040311

$$z_{ij} = \frac{x_{ij-}\overline{x_j}}{s_j} \quad i = 1,2,...,n;\ j = 1,2,...m \tag{1}$$

In formula (1), $\overline{x_j} = \frac{\sum_{i=1}^{n} x_{ij}}{n}, s_j^2 = \frac{\sum_{i=1}^{n} (x_{ij} - \overline{x}_j)^2}{n-1}$, to get the normalized matrix Z.

(2) Find the correlation coefficient matrix for the normalized matrix Z

$$R = \left[r_{ij} \right]_{m \times n} \tag{2}$$

In formula (2), $r_{ij=} \frac{\sum_{k=1}^{n} \overline{x_{ki}} \times \overline{x_{kj}}}{n-1}, i,\ j = 1,2,...,m$

(3) Find the characteristic equation of R

$\left| R - \lambda I_m \right| = 0$ Get m eigenvalues and determine the principal components,

Determine P from the equation $\frac{\sum_{t=1}^{p} \lambda_j}{\sum_{t=1}^{m} \lambda_j} \geq 0.85$, $j = 1,2,...,m$, solve system of equations $R_b = \lambda_j b$, get the unit vector b_j^0

(4) Convert standardized indicator variables into principal components

$$U_{ij} = z_i^T b_j^0,\ j = 1,2,...,m \tag{3}$$

In formula (3), U_1 is the first principal component, U_2 is the second principal component, U_m is the mth principal component.

(5) Comprehensive evaluation of p principal components

The final evaluation value can be obtained by weighting and summing the p principal components, and the weight is the variance contribution rate of each principal component.

5. Empirical Analysis

Based on the GDP data of Shanghai from 2010 to 2020, this paper selects 10 factors to construct an index system. First, perform KMO test and Bartlett test on the data. When the KMO statistic is closer to 1, the correlation of the variables is stronger, and the KMO statistic is above 0.7, the statistical results are more effective, and the test results are shown in the figure. According to Table 3, the KMO value is 0.755, which is greater than 0.6, and the significance is less than 0.01. The null hypothesis is rejected, and the data are suitable for principal component analysis.

Table 3: KMO and Bartlett test

KMO	Bartlett Sphericity test		
	approximate chi-square	degrees of freedom	salience
0.755	230.979	45	0.000

Further, when performing principal component analysis, the number of selected principal components is often determined by the cumulative contribution rate, and the cumulative contribution rate of principal components generally reaches more than 85%. It can be seen from Figure 4 that a principal component is finally obtained, and the cumulative contribution rate reaches 91.557, indicating that one factor contains 91.557 of all index information.

ISSN 2616-5902 Vol. 4, Issue 3: 58-64, DOI: 10.25236/AJBM.2022.040311

Table 4: Total variance explained

ingredients	initial eigenvalues			Extract sum of squares and load		
	total	variance%	Grand total%	total	variance%	Grand total%
1	9.156	91.557	91.557	9.156	91.557	91.557
2	0.474	4.736	96.253			
3	0.221	2.210	98.503			
4	0.105	1.052	99.555			
5	0.025	0.248	99.802			
6	0.011	0.111	99.914			
7	0.005	0.049	99.963			
8	0.003	0.033	99.995			
9	0.000	0.004	100.000			
10	3.392E-05	0.000	100.000			

Table 5: Coefficients of each index in the linear combination of principal components

index	Principal Component Score Coefficient
x_1 Contribution rate of primary industry	-0.266
x_2 Contribution rate of the secondary industry	0.315
x_3 Contribution rate of the tertiary industry	0.327
x_4 R&Dexpenditure	0.329
x_5 Number of patents granted	0.303
x_6 Environmental investment	0.329
x_7 Total import and export	0.310
x_8 per capita disposable income	0.327
x_9 per capita disposable expenditure	0.32
x_{10} fixed assets	0.326

$$F_1 = -0.266x_1 + 0.315x_2 + 0.327x_3 + 0.329x_4 + ... + 0.326x_{10} \quad (4)$$

The variance contribution rate is used as the weight Q of the principal component, and the comprehensive score of the principal component is obtained by sorting

$$F = Q_1 \times F_1 = 91.557 \times F_1 \quad (5)$$

6. Analysis of empirical results

It can be seen from Figure 5 that R&D expenditure and environmental protection investment contribute the most to Shanghai's GDP, followed by per capita disposable income and tertiary industry contribution, followed by fixed assets, per capita disposable expenditure, secondary industry contribution, per capita disposable expenditure, and finally It is the number of patents granted and the primary industry. And the difference between R&D expenditure and environmental protection investment is small, it can be seen that the role of the two in GDP growth is not much different.

(1) Technology investment is the basis for growing GDP.

Science and technology are the primary productive forces. Shanghai is my country's economic and financial center, and the role of science and technology is self-evident. Only the continuous innovation of science and technology can promote the continuous progress of society. The investment in science and technology is the premise of the continuous innovation of science and technology, and sufficient funds provide a guarantee for the innovation of science and technology.

(2) The increase in per capita disposable income is an important driving force for the continuous growth of Shanghai's GDP.

Consumption, investment, and exports are the troika that drives my country's economic growth. Affected by the current epidemic and the instability of the international economy, the impact of export

ISSN 2616-5902 Vol. 4, Issue 3: 58-64, DOI: 10.25236/AJBM.2022.040311

trade and investment on my country's economy tends to weaken. This shows that to give full play to the role of consumption in economic growth, and income is the basis and premise of consumption, so per capita disposable income is an important driving force for the continuous growth of Shanghai's GDP.

(3) The increase in environmental protection investment is an important factor for the continuous growth of Shanghai's GDP.

For Shanghai, a city with a very mature economic development, economic growth is no longer dependent on high investment, high consumption, and high emissions, but should accelerate the construction of resource-saving and environment-friendly society.

(4) The tertiary industry has a greater impact on Shanghai's GDP growth, while the primary industry's contribution to GDP is small.

In today's world, the development level of the tertiary industry in a country or region is one of the important symbols reflecting the development level of the country's or region's productivity, and it is also one of the important factors to promote economic growth. However, agriculture has developed to a certain extent for Shanghai, and has little effect on GDP growth.

7. Recommendations

Based on the results obtained from the empirical analysis, combined with the development status and policy trends of Shanghai, the following suggestions are put forward from four aspects: technological innovation, consumption, ecology, and coordinated development of the three major industries.

(1) Increase investment in scientific and technological innovation and stimulate innovation vitality.

Technological innovation is self-evident for Shanghai, which is the economic center. Shanghai science and technology workers should further aim at the frontier of world science and technology, strengthen basic research, so as to give full play to the basic role of science and technology investment in GDP growth.

(2) Increase the proportion of labor remuneration in income and increase the income of laborers.

Although Shanghai's per capita income is in a leading position in China, there are still problems of uneven distribution of income and gap between the rich and the poor. Increasing the proportion of labor remuneration in income will help protect the rights and interests of laborers, reduce the gap between the rich and the poor, further stimulate consumption and expand domestic demand, and give full play to the role of consumption in driving economic growth.

(3) Increase investment in environmental protection and build an environment-friendly society.

In recent years, Shanghai has actively implemented the construction of an environment-friendly society, especially in terms of garbage classification. In the future, we should continue to increase investment in environmental protection, which is not only conducive to rationally guiding investment directions and optimizing industrial institutions, but also providing development capacity for economic growth and transforming the mode of economic growth.

(4) Promote the coordinated development of the three major industries

The three major industries have their own roles in the process of national economic development. Agriculture is the foundation for other parts of the national economy to rely on for their independence and further development. The investment in science and technology in the primary industry should be increased. Industry plays a leading role in the development of the national economy. For Shanghai, it can focus on advanced manufacturing. For the tertiary industry in Shanghai, it should maintain a good momentum of development and vigorously develop the emerging tertiary industry that is closely related to people's quality of life.

References

[1] Bai Yu. Empirical Analysis of Influencing Factors of my country's GDP Based on Multiple Regression Analysis [J]. Small and Medium-Sized Enterprises Management and Technology (Latest Issue), 2019(02): 55-57.

[2] Fan Zifu, Wu Yun. Research on the key influencing factors of sustainable development of urban digital

ISSN 2616-5902 Vol. 4, Issue 3: 58-64, DOI: 10.25236/AJBM.2022.040311

economy [J]. Journal of Chongqing University of Posts and Telecommunications (Social Science Edition), 2021, 33(05): 106-115.
[3] Guan Yongqian. Influencing factors of GDP in Henan Province based on multiple linear regression [J]. Rural Economy and Technology, 2021, 32(05): 221-224.
[4] Hu Jincheng. Discussion on the Factors Affecting Shanghai's Economic Development [J]. Small and Medium-Sized Enterprises Management and Technology (Latest Issue), 2020(10): 21-22.
[5] Jin Mofei. Research on the Influencing Factors of Beijing's GDP Growth [J]. Economic Outlook on the Rim of the Bohai Sea, 2020(11): 161-163.
[6] Liang Haonan. An Empirical Study on the Factors Influencing GDP in Anhui Province——Based on Multiple Regression Analysis [J]. Times Finance, 2021(24): 73-75.
[7] Ren Xiaojing. The impact of my country's import and export trade on GDP [J]. Wealth Times, 2019(10): 78.
[8] Rui Ziqiu, Zhao Liyue, Zhao Jiaxue. Research on the evaluation of Nanjing's development capability and construction approaches based on principal component analysis [J].
[9] Yang Manlin. Influencing factors of regional economic vitality based on principal component analysis [J]. China Science and Technology Information, 2020(12): 106+108.
[10] Zhang Yongqing, Zu Xiaomei. The influence of cultural industry on the transformation and development of Shanghai's urban economy based on the VAR model
Empirical analysis of [J]. Productivity Research, 2017(05): 48-53.
[11] Zhao Haoran. Quantitative Analysis of Influencing Factors of my country's GDP [J]. China Collective Economy, 2021(30): 12-14.