An Analysis of the Relevance between the Transition of Japan's Population Structure and Economic Growth: Based on Grey Relational Model

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Abstract: Through the grey correlation analysis of the relevant index data of Japan's population structure and economic growth from 1998 to 2018, it is found that the population age structure, gender structure and population industrial structure are related to the comprehensive economic system. According to the research results, on the basis of summarizing the experience of Japan's economic development, this paper puts forward some countermeasures and suggestions for the coordinated development of China's population and economy.

1 INTRODUCTION

In recent years, some scholars have studied the relationship between Japan's population structure and economic growth. Min Lu, Fang Cai (Lu 2014) believed that the impact of demographic changes on the potential growth rate. After the 1990s, Japan's demographic dividend disappeared, the absolute number of its working age population decreased, and the population dependency ratio increased. Through direct and indirect ways, the transformation of demographic structure led to the rapid decline of Japan's potential growth rate after the 1990s. Xiaofeng Wang, Xueli Ma (Wang 2015) based on the data of economic growth and population age structure changes since Japan entered the aging society, by decomposing the contributing factors of economic growth, pointed out that the improvement of labor productivity is the main driving force of Japan's long-term economic growth, and the reduction of working age population will become an important structural factor that has plagued Japan's economic growth for a long time. Dangchen Sui etc (Sui 2020) research found that Japan's demographic transition has undergone the first demographic dividend and the second demographic dividend development stage, and the declining birthrate and aging population have become more and more serious. This change in the demographic structure has had a greater impact on Japan's labor supply, savings, consumption and social security system, and has hindered Japan's economic growth to a certain extent. Judging from the current research, the impact of Japan's population structure on economic growth is mainly concentrated on the adverse effects of the population age structure, especially the disappearance of the demographic dividend and the increasing aging of the economy. Changes in population structure not only refer to changes in age structure, but also include sex ratio structure, population industry structure, etc. These elements are relatively lacking in previous literature studies.

Based on the current research status, this paper takes Japan as the research object, Study demographic changes The relationship between (age structure, sex ratio structure, industrial structure etc) and economic growth is analyzed by using the grey correlation analysis method. In view of the similarity between China's population structure transformation and economic growth model and Japan, at the end of this paper, based on the experience and training of Japan, this paper puts forward some countermeasures and suggestions for the coordinated development of China's population and economy.

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Table 1: Indicators and codes.

	index		index
X1	Proportion of population under 14	Y1	GDP
X2	Proportion of population aged 15-64	Y2	Output value of primary industry
X3	Proportion of population over 65	Y3	Output value of secondary industry
X4	Sex ratio	Y4	Output value of tertiary industry
X5	Number of employees in the primary industry	Y5	Average household income
X6	Number of employees in the secondary industry	Y6	Per capita income of families with children
X7	Number of employees in the tertiary industry	Y7	Per capita income of elderly families
X8	Total population		

2 DATA SOURCES & RESEARCH METHODS

2.1 Selection of Indicators and Data Description

This paper takes the relevant data of Japan's population and economy from 1998 to 2018 as a sample to analyze the impact of population structure changes on Japan's economic growth. The selected indicators and codes are shown in Table 1.

Among them, the units of X1-X4 are %, the units of X5-X8 are 10000 person, the units of Y1-Y4 are 1 billion yen, and the units of Y5-Y7 are 10000 yen. The data selected in this paper comes from the Japanese government statistics portal e-stat.

2.2 Establishment of Model

This study uses the grey correlation analysis method to analyze the correlation between population structure and economic growth. According to the grey system theory, the grey correlation analysis method mainly calculates the closeness of different data sequences in a certain period, and then analyzes the main and secondary factors affecting the system change. Grey correlation analysis has the unique advantages of requiring less sample data and low requirements for data distribution characteristics, which other mathematical statistics methods do not have (Yuan 1991).

The specific steps are as follows:

1) Dimensionless processing of variable data. Due to different indicator units and different data

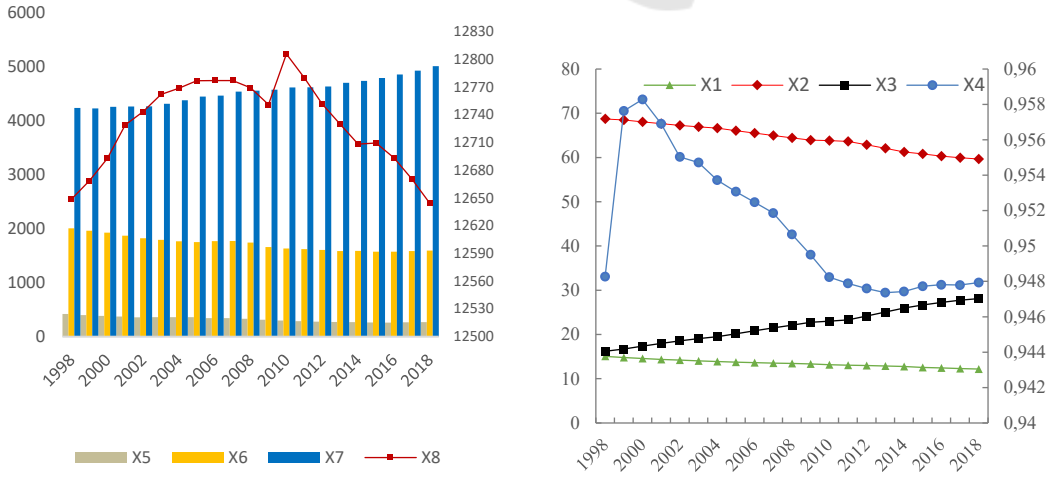

Figure 1: Population structure data of Japan from 1998 to 2018.

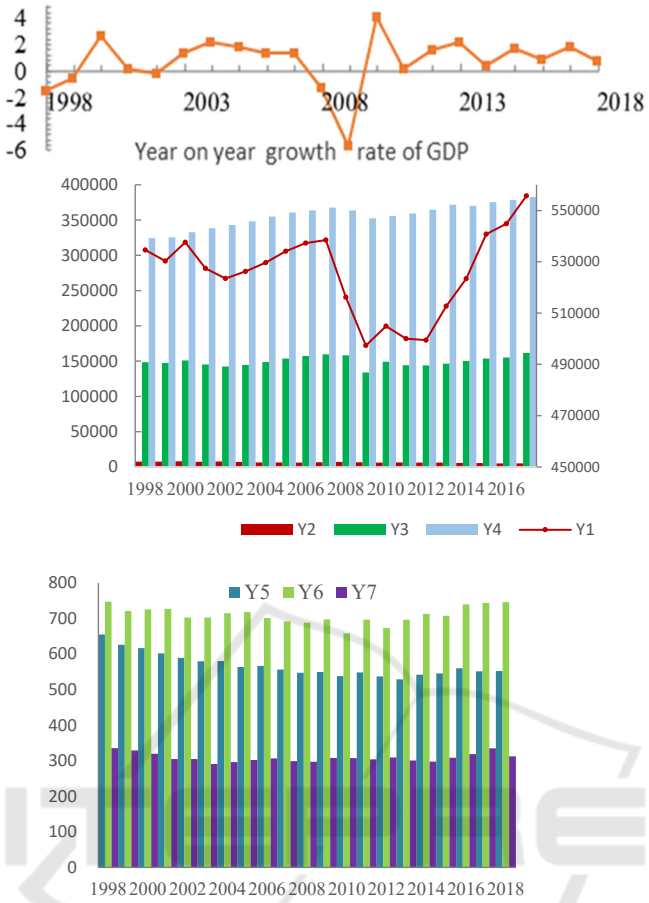

Figure 2: Data of Japan's economic structure from 1998 to 2018.

dimensions, dimensionless data processing is required before correlation analysis. The common dimensionless processing methods mainly include extremum, standardization, mean and standard deviation. Standardized treatment is adopted in this paper:

$$F_{pq} = (X_{pq} - \bar{X}_{pq}) \div (maxX_{pq} - minX_{pq}) \quad (1)$$

2) The coupling correlation degree model of population structure and economic system is used to measure the relationship between population structure and economic growth. The calculation formula of correlation coefficient is as follows:

$$\xi_{pq}(s) = \frac{min_p min_q |X'_p(s) - Y'_q(s)| + \rho man_p man_q |X'_p(s) - Y'_q(s)|}{|X'_p(s) - Y'_q(s)| + \rho man_p man_q |X'_p(s) - Y'_q(s)|} \quad (2)$$

Note: ξ is the correlation coefficient between the p-th population structure and the q-th regional economic index in Japan at time s; $X'_p(s)$、$Y'_q(s)$ are the standardized values of Japan's population structure at time s and the economic indicators of the q-th region; ρ is the resolution coefficient, generally 0.5. After averaging the correlation coefficient according to the sample number k, the correlation degree matrix can be obtained, which reflects the correlation between population structure and economic growth. The expression of correlation degree is:

$$\gamma_{pq} = \frac{1}{k}\sum_{p,q=1}^{k} \xi_{pq}(s) \ (k=1,2,\cdots\cdots,n) \quad (3)$$

3 RESULTS & DISCUSSIONS

This study selects 2018 cross-sectional data, and through the comparative analysis of the correlation degree, the correlation degree between the relevant factors in the population structure and the economic system relationship is obtained (the value is between 0 and 1); when the correlation degree takes the maximum value of 1, it is explained A certain

indicator of the population structure system has exactly the same change law between a certain indicator of the regional economic system; when the value of the correlation degree is between 0 and 1, it indicates that there is a correlation, and the correlation increases with the increase of the value. The reverse is also true; when the correlation degree is between 0-0.35, the two systems are low correlation; when the correlation value is between 0.35-0.65, the two systems are medium correlation; when the correlation degree is between 0.65-0.85 Sometimes, the two systems are highly correlated; when the correlation degree is between 0.85-1, the two systems are highly correlated.

Table 2: Correlation coefficient matrix between population structure system and economic indicators.

ξ	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Average	
X1	0.3764	0.8988	0.3814	0.3958	0.6455	0.4026	0.5188	0.5170	
X2	0.3573	1.0000	0.3618	0.3748	0.5915	0.3809	0.4833	0.5071	0.5847
X3	0.9991	0.3572	0.9655	0.8839	0.4742	0.8518	0.5779	0.7299	
X4	0.4217	0.7152	0.4279	0.4462	0.7914	0.4549	0.6090	0.5523	0.5523
X5	0.4011	0.7835	0.4068	0.4232	0.7218	0.4310	0.5670	0.5335	
X6	0.4180	0.7260	0.4242	0.4421	0.7786	0.4506	0.6015	0.5487	0.5769
X7	0.8636	0.3382	0.8384	0.7761	0.4413	0.7513	0.5298	0.6484	
X8	0.3546	0.9787	0.3590	0.3718	0.5839	0.3777	0.4783	0.5006	0.5006
Average	0.5240	0.7247	0.5206	0.5142	0.6285	0.5126	0.5457	0.5672	0.5536

Table 2 shows the correlation coefficient matrix of Japan's population structure system and economic system calculated by formulas. It can be seen from the correlation coefficients between the indicators of the two systems that they all belong to a medium or above medium correlation, which shows that there is a close relationship between the two systems:

First, the correlation coefficients between the various indicators of the population age structure and the comprehensive economic system are all around 0.5. Among them, the proportion of children aged 0-14 (X1) and the proportion of youth aged 15-64 (X2) are related to the comprehensive economic system. The correlation coefficient of X3 is relatively small, but the correlation coefficient between the proportion of the elderly over 65 years old (X3) and the comprehensive economic system is relatively large, that is, it has the greatest economic effect. It can be seen from Table II that the proportion of elderly people over 65 years old (X3) and the comprehensive correlation coefficient of the economy have reached 0.7299, which has reached a relatively high degree of correlation. The impact of the proportion of the elderly over 65 (X3) on the economy is mainly reflected in the GDP (Y1) and the secondary industry (Y3), of which the correlation coefficient between it and the GDP (Y1) has reached 0.9991, indicating that the proportion of the elderly over 65 (X3) and the GDP The variation law between (Y1) is basically the same.

Second, the correlation coefficient between the population sex ratio (X4) and the comprehensive economic system is 0.5523, which has reached a medium degree of correlation. The correlation coefficient between population sex ratio (X4) and per capita household income (Y5) is up to 0.7914.

Third, from the correlation coefficient matrix of population structure system and economic system, it can be seen that the average coefficient of population industrial structure index and economic comprehensive system index is 0.5763. Among them, the average correlation coefficient between the tertiary industry population (X7) and economic system indicators has reached 0.6484, indicating that there is a medium correlation between the tertiary industry population (X7) and the economic system, and it reflects the development of the tertiary industry population It has a greater impact on the economy, that is, the tertiary industry plays an important role in the entire economy.

Finally, it can be seen from the correlation coefficient matrix of population structure system and economic system, the average correlation coefficient between the total population (X8) and the indicators

of the comprehensive economic system has reached 0.5006, and the total population (X8) is related to the indicators in the economic system. The correlation coefficients all exceed 0.35, and the correlation between the total population (X8) and the primary industry (Y2) exceeds 0.9, indicating that the total population (X8) and the primary industry (Y2) are highly correlated.

4 CONCLUSIONS

After World War II, Japan's economic development experienced four stages: recovery, high-speed growth, slowdown and stagnation. According to the statistics of the comprehensive institute of social economy of the Cabinet Office of Japan, the Japanese economy has experienced 16 business cycles since 1951, when the post-war reform came to an end. From the beginning of the bubble collapse in the early 1990s, the Japanese economy entered the long stagnation period known as the "lost twenty years" (more than 20 years now). It has experienced five business cycles, of which, in 1998 and 1999, 2008 and 2009, the economic growth rate has been negative for two consecutive years. According to the prediction of the Japan Federation of economic organizations and PwC, the Japanese economy will remain in a depressed state in the next few decades. The reasons for the long-term economic downturn in Japan are manifold. From the results of the study, besides the retaliatory influence of the bubble economy, the change of population structure and the adjustment of industrial structure are also important factors. After entering the 21st century, Japan's population growth rate has decreased significantly, and there was a state of zero growth from 2007 to 2010. Since 2011, Japan's population has entered an era of population reduction. In the process of slowing down and even negative growth of the total population, the most important feature of Japan's population change is "young children aging" (Cui 2016). Japan has lost its "demographic dividend" due to population reduction and rapid aging. Japan's persistently low fertility rate has led to fewer children and a reduction in the working population. In addition to the low fertility rate, the aging of Japan's population is also due to the extension of average life expectancy. The characteristics of Japan's population structure will comprehensively affect the economic growth factors such as consumption demand, investment demand, labor supply, capital formation and technological progress. Due to the reduction of demand in the short and medium term and the decline of supply capacity in the medium and long term, economic growth is bound to stagnate or show a negative growth trend (Li 2016).

From the change of industrial structure, after the 1990s, the proportion of employment in Japan's primary industry and secondary industry continued to show a downward trend, especially in 2009, the proportion of labor force in Japan's primary industry was at a low level in the world. On the contrary, the employment of all sectors of the tertiary industry is relatively prosperous, and the labor force begins to transfer not only from the primary industry, but also from the secondary industry to the tertiary industry. The output value of the tertiary industry and the proportion of the employed population occupy a dominant position, which plays a certain role in maintaining stability of the Japanese economy.

Under the background of the continuous weakness of the global economy and the slowdown of productivity growth, the demographic factor, as a structural factor affecting the economy, has attracted more and more attention of policy makers all over the world. Taking Japan as an example, China needs to take positive population countermeasures to promote economic development: Taking Japan as an example, China needs to take positive population countermeasures to promote economic development:

On the one hand, moderate population growth and vigorous labor supply are important factors for economic development. In recent years, China's birth rate has continued to decline, even below the level of population replacement. Therefore, China needs to optimize its fertility policy, promote long-term balanced population development, and improve supporting measures by reducing the cost of fertility, parenting and education. By formulating laws and regulations, we will increase the population fertility rate, slow down the aging of the population, delay the negative growth of the population and improve the population structure.

On the other hand, there is a close relationship between the development of tertiary industry and GDP growth. In order to effectively play the role of the tertiary industry in promoting the economy, China needs to continue to optimize the industrial structure and promote the upgrading of the population industrial structure. As an important part of modern industry, the development of tertiary industry has an important impact on employment, improving people's life and optimizing economic structure. Since the reform and opening up, with the evolution of China's industry, the proportion of the tertiary industry in the economy has shown an upward trend and developed rapidly, becoming the main force to promote

economic growth. However, the employment structure of China's tertiary industry is unreasonable and needs to be optimized. In the future, it is necessary to promote the coordination of industrial structure optimization and employment transformation to achieve sustainable economic development. Scientifically promote supply side reform, expand the contribution of consumption to economic growth, and maintain long-term sustainable economic growth under the condition of population structure change.We hope you find the information in this template useful in the preparation of your submission.

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