ISSN: 2688-9323

The Population Structure and Industrial Structure Transformation of the Yangtze River Delta Region are Coupled

Jiabin Zeng*

Anhui University of Finance and Economics, Anhui China

*zjbbook@qq.com

Abstract

The Yangtze River Delta region is a vital hub of population concentration in China, currently experiencing a period of rapid industrialization and development. Given the pressing need for industrial transformation and upgrading, it is of utmost importance to explore the intricate interplay between population structure and industrial structure to foster high-quality regional development. Drawing on a theoretical analysis of the interaction mechanism between these two structures, we conducted a quantitative study using 84 prefecture-level cities in the Yangtze River Delta region as our research subjects. Utilizing both the gray correlation degree and coupling degree model, we sought to investigate the coupling status of population structure and industrial structure. Our findings demonstrate a notable upward trend in the coupling degree between population structure and industrial structure in central China between 2011 and 2021. Indeed, the population structure and industrial structure are mutually influencing and interacting with each other, with the age structure, industrial structure, gender structure, and education structure of the population all playing a significant role in driving regional economic development. Our research underscores the importance of understanding the intricate interplay between population and industrial structures for fostering high-quality regional development in China.

Keywords

Demographics; Industrial Structure; Coupling; Transformation and Upgrading.

1. One. Introduction

1.1. Research Background and Significance

1. Background

The development level of a region can be accurately gauged by measuring both the industrial structure and population structure, as the coordinated development of these two factors serves as a key driver for regional economic growth and high-quality development. The evolution of a country or region's population structure is a critical determinant that directly impacts the regional industrial structure. Conversely[1], the process of industrial structure adjustment, transformation, and upgrading is often accompanied by corresponding demographic changes[2]. To this end, numerous scholars have extensively studied the impact of population structure on industrial structure from multiple perspectives[3], such as urban and rural structures, age structures, and cultural structures. Other scholars have conducted in-depth analyses of how industrial structure changes impact demographic adjustments. Nevertheless, academic research on the interaction mechanism between population structure and industrial structure is still relatively insufficient[4], with most studies currently conducted from a single-dimension perspective, either analyzing the impact of population structure on industrial structure or vice versa. As such, there remains an urgent need to deepen our understanding of

ISSN: 2688-9323

the temporal and spatial coupling of population structure and industrial structure, so as to achieve high-quality regional development in an effective manner.

The Yangtze River Delta region, encompassing Shanghai, Jiangsu, Zhejiang and Anhui provinces, spans over 358,000 square kilometers and comprises a total of 41 cities. With a population of 227 million in 2021, the region accounts for 16.1% of China's total population, while its total GDP of 27.6 trillion yuan represents 24.1% of the country's GDP, making it a critical contributor to China's economic and social development landscape. However, the region, currently in the midst of rapid industrialization, faces a significant challenge of restructuring and upgrading its industries[5]. The tertiary industry structure currently stands at 11.8:48.7:39.5, with the primary and secondary industries proportionately 8.1 and 6.1 percentage points lower than the national average, respectively, and the tertiary industry 6.1 percentage points higher than the national average. Additionally, the Yangtze River Delta region has entered an aging society, with the proportion of the population aged 65 and above reaching 20% in 2021, signifying moderate population aging[6]. The city of Shanghai holds the highest proportion at 36.1%, followed by Jiangsu at 23.5%, Zhejiang at 23.43%, and Anhui at 17.1%.

2. Meaning

Amidst ongoing transformations in population and industrial structures in the Yangtze River Delta region, a theoretical investigation has been undertaken to analyze the mechanism governing their interaction. With 84 prefecture-level cities as research subjects, a comprehensive investigation was conducted by constructing a gray correlation degree and coupling degree model to elucidate the coupling process between population and industrial structures. Spatial features were studied, countermeasures were proposed and targeted suggestions were presented for the adjustment of population structure and industrial transformation and upgrading in the region. In the context of the new era, the implications of these findings are substantial, as they can be expected to contribute to the promotion of high-quality development and a new round of growth.

1.2. A Review of the Current Status of Research

However, despite the progress made in previous studies, there is still room for improvement. Firstly, current research mostly focuses on the relationship between population structure and the evolution or adjustment of industrial structure, while the interactive influence of population structure on industrial structure upgrading [7], especially the impact of industrial structure upgrading on population structure, remains largely unexplored. Secondly, existing studies tend to examine the impact of population structure on industrial structure from a single dimension, neglecting the coupling relationship and mutual constraints between the two systems [8]. Moreover, the measurement of industrial structure upgrading is mostly limited to the tertiary industry level, with little attention paid to the internal industrial level and ecological level. Building on this, our study quantitatively investigates the coupling and coordination relationship between population structure and industrial structure indicators based on industrial development. We explore the optimal coupling mode and promotion strategy for population structure change and industrial structure upgrading [9], providing decision-making support for promoting population structure optimization and industrial structure upgrading in the face of new challenges.

2. Two. Empirical Analysis

2.1. Research Methods

This study employs the gray association analysis method, which is based on the gray system theory, to investigate the correlation degree and coupling degree between population structure and industrial structure upgrading. Unlike other correlation measurement methods that rely

ISSN: 2688-9323

on mathematical statistical theory and require a large amount of data, the gray association analysis method uses less data and information to identify statistical patterns. The algorithm adopted in this study involves the following steps:

1, the industrial structure upgrading system is selected as the reference sequence, and the population structure system is chosen as the comparison sequence.

2. the mean method is employed for dimensionless processing, where each series data is divided by its mean value, and the resulting quotient is listed as an averaging series.

3. the absolute difference between the comparison series and the reference series is computed at each time point, and the minimum and maximum values of the difference series are calculated. $min\Delta(k)$ and $max\Delta(k)$,that $max\Delta(k) = max_i max_j \left|X_i(t) - Y_j(t)\right|$ and $min\Delta(k) = min_i min_j \left|X_i(t) - Y_j(t)\right|$.

4.Calculate the correlation coefficient ε_{ij} ,Set the resolution coefficient $\rho = 0.5$,Calculation formula: $\varepsilon_{ij} = \frac{min\Delta(k)+\rho max\Delta(k)}{\Delta_i(k)+\rho max\Delta(k)}$,Correlation calculation formula: $\gamma_i = \frac{1}{N}\sum_{k=1}^{n} \varepsilon_{ij}(k)$, $k = 1,2,3 \cdots\cdots n$,(Table I)

Table I. Calculate the correlation coefficientε_{ij}

Degree of relevance	0	0-0.35	0.35-0.65	0.65-0.85	0.85-1	1
Grade	No Associaton	Low Associaton	Medium Correlation	High Associaton	Highly Associaton	Full Associaton
Degree of coupling	No Coupling	Weak	medium	Strong	Extremely Strong	Fully Coupled

2.2. Construction of Indicator System

Table 2. The specific calculation method of these indicators

System type	Metric type	index
Population knotStructural system	Age structure	0 ~ 14 years old population ratio, 15 ~ 64 years old population ratio, 65 years old population ratio
	Gender structure	Male to female sex ratio (100 for females)
	Educational structure	Years of education (nationwide), 10,000 people with college and above (provincial)
Industrial structure Upgrade the system	The height of the industrial structure	Energy consumption per unit of GDP (Nationwide)
	The industrial structure is reasonable	Electricity consumption per unit of GDP (provincial)
	Industrial structure ecology	Industrial wastewater discharge per unit of GDP

ISSN: 2688-9323

This paper constructs indicators for the population structure system and the industrial structure upgrading system based on the principles of systematization, scientific rigor, and available data. Drawing from the research findings of previous scholars [10], the population structure system indicator system is constructed based on three key factors: age structure, gender structure, and education structure, with a view to providing a more comprehensive measurement of population structure. In order to achieve rapid economic development through industrial structure sophistication and rationalization, while also taking into account the current need for ecological environment construction, this paper expands the goal of industrial structure upgrading to include the creation of an advanced, rational, and ecological industrial structure. The industrial structure upgrading index system is built from the perspectives of industrial structure sophistication, rationalization, and ecology. The advanced industrial structure mainly refers to the sequential evolution of labor-intensive, capital-intensive, and technology-intensive industries within the sector. The rationalization of the industrial structure refers to whether the quality of the main industries is coordinated, whether there is a fault in the technical level, and whether there is a strong contrast between the relevant industries. Lastly, the ecological industrial structure mainly refers to the reduction in industrial energy consumption. The specific calculation method of these indicators is presented in Table 2.

2.3. Coupling Analysis of Chinese Port Structure and Industrial Structure Upgrading.

To investigate the coupling relationship between Chinese port structure and industrial structure upgrading through time series analysis, we selected 11-year sample data from 2010 to 2021. By analyzing the coupling trend and evolution law of population structure and industrial structure upgrading, we obtained insightful results, as presented in Figure 1. Our analysis indicates that the Chinese port structure and industrial structure upgrading system are closely related, with a coupling degree mostly greater than 0.6, indicating medium to high correlation. Furthermore, the population structure system and the industrial structure upgrading system change linearly, showing an increasing trend and phased characteristics.

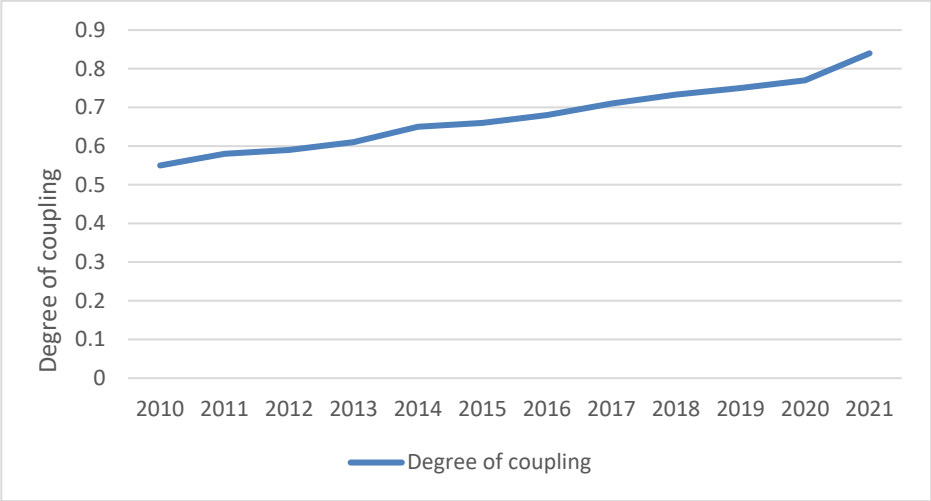

Figure 1. The coupling degree change trend of Chinese port structure and industrial structure upgrading

The fluctuation characteristics of the coupling degree of the two systems suggest that the coupling degree between population structure and industrial structure upgrading is increasing. As industrial structure upgrading accelerates and demographic changes occur, the coupling

ISSN: 2688-9323

degree between the two has gradually increased. From 2011 to 2021, it increased from 0.56 to 0.81, demonstrating an upward trend. China's industrial structure is still primarily industry-based, but the proportion of high-tech industries is rapidly increasing. The number of the labor force and population quality can meet the demands of industrial structure development, leading to a coordinated development between population structure and industrial structure.

2.4. The Main Influencing Factors of Coupling the Chinese Structure and the Upgrading of the Industrial Structure

Grey correlation analysis is a powerful tool for assessing the degree of influence of various factors on the behavior of a system, as it can provide valuable insights into the interdependence of different factors within a system. In this study, the population structure system and the industrial structure upgrading system are both considered as gray systems that can mutually influence each other. Using time series data from China spanning the period from 2010 to 2021, we have conducted a rigorous analysis of the correlation between the indicators of the population structure system and the industrial structure upgrading system, as well as between the indicators of the industrial structure upgrading system and the population structure system. By identifying the advantages of related factors, we have been able to identify the key drivers that have the greatest impact on each system. The results of this analysis are presented in Table 3.

Table 3. Correlation matrix between Chinese structure elements and industrial structure upgrading indicators

	index	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
population structure system	industry structure upgrade system												
	X1	0.65	0.69	0.63	0.68	0.67	0.61	0.69	0.65	0.71	0.61	0.73	0.67
	X2	0.64	0.74	0.74	0.70	0.80	0.80	0.61	0.79	0.82	0.71	0.64	0.79
	X3	0.78	0.77	0.71	0.78	0.72	0.70	0.71	0.71	0.72	0.69	0.76	0.72
industry structure upgrade system	Population structure system												
	Y1	0.71	0.71	0.68	0.59	0.74	0.75	0.62	0.70	0.60	0.61	0.59	0.66
	Y2	0.77	0.74	0.69	0.82	0.70	0.64	0.68	0.79	0.70	0.71	0.71	0.81
	Y3	0.75	0.70	0.74	0.71	0.75	0.71	0.79	0.77	0.71	0.75	0.76	0.71

Table 3 demonstrates that education years exhibit the highest level of comprehensive correlation with industrial structure upgrading, with a score of 0.81, and this figure has remained above 0.75 between 2015 and 2021. This finding suggests that high-quality labor force plays a crucial role in driving the transformation and upgrading of China's industrial structure. Moreover, the proportion of the population between the ages of 15 and 64 shows a significantly positive correlation with industrial structure upgrading, with a score of 0.72. This result indicates that the labor force within the appropriate age range is vital in facilitating the upgrading of the industrial structure. It is noteworthy that labor-intensive industries still dominate the primary industrial structure of China, implying that the demand for a large workforce is a significant driver for industrial structure upgrading.

ISSN: 2688-9323

3. Three. Conclusion and Policy Recommendations

3.1. Conclusion

The coupling relationship between population structure and industrial structure adjustment has a strong linkage effect, and their coordinated development is of great significance for promoting regional high-quality development. Based on the analysis of the interaction mechanism between population structure and industrial structure, this study used gray correlation degree and coupling degree model to quantitatively study the coupling characteristics of population structure and industrial structure in the Yangtze River Delta region, and obtained the following conclusions:

Firstly, population structure and industrial structure interact and influence each other. The age structure, urban-rural structure, cultural structure, and gender structure of the population have complex interactions with industrial structure, which jointly promote regional economic development.

Secondly, the coupling degree between population structure and industrial structure in the central region showed an upward trend from 2011 to 2021. Overall, the changing trend of the coupling degree between population structure and industrial structure in the central region is similar to that of the whole country. The main reason is that the Yangtze River Delta region has taken the lead in development. The optimization and adjustment of population structure and industrial structure are urgently needed, and the two systems are generally in the stage of coordination and adaptation.

3.2. Policy Recommendations

Firstly, to promote regional high-quality development, it is essential to expedite the adjustment of the industrial structure and optimize the population structure. The construction of the Yangtze River Economic Belt and the Yangtze River Midstream City Cluster should be actively pursued, while simultaneously advancing "Made in China 2025" and supply-side structural reform of the manufacturing industry. The transformation and upgrading of traditional industries must be accelerated, and advanced technology should be integrated with traditional industries to promote the deep integration of emerging industries. New impetus for economic growth must be created through scientific guidance of emerging industries. The promotion of new-type urbanization, with the core of urbanization, and the development and expansion of the urban agglomeration in the middle reaches of the Yangtze River should be accelerated. Drawing inspiration from the "retiring without ending" concept in Japan and the United States, corresponding industries should be developed for the elderly labor force, promoting their re-employment and the development of the "silver industry." Furthermore, healthcare, tourism, pension, culture, and entertainment industries should undergo supply-side reforms to meet the consumption needs of the elderly and expand demand to drive economic growth.

Secondly, to promote the benign interaction between population structure and industrial structure upgrading, it is necessary to attract talents from related industries according to the characteristics of the industrial structure and the direction of industrial structure upgrading in the region. Local universities should be engaged in jointly cultivating high-quality talents required by future industries. The upgrading of industrial structure in low-coupling areas should be increased, and energy consumption standards should be reduced. Most of the low-coupling areas are dominated by resource-based industries, and the proportion of high-tech industries is low, leading to high deviation of the industrial structure, low labor efficiency, and high energy consumption per unit of GDP. Accelerating the transformation and upgrading to high-tech industries and tertiary industries is therefore an important direction for the transformation and upgrading of the western region.

ISSN: 2688-9323

Acknowledgments

Anhui Province 2021 Provincial Project Innovation Training Project: “Coupling Analysis of Population Structure and Industrial Structure Transformation: A Case Study of Yangtze River Delta Urban Agglomeration”. Item number: S202110378259.

References

[1] Romalis, J. Factor Proportions and the Structure of Commodity Trade. American Economic Review, 2004, 94(01): 67-97.

[2] R Hausmann, Ricardo, J Huang, and D Rodrik. "What You Export Matters." Journal of Economic Growth 12, no.1(2007):1-25.

[3] ZHANG Guiwen,, SUN Yanan. An Empirical Study on the Coupling Relationship between Human Capital and Industrial Structure Evolution[J]. Chinese Kou Science, 2014, (06):96-106.

[4] Zhang Guoqiang. Chinese Capital Structure, Human Capital Structure and Industrial Structure Upgrading. Chinese Kou Resources and Environment, 2011, (10): 138-146.

[5] Zhou Haiyin. Human Capital and Industrial Structure Upgrading--Examination Based on Interprovincial Panel Data. Dongyue Nongcong 2014, (09): 95-99.

[6] Yang Xiaokai. Principles of Economics. Beijing: China Science Press, 1998. 164. Huang Qian and Li Jingbo. Research on the influence of comprehensive population factors on industrial structure upgrading. Exploring Economic Issues, 2018 (01), 130-137.

[7] Wang Wei, Liu Yufei, and Peng Dongdong. Research on the Effect of Industrial Structure Upgrading on Population Aging. China Industrial Economics, 2015(11), 47-61.

[8] Lin F,Chen J. A Study on the interactive relationship betweenregional human capital and industrial structure adjustment in Shanghai [M]. London： Springer-Verlag,2013.

[9] Golley J,Zheng W. Population dynamics and economic growth in China[J]. China Economic Review, 2015(35): 15 - 32.

[10] David H, Dorn D. The growth of low-skill service jobs and the polarization of the US labor market[J]. American Economic Review,2013,103(5): 1 553 - 1 597.