An Empirical Study on the Impact of Regional Population Age Structure on Urban and Rural Economic Growth

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Abstract: - Whilst the shift in population structure remains one of the pivotal factors influencing urban and rural economic growth, a thorough probe into the relationship between the two is of important significance for beefing up economic growth in both urban and rural areas. On the basis of the results of literature analysis, this paper analyzes the theories related to regional population structure and urban and rural economic growth, builds an analysis model of the impact of regional population structure on urban and rural economic growth, and selects Fujian Province as the research object, combining multiple linear regression to carry out empirical analysis. Our results reveal that the shift in population structure would boost economic growth to a certain extent, yet due attention must be paid to improving the quality of population in order to avoid the decline in economic growth rate caused by the increase in old-age dependency ratio.

Key-Words: - Shift in population structure, Economic growth; Demographic transition, Demographic dividend, Empirical research, Regional economic development.

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1 Introduction

The change of population age structure is a historical, comprehensive and complex natural and social process, and an important factor to promote China's regional economic development. However, China's advantages in population structure will continue to wane in the years to come. In tandem with the ongoing decline in birth rate and death rate, the demographic dividend China is currently reaping will dwindle over time, [1], [2], the deep-seated problems such as the aging of the population and the heavy burden of labor support accumulated in the process of population development have become increasingly prominent. The age structure of the population plays a role in supporting various fields of economic development in the process of change. The change of the age center to the non working age stage, to some extent, has led to economic and social risks such as the weakening of the driving force supporting economic development and the reduction of development quality, which will restrict the long-term development of China's regional economy.

In the context of economic development speed and structural depth adjustment, as well as the urgent transition of population age structure, it has become an extremely urgent task for Chinese scholars and government departments to study the impact of population age structure on economic growth.In the important period of economic transformation, in-depth qualitative and quantitative research on the relationship between the population age structure and economic growth, and a clear understanding of the path, degree of influence and future development direction of the change in the population age structure on economic growth have certain theoretical and practical value for a comprehensive understanding and correct understanding of the economic effects of the change in the population age structure in China's regions and the formulation of relevant policies.

2 Journals Reviewed

The most basic structure in the population structure is the age structure of the population. How the change of the age structure of the population affects economic growth is a typical problem with Chinese characteristics. Scholars at home and abroad have launched a long-term multi angle exploration on this.

Whether changes in the age structure of the population affect economic growth. In foreign countries, based on endogenous technology model, human capital theory and life cycle theory of savings, Malmberg took Sweden's population data from 1950 to 1989 as the research object to verify the economic effect of age structure, that is, the increase in the proportion of people under 29 and

over 75 years old will inhibit economic growth, while the increase in other age groups will promote economic growth, Among them, the largest contribution to economic growth is the proportion of people aged 50-64, [3]. Thomas and other scholars introduced the population age structure variable into the neoclassical growth model, analyzed the data of OECD countries from 1950 to 1990, and found that the per capita GDP growth of OECD countries can be explained by the change of age structure to a large extent, [4]. Bjö rn used the data of Denmark, Finland and other countries from 1950 to 1992 to test the impact of age structure distribution on economic growth, the results show that the increase of the proportion of working age population can significantly promote economic growth, [5]. Jinying Wang and other scholars studied the data of 17 OECD countries from 1960 to 2016 and found that the change of population age structure has a profound impact on the economic structure of OECD countries, [6]. At home, in recent years, the relationship between the age structure of China's population and economic growth has gradually attracted the attention of the academic community. Xibao Guo and other scholars believe that the decline of the proportion of working age population in China, like most middle-income countries, is not conducive to entering the high-income stage, [7]. Dewen Wang believed that the "demographic dividend" generated by the decline in the burden of population support caused by the change in the age structure of the regional population has a high contribution rate to the rapid growth of the regional economy, and is one of the strong drivers of regional economic growth. With the aging age structure of the regional population, the demographic dividend tends to decrease and will eventually close, [8].

With regard to the impact of changes in the age structure of the population on China's economic growth, existing studies have not reached a consistent conclusion. The main point of view is that the changes in the age structure of the population in a long period after the reform and opening up have promoted China's economic growth, but at this stage, the impact is uncertain, mainly because of the particularity of the age structure of China's population. For example, the age structure of China's population is showing the deepening of aging The implementation of the second child policy has led to the increase of child dependency ratio and other characteristics, which has brought many uncertainties to China's future economic development. In addition, most of the current studies focus on the impact of population age structure on economic growth and the role of characteristics of different development stages of population age structure on economic growth. There is less in-depth analysis on the impact mechanism of population age structure on economic growth. In this regard, many studies have focused on the relationship between the change of population age structure and economic variables. These studies contain the relationship between population age structure and economic growth. These documents can be summarized as the impact of population age structure on China's investment, savings, public expenditure, import and export, consumption and other fields. From these studies, it can be found that the change of population age structure is widely concerned by society, one of the important reasons is that the change of population age structure will affect the economic growth of the country by affecting various regions. This paper sorts out these studies as the empirical basis for studying the mechanism of the change of population age structure on economic growth.

3 Theories about Regional Population Structure and Urban/Rural Economic Growth

3.1 Theories about Population Structure

On the basis of literature review, we hereby divide the theories about population structure into two categories, i.e., the theory of demographic transition, and the theory of demographic change and economic growth.

1.Theory of demographic transition

Originating at the beginning of the 20th century, the theory of demographic transition is the conclusions drawn by comparing the demographic statistics and the economic development status in the same period, [9], [10]. Today, in parallel with the burgeoning development of economic globalization and urbanization, death rate and birth rate continue to slide downwards, and the population growth rate has been lingering at a low level for a long time. All of these are reflective of the main points of the theory of demographic transition. The theory of demographic transition has close links to economic development, and the integration of the two has given rise to the "Five-stage Theory" of demographic transition, as shown in Figure 1.

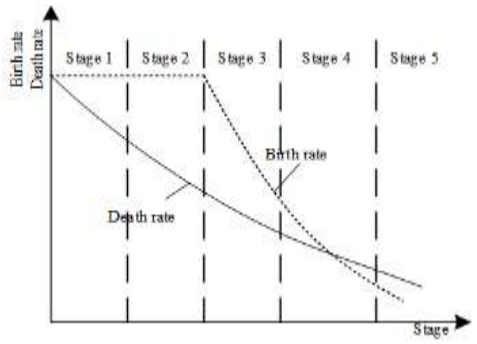

Fig. 1: Five-stage theory of demographic transition

As shown in Figure 1, in Stage 1, population growth remains static. In Stage 2, economic growth drives up the population growth rate. In Stage 3, population growth slows down due to further economic growth. In Stage 4, population growth comes to a halt. In Stage 5, death rate gradually surpasses the birth rate, leading to negative population growth.

2.Theory of Demographic Change and Economic Growth

After a detailed analysis of this theory as explained in previous studies, we have constructed an equation to model the relationship between the two. Here, we have A as the workforce in the region, B as the total population in the region, C as elderly people aged over 60 in the region, and D as children in the region. We can then get the old-age dependency ratio α , the young-age dependency ratio β and the total-age dependency ratio χ for this region. Using w to represent the GDP created by people of working age in this region, the relationship between population and economic growth can be modelled as:

$$GDP = N \times \frac{1}{N} \times \frac{GDP}{A} \tag{1}$$

It can be seen from Equation (1) that different population structures would have different impact on the local economic development. This Equation can be used as the theoretical basis for the empirical analysis part of this study.

3.2 Relationship between Population Structure and Economic Growth

A large number of scholars have focused their research on the association between demographic outcomes and economic growth, whilst ongoing literature review and research efforts have produced three types of perspectives on the association between population structure and economic growth, i.e., pessimistic theory of population growth, optimistic theory of population growth, and neutral theory of population growth, [11].

The pessimistic theory of population growth argues that population growth will lead to a shortage of social materials, thus resulting in negative economic growth. This perspective is incomprehensive and can only be used to analyze agricultural societies. With the boom in industrial development, this theory could no longer comprehensively explain the relationship between population growth and economic growth, and thus optimistic theory of population growth came into being. According to the optimistic theory of population growth, population growth can boost investment and consumption, thereby shoring up economic growth. In the wake of technology advances, the drawbacks of this theory gradually came to the surface, and the neutral theory of population growth was proposed in such a context. The neutral theory regards the quality of population as the linchpin of economic growth, arguing that the changes in population size and population structure will lead to a fundamental shift in labor productivity and working environment, which will in turn lead to the continued changes in economic growth. In this study, we will build our analysis on the neutral theory of population growth to shed light on the impact of regional population structure on urban and rural economic growth.

4 Statistical Model and Methodology

4.1 Statistical Model

In this study, economic theories and practical systems were introduced, and the BDS technique was harnessed to construct an empirical statistical analysis model. Based on nonlinear characteristics, we performed statistical analysis on the collected data to complete the empirical analysis. Through literature review, we can learn that BDS is a technique for nonlinear data analysis, [12], [13]. According to this method, let T be the time series for the target region and $(T_i, T_{i+1}, ..., T_{i+m-1})$ be the observations at this stage, in which case the correlation integral, an estimator of spatial probabilities across time in the region, is computed as:

$$R(E,q) = \sum_{t=1}^{E_{m-1}} \sum_{u=t+1}^{E_{m-1}} H(T_i, T_j, q) * \frac{2}{T_j(T_j - 1)} \tag{2}$$

In Equation (2), $H(T_i, T_j, q)$ refers to the indicator function; $\|T_i, T_j\|$ refers to the Euclidean distance between the series T_i and T_j; q refers to the bandwidth in space; E refers to the total number of data samples. By dividing the series T_j into multiple subsamples, the resulting statistic after testing this model can be expressed as:

$$L_m(E,q) = \frac{\sqrt{E}\left(R_i(E,q) - R_1(E,q)\right)}{\varphi_i(q)} \quad (3)$$

In Equation (3), $\varphi_i(q)$ refers to the standard deviation of a given data sample, and $L_m(E,q)$ refers to the BDS statistic, which conforms to the normal distribution. This equation was used for the statistical analysis of the data collected for this empirical study.

4.2 Model Testing

After comparing multiple models, the RCM test model, [14] was selected to test the results obtained in this study. Assuming that the state classification number Z is a measure built on a random variable, it has two states -correct and incorrect:

$$RCM = N * \frac{1}{T}\sum_{t=1}^{T} \partial\left\{x_t = j \middle| \sigma_i\right\}\left(1 - \left\{x_t = j \middle| \sigma_i\right\}\right) \quad (4)$$

In Equation (4), N refers to the normalized value of RCM, and $\partial\left\{x_t = j \middle| \sigma_i\right\}$ refers to the smoothed probability of all information in each state in the information set. Where there are F states, then:

$$RCM(F) = 100F^2 \frac{1}{T}\sum_{t=1}^{T} \partial\left\{\prod \sigma_i\right\} \quad (5)$$

In Equation (5), F refers to the number of states, T refers to the number of samples, and σ_i refers to the data smoothed probability. When RCM is close to 0, the result obtained will be more reliable. In this study, this model was used to test the empirical results.

4.3 Production Function Model

In this study, the production function model will be used to complete the empirical analysis. This model can help determine the relationship between labor input and capital input, and the computational process can be summarized as:

$$Y = O(t)G^{\partial}P^{\wp}\theta \quad (6)$$

Where Y refers to economic output; $O(t)$ refers to factors affecting economic growth, such as technological advances; G refers to labor input; P refers to capital input; ∂ refers to the output elasticity of labor; $\wp$ refers to the output elasticity of capital; and θ refers to the random error. In this study, this model was utilized to probe into the impact of intra-regional economic outcomes on urban and rural economic growth.

5 Empirical Analysis of the Impact of Regional Population Structure on Urban and Rural Economic Growth

In order to systematically probe into the impact of regional population structure on urban and rural economic growth, we selected China's Fujian Province as the subject of our empirical analysis. By obtaining the relevant demographic data for Fujian, we analyzed the demographic transition and the shift in population structure in Fujian, and also probed into its trends in economic growth. All data are from China Statistical Yearbook of each year.

5.1 Descriptive Analysis of Population Structure

Amid the ongoing population change, after the birth rate has peaked, it will go down gradually, in which case there will be a period during which both children and elderly people take up a lower proportion in the total population. This study will build its analysis of regional population structure on the United Nations' classification of age structures, as shown in Table 1.

Table 1. Classification of age structures

Type	Young-age dependency ratio	Old-age dependency ratio	Proportion of youth and elderly populations	Median age
Young	Above 45%	Below 5%	Below 16%	Below 18 years
Adult	30% to 45%	5% to 8%	16% to 35%	18-30 years
Old	Below 30%	Above 8%	Above 35%	Above 30 years

After taking statistics of the labor force and employed population in this region in the past years according to Table 1, the variations in age and employment are shown in Table 2.

Table 2. Working-age population and employed population in Fujian Province over the past 30 years (in 10,000s, %)

Year	Young-age Dependency Ratio	Old-age Dependency Ratio	Employed Population	Employ-ment Rate
1990	31.47	5.07	1348.38	44.40
1995	30	6.5	1567.1	48.56
2000	23	6.68	1794	52.61
2005	18.3	8.8	1923	54.06
2010	15.47	7.9	2114	57.24
2015	16.22	8.45	2768.41	72.11
2020	10.47	11.12	2206	53.02

According to the statistics shown in Table 1 and Table 2, it can be seen that the population structure of this region has shifted in tandem with the changes in birth rate and death rate. Fujian Province has embarked on a trajectory of population ageing since 2000. During the period covered by this study, in the wake of technological advances and economic boom, people's life expectancy continued to edge up, whilst birth rate kept going down. Total-age dependency ratio was dominated by old-age dependency ratio, and such a situation is likely to last long. In the meantime, the influx of massive working-age population into cities led to a fundamental shift in the population structures of both urban and rural areas, which in turn spurred the gradual change in total-age dependency ratio and posed daunting challenges on regional economic growth.

Amid the ascent of total-age dependency ratio, Fujian's demographic dividend gradually waned, with employed population and employment rate also falling year by year. By using the demographic equation to project the population structure of this region, it's found that Fujian's demographic dividend could last until 2030. With the advent of the "Three-child Policy", both the proportion of youth population and the birth rate are likely to increase in Fujian. Although such increase might push up the young-age dependency ratio in the foreseeable future, it can also drive up future labor supply and thus lengthen the period of demographic dividend. Therefore, Fujian Province should seize the opportunity and maximum the benefits of its own population structure.

5.2 Relationship between Regional Population Structure and Urban/Rural Economic Growth

1.Construction of Research Model

On the basis of the production function model described above, variables such as regional total-age dependency ratio, young-age dependency ratio and old-age dependency ratio were introduced to perform multiple linear regressions on labor input and capital input, in a bid to shed light on how the shift in population structure would have impact on economic growth.

On the basis of Equation (6), we first took the logarithm to eliminate the variances on both sides of the equation, thereby obtaining the double-log production function model, [15] :

$$\ln Y = O + \partial \ln G + \wp \ln P + \theta_1 \tag{7}$$

On the basis of this model, we utilized Equation (1) to introduce variables to expand the production function, thereby obtaining the model for measuring economic growth:

$$\begin{cases} \ln Y = O + \partial \ln G + \wp \ln GDP + \theta_2 \\ \ln Y = O + \partial \ln(G^{-\chi}) + \wp \ln GDP + \theta_2 \\ \ln Y = O + \partial \ln(G^{-\alpha}) + \wp \ln GDP + \theta_2 \\ \ln Y = O + \partial \ln(G^{-\beta}) + \wp \ln GDP + \theta_2 \end{cases} \tag{8}$$

After constructing Model (7), we extracted the total-age dependency ratio as an independent economic growth determinant for analyzing the direct effects of the shift in population structure on economic growth. As stated in the theoretical analysis part of this paper, the decline in total-age dependency ratio will drive up the labor force participation rate, thus contributing to economic growth, [16], [17].Therefore, in this study, we will use Equation (8) to measure how the shift in population structure would contribute to economic growth.

Since only a few model variables were used in this study, in order to ensure the validity of the model, we used Eviews 6.0 in combination with the test model mentioned above to test the calculation results.

2.Model Calculation Results

Calculation results obtained using the above models, indicators and variables are shown in Table 3.

Table 3. Indicators of urban/rural economic growth in Fujian Province (in 100 millions of RMB)

Year	GDP	Capital Stock
1990	522.28	306.239
1995	2094.9	647.233
2000	3764.54	1276.367
2005	6415.47	2279.981
2010	15002.51	5310.194
2015	26819.46	8617.032
2020	43903.89	12952.468

The analysis was done using Equation (8) and the data in Table 3 and Table 2. Data analysis and processing were done using the data analysis software of SPSS. Linear regressions were performed using the least squares method. The test results of the model calculation results are shown in Table 4.

Table 4. Model regression estimates and test results

Model Variable	Unstandardized Coefficient	Standard Deviation	Standardized Coefficient	Significance
lnY	0.504	0.009	0.640	0.000
lnG	1.298	0.007	0.204	0.000
GDP	-0.734	0.142	-0.071	0.025
lnY	0.470	0.014	0.184	0.000
LnY^{-x}	1.104	0.064	0.539	0.000
lnY	0.454	0.014	0.504	0.000
$LnY^{-\alpha}$	1.105	0.068	0.404	0.000
lnY	0.571	0.011	0.614	0.000
$LnY^{-\beta}$	1.405	0.085	0.204	0.000

Figures shown in the above table are the results exported by SPSS. According to Table 4, the proposed model can produce relatively stable calculation results, and the significance of the calculated results of each variable is greater than the critical value. The calculation results exhibit a certain extent of stability, and can be tested to confirm the existence of a long-term dynamic relationship. According to Equation (5), the stationarity of calculation results must be tested through unit root test. In order to enhance the robustness of the calculation results of Equation (5), the unit root test must be done using two different methods. If the two methods produce consistent test results, the results can be exported directly; if the two methods produce inconsistent test results, adjustments would be necessary. After using the test model to make necessary adjustments, the significance of variables improved greatly, confirming the existence of a long-term dynamic relationship between the calculation results and the variables. Finally, by analyzing the model calculation results, the impact of regional demographic outcomes on urban and rural economic growth can be discerned.

According to the calculation results of the model, China's market economy was still in its infancy in the 1990s. With the influx of capital into the market, the industrial structure gradually shifted from a labor-intensive one to an asset-intensive one, and Fujian also closely followed the footsteps of the market economy. During this period, capital contributed greatly to economic growth, and the total-age dependency ratio was negatively correlated with economic growth — that is, when the total-age dependency ratio came down, economic output would climb up. Our calculation results well accord with the economic growth characteristics in this period as described in other studies. After 2005, due to the impact of economic crisis, the market saw another round of massive capital inflow, and market economy posed increasingly higher requirements on human capital. During this period, the total-age dependency ratio was positively correlated with economic growth. The sweeping inflow of rural population into the cities led to rapid industrial development and boosted the market economy. However, the increasing proportion of elderly people and children in the total population in rural areas has brought agricultural development to a standstill. While population ageing, which is gradually stepping up its pace, is stalling economic growth, the early economic dividends still remain.

By analyzing the standardized coefficients of labor input in the calculation results of the proposed model, it can be seen that the impact of labor input on economic growth remains around 0.350 when the impact of total-age dependency ratio on labor output is not taken into account. When the total-age dependency ratio is taken into consideration, the economic growth would be greatly affected by labor input. Meanwhile, a systematic analysis of the calculation results can confirm that the shift in population structure would lead to a shortage of labor resources, which would in turn hold back economic growth. Comprehensive analysis of the above results confirms that the shift in regional population structure and the continued increase in the total-age dependency ratio would drive down labor output and compromise economic growth, thereby reducing the contribution of the shift in population structure to economic growth.

6 Summary

After an empirical analysis of the impact of regional population structure on urban and rural economic growth, we have obtained the following results:

1.During the period covered by this study, there existed long-term dynamic relationships between total-age dependency ratio, population structure and economic growth in the subject region, and there was a negative correlation between dependency ratio and economic growth. In the years to come, the subject region is expected to heighten its utilization of demographic dividend.

2.In analyzing the impact of regional population structure on urban and rural economic growth, it's found that the contribution rate of population structure to economic growth, as estimated in this study, basically accords with the findings of existing studies, suggesting that the analysis model used herein is valid and can be used for subsequent research.

3.To push up economic growth rate and plug the yawning gap in economic growth between urban and rural areas, it's necessary to enhance the quality of population, tap the huge potential of the elderly, optimize the current labor force structure, and effectively mitigate the employment pressure.

4.Current demographic outcomes are not conducive to economic growth. The total-age dependency ratio has been edging up due to the plunge in birth rate. Whilst the shift in population structure has long been a driver of economic growth, population ageing is apparently hindering economic growth. If population quality remains unimproved, urban and rural economic growth will surely be compromised.

7 Conclusion

Whilst population structure has long been a crucial determinant of China's economic development, the ongoing shift in population structure is having a seismic impact on China’s urban and rural economy, with certain regions even undergoing negative economic growth. Through thorough empirical analysis, this study attempts to shed light on the relationship between the regional population structure and urban and rural economic growth, in the hopes that its findings would inform future policies and provide theoretical basis for future economic development.

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Contribution of Individual Authors to the Creation of a Scientific Article (Ghostwriting Policy)

Tzu-kuang Hsu conceived idea; Chien-hsien Wu performed the data analysis and wrote the paper.