

Analysis on Economic Effects of Urban Population Structure in China

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Abstract—Based on the production function of Cobb-Douglas and the model of Solow growth, the paper set up the state space model as the core of the urban population structure. Then use the national economic statistics from 1995 to 2014 to measure the economic effect of age structure, urban and rural structure and cultural quality structure. The results were as follows. The conclusions of the paper can be presented that the promotion of economic development from the urban and rural structure of urban population was gradually increasing, the second was relatively stable from the age structure of urban population, the third was gradually weakened and even played a hindrance from the cultural quality structure of urban population in China after 2005, which has been obviously getting better.

Keywords—urban population; urban and rural structure; age structure; cultural quality structure; state space model

I. INTRODUCTION

Since the reform and opening up, Chinese economic and social achievements have made great achievements. With the sustainable development of the national economy, the achievement has led to a significant change in the demographic structure of the country. As both the producer and the consumer, the effects of these demographic factors on the national economy have aroused great attention from governments. At the same time, the urban and rural structure, age structure and cultural quality structure of the population are gradually formed by the national policies such as household registration, birth, education and urbanization. The influence and effect of these structures on the national economy has aroused extensive discussion from scholars at home and abroad. At present, most of the literature on the economic effects of population structure research focus on the study of population age structure, cultural quality structure, urban and rural structure on the effect of the economy. Andersson (2001), after studying Sweden, Denmark, Norway and Finland and other Nordic countries, found that age structured (1952-1992 years) and the proportion of economic growth in the working age population is significantly positive correlation [1]. Meifeng Wang and Rong Chen (2015) used the CGE model to analyze the economic effect of quantitative analysis only changing the age structure of the population, finding only by simulating the population age structure change will lead to China's economic growth rate slow [2]. Denison (1962), through the analysis of

the cultural quality of economic analysis, during the 1929-1973 growth, found that the cultural quality of the population of the United States education on the economic contribution were 20 percentage points on workers' cultural and technical education of the average American labor efficiency increased by 0.97 percentage points [3]. Qianchang Cheng (2009) based on the statistical data of China population culture quality structure and economic development level of 1994-2006 years of analysis, Xianhong Qin (2008) based on the relevant data and Shujuan Chen (2013) based on the establishment of VAR model, they found a strong correlation between the development level of China's economic and cultural quality of population [4-6]. Ting Wang (2013) based on using 1996~2011 Chinese provincial panel data and Kaihao Liu (2014) based on the provincial panel data in China during 1990-2012, found the population urbanization and economic growth showed a positive correlation [7-8]. Based on the knowledge, the Cobb-Douglas Production Function and the Solow Growth Model, the paper constructed the state space model to analyze the age structure of our population, cultural quality structure, and urban and rural structure on the effects of the economy.

II. THEORETICAL MODEL OF ECONOMIC EFFECT

Scholars generally started from the aspects of labor, capital and technology on economic growth, of which the Cobb-Douglas Production Function is one of the best. The late Solow growth model illustrated how the capital stock growth, the labor growth and the technological progress interact mutually in an economy and then affect the total output of products and services [9]. The improved Solow Growth Model on technological progress is as following.

$$\log(Y) = \log(A) + \alpha \times \log(K) + \beta_1 \times \log(L) + \beta_2 \times \log\left(\frac{L^2}{L^1}\right) + \beta_3 \times \log\left(\frac{L^3}{L^2}\right) + \beta_4 \times \log\left(\frac{L^4}{L^3}\right) \quad (1)$$

Where K is capital, L is labor, E is labor efficiency. The specific function of (1) is as following.

$$\log(Y) = \log(A) + \alpha \times \log(K) + \beta_1 \times \log(L) + \beta_2 \times \log\left(\frac{L^2}{L^1}\right) + \beta_3 \times \log\left(\frac{L^3}{L^2}\right) + \beta_4 \times \log\left(\frac{L^4}{L^3}\right) \quad (2)$$

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In order to eliminate the possible influence from the heteroscedasticity, (2) is subjected to logarithmic processing. So (2) is treated as following.

$$\log(Y) = \log(A) + \alpha \times \log(K) + \beta_1 \times \log(L_1) + \beta_2 \times \log\left(\frac{L_2}{L_1}\right) + \beta_3 \times \log\left(\frac{L_3}{L_2}\right) + \beta_4 \times \log\left(\frac{L_4}{L_3}\right) \quad (3)$$

The paper built a new model based on (3). It can be seen from the literature review that population structure research could be divided into population age structure, urban and rural structure and population culture quality structure. Based on the above, the paper considered the effects of Chinese urban population structure on the economy as in (4).

$$\log(Y) = \log(A) + \alpha \times \log(K) + \beta_1 \times \log(L_1) + \beta_2 \times \log\left(\frac{L_2}{L_1}\right) + \beta_3 \times \log\left(\frac{L_3}{L_2}\right) + \beta_4 \times \log\left(\frac{L_4}{L_3}\right) \quad (4)$$

Where L_1 is the total population of society, L_2 is the urban population; L_3 is the employed population in the urban population. K represents the efficiency of the labor force. As Manhunt thought that the improvement of labor efficiency is based on the role of education [9], we take into account the proportion of college students in the proportion of the total population as an important indicator of the quality of culture and education [10-11]. So this article placed the proportion of ordinary college graduates on the proportion of the working population labor efficiency. Thus there is (5).

$$\log(Y) = \log(A) + \alpha \times \log(K) + \beta_1 \times \log(L_1) + \beta_2 \times \log\left(\frac{L_2}{L_1}\right) + \beta_3 \times \log\left(\frac{L_3}{L_2}\right) + \beta_4 \times \log\left(\frac{L_4}{L_3}\right) \quad (5)$$

Where L_4 is the number of ordinary college graduates. Put (4) and (5) into (3) to obtain (6).

$$\log(Y) = \log(A) + \alpha \times \log(K) + \beta_1 \times \log(L_1) + \beta_2 \times \log\left(\frac{L_2}{L_1}\right) + \beta_3 \times \log\left(\frac{L_3}{L_2}\right) + \beta_4 \times \log\left(\frac{L_4}{L_3}\right) \quad (6)$$

In this paper, (6) is simplified (7).

$$y = \alpha_0 + \alpha_1 \times x_1 + \alpha_2 \times x_2 + \alpha_3 \times x_4 + \alpha_5 \times x_5 + \varepsilon \quad (7)$$

Where $y = \log(Y)$, $x_1 = \log(K)$, $x_2 = \log(L_1)$, $x_3 = \log\left(\frac{L_2}{L_1}\right)$, $x_4 = \log\left(\frac{L_3}{L_2}\right)$, $x_5 = \log\left(\frac{L_4}{L_3}\right)$.

This paper took into account the per capita GDP and per capita investment to show the level of economic development, and we knew that due to the huge gap between urban and rural economic level and the gap level was often at a variable level, which resulted in rural vulnerable economic development of policies at all levels. The primary industry was mainly agricultural production activities. In order to effectively observe the law of the market, we used the sum of the added value of the second industry and the added value of the tertiary industry to divide the urban population, which was described by Y , and to reflect the economic development through y in (7). In this paper, what urban social investment was divided by the

urban employment population was to describe the investment (K), so we through x_1 to describe the effects of investment on the economy, and its effects through α_1 to reflect in (7). L_1 was the total population of society, so x_2 was described the effects of the total population on the economy, and its effect was reflected by α_2 in (7). Because L_1 was the total population of society, L_2 was the urban population, so this article described the population of urban and rural structure by the effects of x_3 , and its effects was reflected by α_3 in (7). As L_2 was the urban population, L_3 was the urban labor force, we considered that according to the National Bureau of Statistics of the labor population explained that the labor population for the 15 years of age and above 65 years of labor force, L_3 and L_2 ratio reflected the 15-64 years of age population in the proportion of the total population, and with a subtraction of its proportion to the total dependency ratio, so this article through x_4 could describe the effects of population age structure on the economy, and its effects was reflected by α_4 in (7). As the L_3 was urban labor force, L_4 was the number of ordinary college graduates, so through x_5 to describe the cultural effects of population culture on the economy, the effects was reflected by α_5 in (7). α_0 reflected the effects of other factors on the economy in (7), and ε was the system error in (7). The above data was derived from official data published by the National Bureau of Statistics website (<http://data.stats.gov.cn/>).

III. EMPIRICAL ANALYSIS ON THE ECONOMIC EFFECT OF POPULATION STRUCTURE

A. Data inspection

In order to explore the rationality of the model, we first need to verify the causal relationship between the data. Granger causality test is one of the important and commonly used causal analysis methods [12]. The Granger causality discussed in this paper is presented by Granger (1969). Under the condition of a significance level of 0.05, the change of x_1 , x_2 , x_3 , x_4 , and x_5 was not caused by y through the Granger causality test, and x_1 , x_2 , x_3 , x_4 , x_5 were all the cause of the change to y through the Granger causality test.

In order to avoid pseudo-regression of the model, it was necessary to co-integration the data. Before the co-integration test, we need to make a single test of the data. We knew that the standard method of testing sequence smoothness is the unit root test. The unit root test used herein was the Augmented Dickey-Fuller test (ADF) test. We compared the absolute values of the T values corresponding to each variable to the absolute value of the values at the corresponding critical values and the corresponding Prod values by performing a monolithic test on y , x_1 , x_2 , x_3 , x_4 , and x_5 . Finally, we found that y , x_1 , x_2 , x_3 , x_4 , and x_5 were second order singlet at the explicit level of 5%, thus satisfying the co-integration test condition. The co-integration test is generally more commonly used for the Johansen co-integration test and the regression residual stability test. We considered that the selected variables were second-order integers, but because the Johansen co-integration test is not suitable for single-order second-order process testing [13]. Therefore, the covariance test was used to test the stability of the regression residual of model (7). It can be seen

from the results, at the significance level of 5%, which we could think that the regression residual smooth, in other words, y and x_1, x_2, x_3, x_4, x_5 were co-integration.

B. Construction of State Space Model and Estimation of Parameter

In the econometric literature, the state space model is often used to estimate unobservable time variables such as rational expectations, measurement errors, long-term income, and unobservable factors (trends and cycle factors). There are two main advantages to use dynamic space in the form of state space. First, the state space model combines unobservable variables (state variables) into the observable model and obtains the estimated results together. Secondly, the state space model is a powerful iterative algorithm (Kalman filter) to estimate. Based on the above analysis and model (7), the corresponding state space model was constructed and the Kalman filter algorithm was used to estimate the final state space model with better effect.

The signal function is as following:

$$y = c(1) + sv1 \times x1 + sv2 \times x2 + sv3 \times x3 + sv4 \times x4 + sv5 \times x5 + [var = \exp(c(2))]$$

The state function is $sv1=sv1(-1)$, $sv2=sv2(-1)$, $sv3=sv3(-1)$, $sv4=sv4(-1)$, $sv5=sv5(-1)$.

The $sv1, sv2, sv3, sv4$ and $sv5$ are represented the elasticity of the investment, the elasticity of the total population, the elasticity of the urban and rural structure, the elasticity of age structure, and the elasticity of cultural quality structure. Finally, the consequence was shown in Fig.1, Fig.2, Fig.3, and Fig.4.

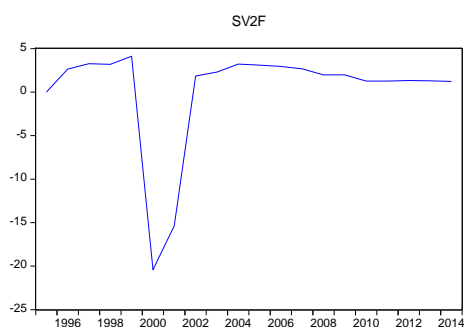


Fig. 1. The elasticity of the total population to the economy

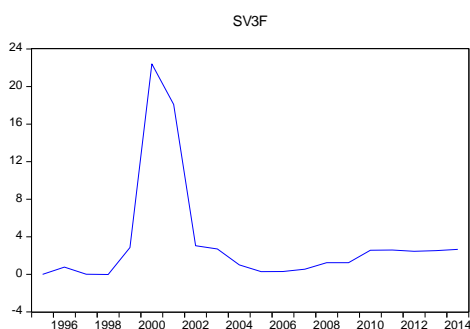


Fig. 2. The elasticity of the urban and rural structure to the economy

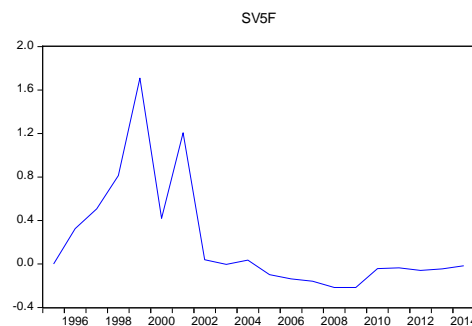


Fig. 3. The elasticity of the population age structure to the economy

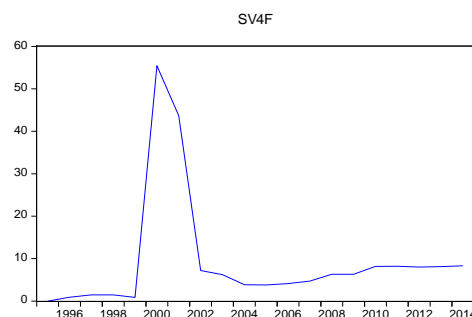


Fig. 4. The elasticity of the population cultural structure to the economy

C. Analysis on the result

We could analyze the economic effects of Chinese population structure on China from 1995 to 2014 through the above-mentioned results of spatial estimation.

1) The effects of the total population on the economy

Through Fig.1, we could see that the total population of Chinese economy were playing a significant role in promoting, and the demographic dividend was very obvious except in 1999 (the elasticity was -20.4071) and 2000 (the elasticity was -15.3727). Although the effects of the total population on Chinese economy in 2004 and 2014 played a catalytic role, the role was declining (the elasticity was 3.2150 in 2004 and the elasticity was 1.2240 in 2014). Taking into that account the growth rate of the total population size is slowing down in China and more enterprises are adopting a higher level of technology, so social management should adjustment the old pattern of population divides and tap the new dividend model of Chinese huge population.

2) The effects of urban and rural structure on economy

Through Fig.2, we could see that the population and urban and rural structure on Chinese economic effects, in addition to 2000 (the elasticity was 22.4100) and 2001 (the elasticity was 18.0867), was relatively stable. And in general, in addition to 1998 (also only the elasticity was -0.0246, the negative effect was not significant), the other years of urbanization on Chinese economy were playing a catalytic role. The elasticity of urban and rural population in China was greater than 2.45, and it was an upward trend from 2010 to 2014. Therefore, it reflected that the urbanization of our country was correct, and the promotion effect of urbanization on Chinese economic development was

obvious. Therefore, we should adhere to the urbanization path in the urban and rural structural reform.

3) The effects of population age structure on economy

Through Fig.3, we could see that the population age structure of China's economic effects is relatively stable and relatively steady was increasing in addition to 2000 (the elasticity was 55.4423) and 2001 (the elasticity was 43.6791). The elastic of was 3.8119 in 2005, but the elastic steadily rose to 8.3223 by 2014. This reflected the rationality of the current age structure of the population in China. But take into account the increase in the aging of our country and the decline in the birth rate, which will lead to Chinese population age structure of the economic role of the weakened. So this requires us to prepare for the response.

4) The effects of population cultural quality on economy

Through Fig.4, we could see that the elasticity were positive in 1996-2002 and 2004. The cultural quality of the population played a significant role in promoting the development of Chinese economy from 1996 to 1999. The cultural quality of population on Chinese economic development hinder the role, which we understood the opposite before form 2005 to 2014. Although the cultural quality of population form 2008 to 2014 played a hindrance on Chinese economic development, this effect was markedly declining (the elasticity was -2.2157 in 2008, the elasticity was -0.0169 in 2014). Taking into account the lag of cultural education and the great externalities, we believed that Chinese population cultural quality in the near future would certainly play a significant role in promoting economic development; so that Chinese huge population education dividend will be highlighted.

IV. CONCLUSION

The paper applied Granger causality test, single test, co-integration test based on Cobb-Douglas Production Function and Solow Growth Model, analyzed the economic effects of urban and rural structure, age structure and cultural quality structure of urban population by the state space model in China. In the paper, through the analysis of Chinese family planning policy in the process of continuous adjustment, the total population of the city role in promoting the economy was gradually declining. With the adjustment of our household registration policy and the implementation of the strategy of urbanization, the urban population structure of urban and rural areas promoting the role of the economy were gradually increasing. Under the enormous pressure of population aging, the age structure of urban population in China was relatively reasonable, and the promotion effect of economy was relatively

stable. Due to the lag and externalizations of culture and education, the cultural quality structure of urban population has gradually weakened and even played a role in promoting the economic development in China from 2005, but this effect was becoming more and more positive. The data used in this paper was relatively simple, especially the average investment of the working population and the cultural quality of the population were incomplete. In spite of the paper got better analysis results, its limitation was also obvious. The mathematical model applied in this paper was only focused on the relationship level, which was still to be improved in the future research on the contribution degree analysis, the weight evaluation and the combination effect.

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