
THE IMPACT OF POPULATION AGEING AND LABOR SUPPLY ON ECONOMIC GROWTH - ANALYSIS BASED ON PANEL AUTOREGRESSIVE MODEL

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Abstract

Population Ageing will increase the proportion of the elderly in the population and affect the Labor supply, which will eventually have an effect on the economy. This paper first analyzes the impact of aging on labor supply and economic growth from the theoretical level. Population ageing argues will reduce the supply of labor and hamper economic growth. Then, based on the panel data of 31 provinces, municipalities and autonomous regions in China, this paper uses panel auto-regression Model. An empirical analysis of the interaction between population ageing and labor force is carried out by means of Impulse Response Diagram and variance decomposition. The study adds to evidence that ageing reduces the supply of labor and hence economic growth.

Keywords: Population Ageing; Panel autoregressive model; pulse effect; variance decomposition

1. Introduction

As China's economy grows and the country stabilizes, its population structure has changed from "high birth rate, high mortality rate and low life expectancy" to "low birth rate, low mortality rate and high life expectancy". In 2000, China's population aged 65 and over accounted for 6.96% of the total population. According to the international standard of 7% aging, China began to enter the population ageing society, and in 2014 it became the country with the largest elderly population in the world. By the end of 2017, the proportion of the elderly population was 11.39%, far exceeding international standards.

At the same time, the developed countries in the world basically entered the population ageing stage when their economies were developed, while China entered a new stage of demographic transition when its per capita income level was still low, forming the characteristics of "old before getting rich". Therefore, in the context of the deepening of

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the population ageing and the slowing of economic growth, it is necessary to study the mechanism and actual consequences of the population ageing on the Labor supply, which is the prerequisite for standardizing the countermeasures and scientifically controlling the influence of population ageing.

2. Literature Review

2.1 . A study on population ageing and Labor supply

The first is the impact of population ageing on the size of the labor force and labor force participation rate. Examples include Wang Lijun, Ma Wenxiu (2012); Guo Yu (2013); Wei Xiahai (2015); Wang Huan (2015); Zhu Qin, Wei Taoyuan (2017).

Second, population ageing affects labor productivity. Such as Xu Shengyan, Zhou Mi (2013); Ren Ming, Jin Zhouyong (2015); Zhou Hao, Liu Ping (2016); Liu Yulin, Zhangmin (2017), etc.

Third, population ageing affects the composition of the working age population, Such as bloom.et al (2010); Qi Chuanjun (2010); and Chen Yuxue (2015).

2.2. Research on population ageing, Labor supply and economic growth

Domestic scholars mostly study the effect of the Labor supply of the aged on the economic growth from the angle of the structure change of the working-age population. Some scholars analyzed the proportion of working age and the aging of working age structure, such as Deng Junjun et al (2014); Sui Che, Zhou Xiaomei et.al (2014). Still some scholars carry on the analysis with the Labor Participation rate and the Labor Productivity Angle. Wang Yunduo (2014), Feng Jianfeng, Chen Weimin (2017) and others. In the current study of the effects of population ageing on economic growth, scholars have analyzed the effects of population ageing on labor supply in terms of both quantity and quality of labor supply. But there is little literature on the relationship between population ageing, labor supply, and economic growth, and most scholars use theory and statistics to study population ageing, labor supply, and economic growth. The econometric empirical model is seldom used.

In the absence of sufficient theoretical models for empirical research, Panel Vector Autoregression is an effective choice. Moreover, the Endogenous Problem Variables of the empirical model are very important, and the mutual feedback among different variables should be considered, otherwise it may cause bias, and the use of the PVAR model can generate more reliable results under the endogenous condition. This paper uses Vector autoregression to empirically examine the relationship between population ageing, Labor supply, and economic growth.

3. Mechanism analysis

According to the typical economic growth model, capital, labor and technological progress are the three main factors that affect economic growth. The population ageing affects capital, labor, and technology, directly or indirectly, in terms of the quantity and quality of the Labor supply. And that has an impact on the economy.

3.1. The population ageing will reduce the supply of productive labor

First, population ageing means a relative decline in the working age population and a reduction in supply in the labor market. Although China's industrial structure is facing upgrading, it is still dominated by labor-intensive industries, and the demand for Labor has not decreased. Therefore, in the context of the population ageing, there is a certain scarcity of labor, and if the supply of labor factors is insufficient, it will hinder economic development.

At the same time, in the reality of Labor scarcity and rising labor costs, the industrial structure will upgrade to technology-intensive and capital-intensive industries, which will eventually increase the demand for high-quality Labor and further reduce the demand for low-quality Labor. And then there is the phenomenon of structural labor shortage, which exists at the same time as unemployment and vacancy. This will also have a negative impact on the economy. Second, a deepening of the population ageing would lead to an ageing of the working age population and a decline in the labor force participation rate, thereby reducing the supply of labor. The labor force participation rate is inversely proportional to age, and the older labor force in China is at a competitive disadvantage in the labor market. The labor force participation rate of the working-age population has dropped significantly from about 45 years old. The ageing of the labor force, brought on by the population ageing, will lead to a decline in the number of people over the age of 45, as the labor force increases and the participation rate decreases.

3.2. The population ageing will reduce the quality of the Labor supply

Population ageing means the aging of the workforce, which is bound to affect productivity. On the one hand, a deepening of the population ageing represents a continuous increase in the elderly population, a continuous decrease in the labor force population, a corresponding decrease in the labor force participation rate in society and a relative decrease in the labor force involved in production, resulting in a decline in the average productive capacity of society.

On the other hand, the aging of the labor force refers to the aging of the labor force structure. Although older workers have many advantages in accumulating experience and knowledge, on the one hand, the physical quality of older workers is significantly lower than that of younger workers. Their working capacity and skills are also more likely to be derailed by the rapid development of a technological society; on the other hand, the mental and learning abilities of the most older workers are significantly reduced poor acceptance and adaptation to new knowledge, skills and facilities can lead to lower labor productivity, which in turn hampers economic development.

4. Model setting and variable description

4.1. Construction of metrological model

In this paper, we construct a panel Vector autoregression to analyze the effects of population ageing on labor force and economic growth, and population ageing on consumption and economic growth.

The basic form of PVAR MODEL in this paper is:

$$Y_{i,t} = a_i + \beta_t + \sum_{j=1}^p \beta_p Y_{i,t-p} + \varepsilon_{i,t} \quad (1)$$

Y is a vector containing three variables. i is province; t represents years. P is a lag order. a_i will represent individual effect, being a regional difference in the variables, β_t can represent time effect, describing time trend of the variables, β_p is a coefficient matrix, $\varepsilon_{(i,t)}$ is a random disturbance.

4.2. Description of data sources and variables

This paper uses 31 provincial panel data from 2001 to 2017. All the original data are taken from China Statistical Yearbook, Provincial Statistical Yearbook, China Labor Statistical Yearbook and China Demographic and Employment Statistical Yearbook. (Taiwan, China and Hong Kong and Macao are excluded because some data are missing) The model is tested by unit root test and cointegration test, and the order of lag is determined to be 1.

5. Impulse Response Analysis

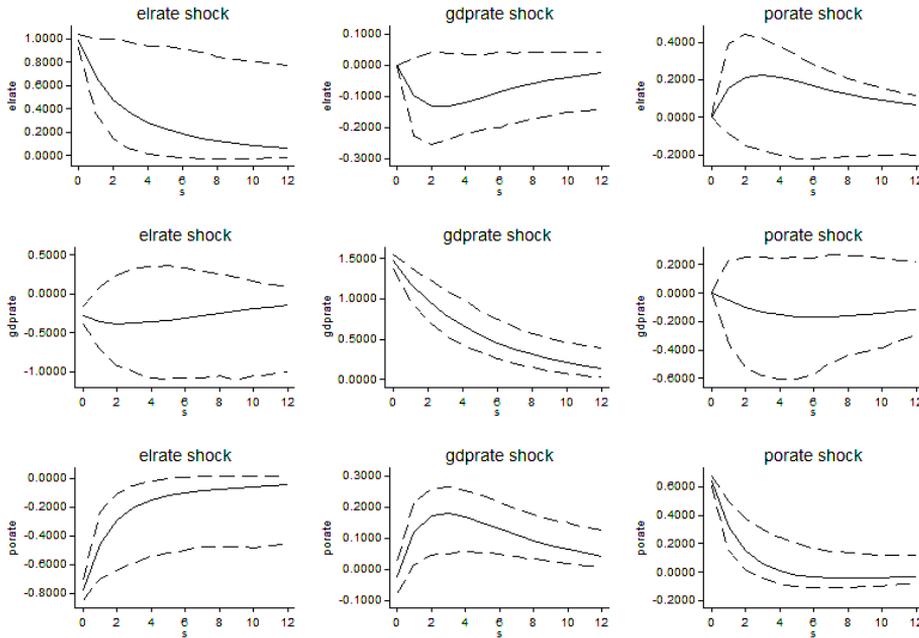
To examine the dynamic relationship between population ageing and economic variables, the impulse response function is used to study the effects of endogenous shocks on the self and other endogenous variables. Using the PVAR model of the elderly dependency ratio, the proportion of labor force and the logarithm of GDP growth rate, the impulse response function of the variables {elrate, porate, gdprate} is obtained by Monte Carlo Simulation.

From figure 1, the impulse response function of elrate to the logarithm of GDP growth rate gdprate (second row, first column) is shown, taking into account the labor force. The impact of an orthogonal population ageing rate on economic growth has been consistently negative, followed by a decreasing trend in the negative effect but has remained significantly negative, indicating that in the face of population ageing shocks, the economic growth appears the negative change, but the negative influence has weakened somewhat.

From the chart of the impulse response function of elrate to the proportion of the labor force (third row, first column), we can see that the impact of the degree of population ageing on the proportion of the labor force is negative in the first period to the twelfth

period However, the negative effect decreases continuously at a decreasing rate and finally tends to stabilize the negative effect. This suggests that population ageing shocks have a negative effect on the size of the labor force, reducing the size of the population ageing, which in turn reduces economic growth.

Figure 1 "aging-labor-economic growth" impulse response function



Errors are 5% on each side generated by Monte-Carlo with 500 reps

Source: Author computation

6. Analysis of variance decomposition

In order to examine more precisely the degree of interaction between population aging, economic growth, and the proportion of people consuming or working, this part uses Monte Carlo Simulations 500 times to obtain variance decomposition. The contribution of structural shocks to the volatility of endogenous variables is analyzed.

By using the PVAR model of the elderly dependency ratio, GDP growth rate and labor force proportion, the variance decomposition of variables {elrate, porate, gdprate} is obtained by Monte Carlo Simulation. The variance decomposition results for the 10th, 20th and 30th forecast periods are shown in Table 1.

Table1 Variance decomposition results of "aging-labor-economic growth"

Variable	Times	elrate	gdprate	porate
elrate	10	0.845303	0.037702	0.116994
gdprate	10	0.133087	0.842207	0.024706

porate	10	0.585499	0.097798	0.316703
elrate	20	0.836066	0.038536	0.125398
gdprate	20	0.144856	0.820214	0.034930
porate	20	0.581894	0.102994	0.315112
elrate	30	0.835848	0.038529	0.125624
gdprate	30	0.145378	0.819010	0.035613
porate	30	0.581782	0.103042	0.315176

Source: Author computation

The results of variance decomposition in table 1 show that the elderly dependency ratio has a greater impact on themselves, and the contribution rate to their own variance is as high as 84.53% in the 10th period. The contribution to variance decreased slightly to 83.60% in the 20th period and continued to decrease to 83.58% in the 30th period. The contribution of the old dependency ratio to the variance of GDP growth rate is 13.31% in the 10th period, which shows that the 13.31% of the change of economic growth can be explained by the population ageing. You can see that the explanatory power increases over time. The impact of GDP growth rate on itself is the biggest, but the explanatory power decreases over time, reaching 84.22% in the 10th, 82.02% in the 20th and 81.90% in the 30th. The ratio of old age dependency to old age dependency has a strong explanatory power to the change of the proportion of the labor force. The contribution rate to the variance of old age dependency ratio is 58.54% in the 10th period, which shows that the 58.54% of the change of the proportion of the labor force can be explained by the population ageing, while the 30th period remains flat to 58.17%. This is consistent with reality.

To sum up:

1. The impact of the population ageing on economic growth has a lag effect, a significant negative effect in the short term, the long term negative effect gradually weakened but still negative. In the short term, growth will be depressed, but in the long term it will be less so. That's because in the short term, population ageing will reduce the supply of labor, which in turn will reduce economic growth.
2. Population ageing shocks have a negative effect on the share of the workforce, reducing the size of the workforce, which in turn reduces economic growth by population ageing. The population ageing's shrinking workforce is the result of a combination of an ageing population and low fertility. The decline of the labor force and the increase of the aging population make the labor force participation rate and the Labor productivity decrease, which eventually hinders the economic development.
3. The variance decomposition results show that the change of population ageing index has a strong explanatory power to the change of economic growth, which further confirms that the significant negative effect of population ageing on economic growth is reliable.

7. Policy recommendations

In the future, the negative effect of population ageing on China's economic growth will be more obvious. The proper management of the relationship between the population ageing and the economy is essential to sustain our economic growth and promote the structural transformation and upgrading of our economy. Policy adjustments can be made in the following areas.

7.1. Focusing on improving the quality of the labor force and pushing forward the implementation of the policy of postponing retirement

The most direct way to increase the overall size of the labor force and reduce the burden on the elderly population is to increase the number of the labor force in the market by delaying retirement. However, the current implementation of the policy of delaying retirement has the phenomenon that the human capital of the aged labor force is relatively backward, and it is difficult to keep up with the market demand and the market competitiveness is low. The unilateral application of a policy of delayed retirement is likely to leave those close to retirement in a vulnerable position. Therefore, on the basis of delaying retirement, we should focus on training the working quality of the younger generation, improving the level of human capital, and providing guarantee for the sustainability of the delaying retirement policy.

7.2. To improve the two-child policy and provide reasonable maternity protection

Although the effect of the two-child policy is lagging, it can also fundamentally increase the supply of Labor in the future. In 2015, China implemented a comprehensive two child policy, but the effect is not obvious, since 2016, China's birth rate has declined year by year, by birth rate dropped to 10.94%. The function of the two-child policy needs the corresponding auxiliary conditions. First of all, we should improve the reproductive technology guarantee, improve the reproductive quality, to avoid the birth defect children to cause the blow to the family and reduce the family fertility confidence. Secondly, we should protect women's rights and interests in childbirth and provide relevant policies to protect women's rights and interests, such as policies to protect women's rights and interests in labor and employment.

7.3. Improve the social old-age security system and induce the motivation of saving for the aged

At present, China's old-age pension model mostly relies on family support for the aged, the subjective old-age pension savings is low, the social old-age insurance participation rate is low, and the coverage scope is narrow. Therefore, publicity and education of the old-age insurance system should be increased to raise the awareness of independent old-age pension. Increase the source of income for the elderly and reduce the burden of support for the younger generation of families. Secondly, we should change the system of combining the public accounts with the old-age pension, speed up the individual

account accumulation system, let the old-age pension fund rely on the previous accumulation, rather than the unified public accounts, stimulate the motive of the old-age pension savings.

7.4. Vigorously develop the "silver hair industry"

Pay attention to the needs of women in providing for the aged, and increase the labor force participation rate of the young population. The increasing level of population ageing will lead to the need for social support services for the aged. At present, the industry should cater to the needs of old-age consumption and service, speed up the upgrading of industrial technology and structure, and provide a platform for the future.

Secondly, the proportion of women in the elderly population is relatively large, and there is an upward trend, we should focus on the elderly female population related to old-age consumption and service needs, to adapt to social development trends. Finally, the aging of male and female labor force structure is on the rise, and the aging of female labor force is more serious. We should improve labor market policies, increase the Labor participation rate of the young population, and alleviate the aging of labor force.

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