

Analysis of the Impact of Aging on Factors Affecting Economic Dynamism

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Abstract. Population aging is one of the biggest demographic challenges facing China in the 21st century. Its impact on the economy cannot be ignored. This study employs empirical research to illustrate how population aging affects China's economic development. It is mainly explained from the perspectives of the labor force, savings rate, GDP, and pension insurance participation. According to the relevant data and the definition standard of the United Nations on aging society, the relevant data from 2002 to 2020 are selected for empirical analysis. The conclusion is obtained through the ADF test, determination of optimal lag order, the AR characteristic root test, and impulse response analysis. The results display that from the perspective of GDP and savings rate, population aging has an inhibitory effect on the economy, and has a lasting negative impact on the labor force. These results suggest that some measures should be taken to deal with the effects of aging in order to counteract its negative impacts on the economy and society.

Keywords: The Aging Population, Economic Growth, Var Model.

1. Introduction

At present, China is one of the nations with the world's greatest elderly population. The United Nations has formulated a new standard based on the age ratio of the global population. The new standard defines an "aging society" as the percentage of the population age distribution in a region where the proportion of the population aged 65 and above is higher than 7% of the total population in the region; A proportion higher than 14% is called a "deeply aging society". According to the demographic data released by the report on China's people conditions in 2010, the aged population's share was approximately 5% at the end of 2009, and the number was as high as 113 million people, an increase of about 3.22% over the same period last year [1]. In China, there were 253 million seniors over the age of 60 by the end of 2019, making up 18.1 percent of the overall population [1]. On average, nearly 4 labor forces supported 1 elderly person, and social pressure was great. Among them, the elderly living alone, the disabled and semi-disabled elderly, the rural elderly, and those who will grow old before they grow old are the targets that society should focus on. According to Ge et al.'s prediction, in 2030, there will be 64.63 million semi-disabled seniors and 11.48 million disabled seniors, while by 2050, there will be about 100 million semi-disabled seniors with an average annual growth rate of 3% and 20.72 million disabled seniors with an average annual growth rate of 3.7% [2].

An aging society will cause many disadvantages, which encompass a variety of social issues in addition to those that are specifically related to the needs of the old. For example, the labor force will be smaller, the savings rate will decrease, the total basic pension expenditure will increase, and the huge living pressure for young people of having both parents and young children to take care of. Nowadays, most scholars analyze the impact of aging from the perspective of the structure of the workforce and the impact on the economy.

China's industrial structure at this stage is still mainly labor-intensive, and changes in labor supply will have a non-negligible impact on the economy and society. As mentioned in Lv's article, according to the law of diminishing marginal returns of factors, the increase in labor input offsets the tendency of declining marginal returns from investment expansion, allowing China to maintain a high rate of investment growth for a long period of time, but as labor supply growth slows or even becomes

negative, this investment-led growth model will not be sustainable [3]. The impact of population aging on labor supply is mainly reflected in both the quantity of labor supply and the labor force participation rate. According to Zhang's research, the implementation of the comprehensive two-child policy can no longer reverse the decline in the size of China's labor supply, but it can improve the labor supply structure [4]. Liu's study shows that the aging of the population will bring a negative impact on labor supply, but the continuous promotion of urbanization will improve the cultural quality and skill structure of the labor force, which will ease the aging of cities [5]. In Jing's study, developed countries hedge population aging's effects on economic growth by promoting technological innovation through structural reforms to achieve economic transformation and growth, like restructuring the shift of employment from primary and secondary industries to tertiary industries [6]. Feng mentioned that the increase in labor costs caused by corporate social security contributions will prompt enterprises to replace labor with capital, which in the short term will lead to a reduction in corporate cash flow detrimental to investment activities, and in the long term will cause enterprises to readjust the allocation of production factors and replace labor with machines [7]. Lu et al. showed that savings and aging further affect economic growth through synergistic effects, with increased savings reducing the dampening effect of aging on economic growth, and increased aging enhancing the growth-enhancing effect of savings [8].

In aging studies, changes in savings rates are often used to analyze the impact on the economy. According to World Bank national accounts data, the world average savings rate is around 25% while China's savings rate has remained above 35% since the 1980s. According to Gong, when savings and spending are too far apart, the connection between output and consumption may be harmed [9]. It increases the operating costs of banks and does nothing to promote the effectiveness of the use of funds [9]. Li's study mentions that China has too much savings, the savings rate is high, and the consumption rate is low, the lack of consumption inhibits the growth of investment, and the path of conversion of savings to investment is poor and inefficient, resulting in a lower correlation between savings and investment [10]. The high savings rate reflects the not-so-strong consumption desire of the population and is not conducive to stimulating economic development. Modigliani et al. have verified that since the reform and opening, the sharp decline of the child population relative to the working population and the rapid economic growth are important reasons for the increase in the savings rate of Chinese residents [11]. Due to differences in model setting, data composition, or estimation methods, it is debatable how aging affects household savings and the population as a whole. In a study by Gai et al., Liu et al. argue that the savings rate rises as the share of elderly people grow [12,13]. Fan et al. argued that the impacts of the juvenile dependency ratio and the old-age dependency ratio on the savings rate are directly influenced by the addition of time effects, and the old-age dependency ratio has a negative effect on the country's saving rate [14]. Besides, in the study of the relationship between aging and saving rate, the social pension insurance system also has a significant impact on the results. Gai et al. showed that in regions with low pension dependency, increasing the participation rate of active employees, increasing the ratio of pensions to wages, and decreasing the pension insurance contribution rate is conducive to reducing residents' savings [12]. The analysis of Jiang et al. shows that population aging weakens the contribution of the pension insurance system to residents' consumption levels [15].

Many nations are actively researching and developing corresponding countermeasures to adapt to the development of the aging population, aggressively advancing the cause of the aged. Therefore, this paper will take China's population as an example, from the perspective of data analysis, to explore the relationship and impact of aging on the labor force ratio, the household savings rate, and the number of people participating in basic pension insurance.

2. Methodology

This research aims to investigate the impact of population aging on economic growth in China. To achieve this goal, this paper uses the SPSS software to implement the analysis with the Vector Autoregression (VAR) model, and the specific process is detailed in this paper.

First, this paper should determine the indicators to measure economic growth and select the representative indicators from several large aspects, such as labor force, savings rate, and aging level. The selected index is then tested with the Spearman correlation coefficient. The Spearman correlation coefficient is calculated as follows:

$$r_s = 1 - \frac{6 \sum_{i=1}^n d_i^2}{n(n^2-1)} \quad (1)$$

The indicators with large correlation, namely, the value of r_s was close to 1, were selected as the representative indicators. Due to the dynamic connection between the variables, this paper chose a model with the unstructured method to establish the relationship between the variables, namely the VAR model. It constructs the model with each variable in the system as the lag value of all the endogenous variables in the system, thus generalizing the univariate regression model to a "vector" autoregressive model composed of multivariate time-series variables. The VAR model expression with the lag order of p is as follows:

$$Y_t = c + A_1 Y_{t-1} + A_2 Y_{t-2} + \dots + A_p Y_{t-p} + B X_t + \varepsilon_t \quad (2)$$

In the model, Y_t is the k -dimensional endogenous variable vector, X_t is the d dimensional exogenous variable vector, ε_t is the k -dimensional error vector, and A_1, A_2, \dots, A_p, B is the matrix of coefficients to be estimated.

Before using the results of the VAR model, stability tests and plots of the AR roots should be made. The VAR model is stable if the inverse of all the root modes is less than 1, and also all points within the unit circle. If the estimated var model is unstable, the resulting result is invalid. So, it is needed to do some processing with the variables, such as difference operation, to make it pass the test.

The pulse response function is then used to describe how an endogenous variable would react to the impact of the error after the VAR model has been established. That is the degree of impact on the current and future values of the endogenous variable after applying the impact of a standard deviation size on the random error term. This paper will map the pulse response of each variable, observe the trend of the middle curve, and study the degree of aging and the influence duration.

3. Results and Discussion

3.1. Selection of Variables

What this paper studies is how population aging affects China's economic development, so the economic growth rate (Y) is used as the explained variable. Based on the United Nations classification criteria of the aging society, this paper selects the proportion of the population over 65 years old (X_1) as the indicator of the population aging. The paper also selects the labor force ratio (X_2) to measure the changes in the labor force, uses the household savings rate (X_3) to measure the changes in social savings, and uses the number of people participating in the basic pension insurance (X_4) to measure the pension demand. The selected explaining variables were taken logarithmic to make the established model more accurate.

3.2. Data Description

The population has been aging in China since 1999. According to the data of "China Statistical Yearbook" and "World Bank", the data of relevant variables from 2002 to 2020 are selected for analysis. The data used in this paper are relevant calculated based on the original data. The descriptive statistics of the variables are shown in the table below.

Table 1. Descriptive Statistics

Variables	Min	Max	Mean	S.D.	Variance
Y	2.240	14.231	8.691	2.613	6.829
$\ln(X_1)$	1.958	2.440	2.140	0.145	0.021
$\ln(X_2)$	4.025	4.068	4.055	0.013	0.000
$\ln(X_3)$	3.353	3.740	3.583	0.118	0.014
$\ln(X_4)$	9.598	11.480	10.616	0.775	0.600

3.3. Data Verification

Due to the non-stationarity of time series variables, there may be a "pseudo-regression" phenomenon, so this paper conducts a stationarity test and impulse response analysis on the collected data.

Stability Test. In this paper, the ADF method is selected for testing. The test aims to determine whether the selected time series variables are stable. The results are as follows:

Table 2. ADF Test

Variables	t	p	Critical Value		
			1%	5%	10%
Y	0.012	0.960	-3.964	-3.085	-2.682
$\ln(X_1)$	-1.241	0.656	-4.332	-3.233	-2.749
$\ln(X_2)$	-1.518	0.525	-4.332	-3.233	-2.749
$\ln(X_3)$	1.185	0.996	-4.332	-3.233	-2.749
$\ln(X_4)$	-1.086	0.720	-4.069	-3.127	-2.702

In the ADF test, the null hypothesis is time-series-unstable, whether the null hypothesis of in-series-instability can be significantly rejected by analyzing the t-values. According to the table above, this test result is non-significant ($p > 0.05$), which indicates that the null hypothesis is not rejected, and the sequence is an unstable time series. In addition, the critical values of 1%, 5% and 10% which reject the null hypothesis to different degrees compare with The ADF Test result. The ADF Test result is greater than 1%, 5% and 10%, which means that the null hypothesis is not rejected.

Determination of Optimal Lag Order. **The comparisons of different lag orders are as follows:**

Table 3. Comparison of different lag orders

Lag Order	AIC	SC	HQ	FPE
0	-26.438	-26.191	-26.404	0
1	-36.919	-35.449	-36.773	0
2	-50	-47.344	-49.864	0
3	-296.813	-293.037	-296.854	-0.0*
4	-321.662	-316.869	-322.106	0
5	2139.27	-323.308*	-317.658*	-324.469*

According to the results of the four evaluation indicators of AIC, SC, HQ and FPE, the optimal lag order of the established model is selected to be 5th order. Therefore, the VAR (5) model is established.

Model Exogenous Test and Stability Test. In order to pass the stability test of the var model, we second-difference all variables. The VAR model is established on the basis of the lag order of 5, and the stability test results are as follows:

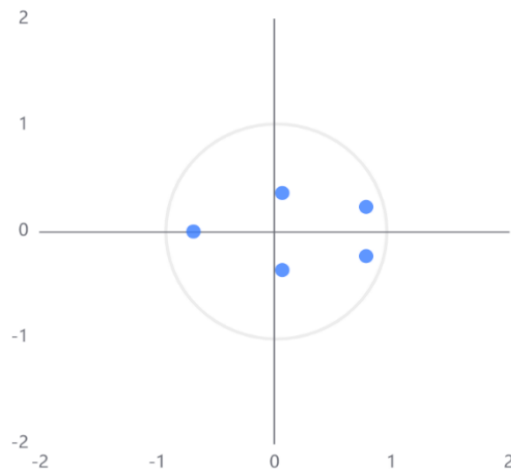


Fig. 1. AR root graph

Figure 1 shows that the characteristic roots all fall within the unit circle, demonstrating that the estimated model has passed the stability test and allowing for the performance of the impulse response analysis.

Impulse Response Analysis. Impulse response analysis refers to the impact of any endogenous variable in the model on other variables, including the response trend and response time.

Figures 2-5 show the impulse responses of the proportion of the population over 65 years old to each variable, where the horizontal axis represents the number of lag periods set, reflecting the action time of the variable under the new shock, and the vertical axis represents the degree of the variable's response to the impulse, the middle blue line represents the pulse process.

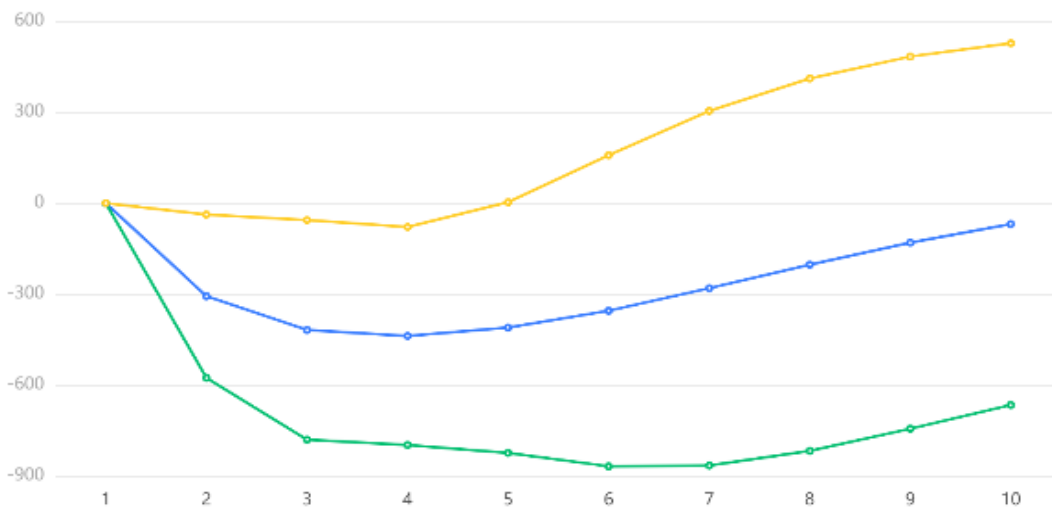


Fig. 2. impulse response of Y to $\ln(X_1)$

It can be seen from Figure 2, after the degree of aging gives a positive impact, the GDP growth rate has a negative response. In the fourth period, the impact of aging on GDP growth rate is relatively large. After the fourth period, the response began to gradually converge to 0, and the convergence rate was slow. It shows that in the short term, the degree of aging has a great negative impact on GDP growth, and it will take a long time to gradually reduce the negative impact.

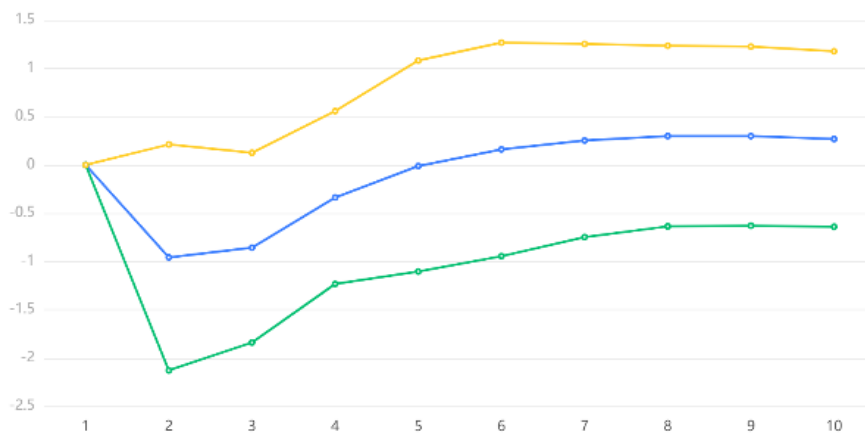


Fig. 3. impulse response of $\ln(X_2)$ to $\ln(X_1)$

It can be seen from Figure 3 that after the positive impact of the degree of aging, the labor force ratio has a significant negative response, and there is no obvious convergence in the tenth period. It shows that the degree of aging has a stable and lasting serious negative impact on the labor force.

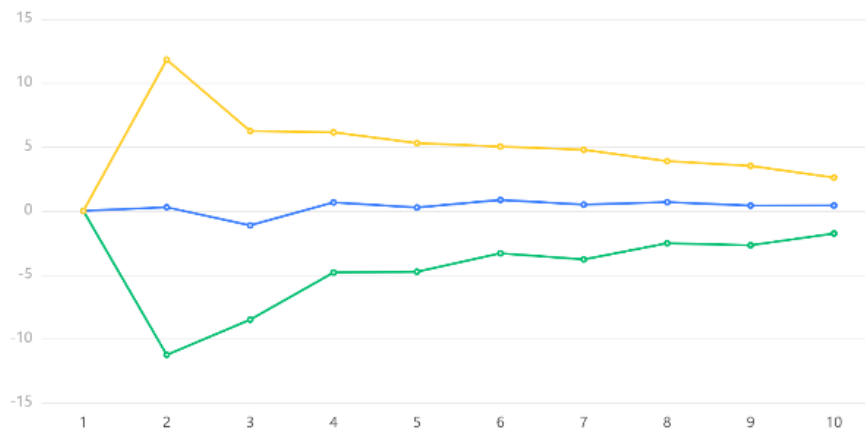


Fig. 4. impulse response of $\ln(X_3)$ to $\ln(X_1)$

Figure 4 demonstrates that, after the degree of aging causes a positive shock, the household savings rate only exhibits a marginally positive reaction, which then turns negative in the second period and positive in the third. It demonstrates that the degree of aging has a short-term, positive impact on the household savings rate, although the effect is not substantial.

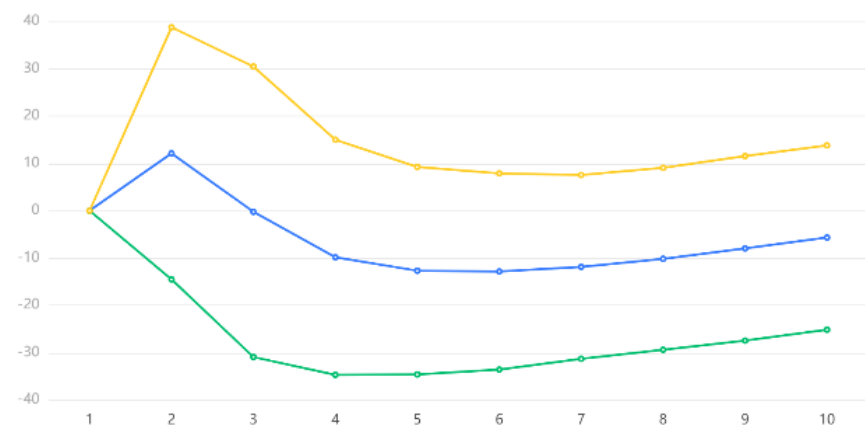


Fig. 5. impulse response of $\ln(X_4)$ to $\ln(X_1)$

It can be seen from Figure 5 that the number of people participating in the basic pension insurance responds positively in the short term. However, from the second period, it turned into a negative

impact, and the negative impact gradually decreased until the sixth period. It shows that in the long run, the degree of aging has an inhibitory effect on the growth of pension demand.

4. Conclusion

In this paper, the VAR model was constructed based on the data of the population over 65 years old, GDP, savings rate, and basic pension insurance from 2002 to 2017, and pulse effect analysis was used to investigate how aging change affects economic viability. The findings demonstrate that aging has a detrimental effect on GDP and labor force structure, with the difference that the negative impact on GDP diminishes over time, but the impact on labor force structure is stable and persistent. In the above study, the resident savings rate was rising during the study period. However, the declining trend in the savings rate is a regular phenomenon in economic and social development, so the key is to stop the economy from being negatively impacted by a sharp decrease in savings rates, promptly replenish pension funds, expand long-term capital sources, optimize resident savings structures, hasten the transformation of the economic development model, and foster sustainable and healthy economic growth. More notably, according to the results of the impulse response analysis, the degree of aging significantly increases the number of members in pension insurance in the short term, but it reduces the number of that over the long term. Directly from the data, the number of members in pension insurance increases as the degree of aging becomes higher in recent years. The conflict between the two findings may be due to the growth of the population base and the fact that at this stage China is still in a phase where the degree of aging has a positive effect on the number of people participating in the pension insurance in the short run. The growing aging presents a positive effect on the economic dynamism of the main working population promoting economic development will gradually diminish, and the pressure of more and more pension contributions will be transferred to the working population. At the same time, the increase in the savings rate of the population reduces the activities that can contribute to the dynamism of economic development, such as consumption. The increasing aging does not only put more and more pressure on the social security system, but more importantly, it has a subtle negative impact on the economy.

The distribution of social resources will shift due to population aging, which will also have an impact on economic growth. The proportion of senior people in an aging society is rising, and they are considered a "consumption" population in terms of economic growth because they don't produce anything. As a result, as more social resources are employed for consumption, capital accumulation will unavoidably experience a "crowding out effect" and its capacity will fall, which will weaken the drive behind economic expansion.

This article selects several factors that can significantly affect economic dynamism for overall analysis but does not specifically analyze the impact effects of each factor. Future research could control for the degree of change in a factor to explore how the negative effects of aging can be attenuated.

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