

# Aging Population, Inflation and Economic Growth

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**Abstract:** With the acceleration of China's aging process, economic growth is affected by population aging to a certain extent, which is universal and special to the world, as China is not only the largest developing country in the world, but also the country with the largest aging population in the world. The impact of aging population structure on economic growth cannot be ignored. Among all economic problems, inflation has always been the most prominent one. Inflation rate measures the overall price level of a country. The average price level of an economy not only measures the monetary purchasing power of its residents, but also is a necessary condition for the smooth operation of the economy. Hence, too high or too low price level will restrict economic growth. Starting from the impact of aging structure on economic growth and inflation rate, this thesis discusses the relationship between aging population structure and economic growth, inflation as well.

**Keywords:** Population aging, Inflation, Economic growth, BVAR model.

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## 1. Introduction

When life expectancy in China increased from 43 years in 1961 to 77 years in 2020, the aging index increased from 9.3% to 67% in 60 years. As the largest developing country in the world, "getting old before getting rich" has become a major problem for sustainable economic development. According to the latest international standards for the definition of aging, when the proportion of the elderly population (over 65 years old) in a country exceeds 7%, it is considered that the country has entered the aging stage. According to the World Bank Development Database, China entered an aging society as early as 2002. The aging process in developed countries has lasted for decades to more than 100 years. For example, it took France 115 years, Switzerland 85 years, the United Kingdom 80 years, the United States 60 years, and China, as a developing country, only 18 years, also the rate of aging is accelerating. The population born in the baby boomer period [referring to 1962-1973] will also enter the elderly from 2027 to 2038. Official data show that China has the largest elderly population in the world, with a nationwide population of 1.91 billion people aged 65 and above, accounting for 13.5% of the total population. The "China Development Report 2020: Development Trends and Policies of China's Population Aging" released by the China Development Foundation predicts that around 2022, China's elderly population (over 65 years old) will account for 14% of the total population, achieving a transformation of aging society. It is estimated that in 2030, China will surpass Japan and become the country with the deepest aging degree in the world [15]. Although some studies have shown that the aging of the population structure will cause residents to take precautions and increase their saving motives, the saving motives brought about by the aging population cannot be compared with the economic growth brought about by the first demographic dividend [16].

The acceleration of the aging process in China is universal and special to the world [17], because China is not only the largest developing country in the world, but also the country with the largest aging population in the world. The impact of the aging population structure on economic growth cannot be ignored. Among all economic problems, inflation has always been the most prominent problem. The inflation rate measures the overall price level of a country. The average price level of

an economy not only measures the purchasing power of its residents, but also a necessary condition that affects the smooth operation of the economy. Too high or too low price levels will restrict economic growth. Therefore, starting from the impact of aging structure on economic growth and inflation rate, this paper explores the relationship between population structure aging and economic growth and inflation.

## 2. Literature Review

The number of the existing literature studying the impact of aging on economic growth and inflation is less. At present, scholars at home and abroad discuss the relationship between aging, economic growth and inflation limited to the impact of aging on economic growth and inflation. This paper divides existing research into two categories.

The effect of aging on inflation. The current mainstream view is that the deepening of the aging degree will curb inflation to a certain extent [1-4]. Igor Fedotenkov (2018) establishes a mechanism by which population aging causes deflation by linking demographic factors such as fertility and longevity to prices by modeling overlapping generations with money-created credit and intergenerational trade. There is a non-linear relationship between population aging and inflation rate. Jiang Wei (2015) used the frontier threshold panel estimation to further find that different countries are in different regional systems, and the effect of population aging on the inflation rate is significantly different. In those countries with deep aging and high economic development level, the effect of demographic aging on the inflation rate is greater. Population aging is closely related to economic development, and demographic phenomena also reflect certain economic phenomena. According to the Phillips Curve, the relationship between inflation and unemployment is an inverse function, that is, inflation increases and unemployment decreases. The decline in inflation rate, the rise in unemployment rate, and the deepening of the aging degree lead to a relative reduction in the proportion of the labor force, and a decline in the unemployment rate, so the inflation rate should rise, which is contrary to the current research conclusion. Therefore, with the acceleration of the aging process of the population, the substitutability of inflation and unemployment is reduced to a certain extent [4],

and the Phillips Curve may no longer be effective in the case of deepening aging, which also leads to social concerns for this phenomenon are deepening as the population ages.

The impact of aging on economic growth. At present, there are different views on the effect of aging on economic growth. The mainstream view is that economic growth will be constrained by population aging [8-10]. With the deepening of the aging degree, the proportion of the labor force is relatively reduced, China's unique demographic dividend disappears, and the labor participation rate is insufficient, which inhibits economic development [10]. Some scholars hold the opposite view, arguing that aging has a positive impact on economic growth under different mechanisms. By analyzing the relationship between economic growth, aging and saving, Lu Jin (2021) found that the interaction between aging and saving rate can promote economic growth. Lee etc. (2006) believe that the deepening of the aging degree can increase the willingness of residents to save, thus forming a "second demographic dividend" in different senses. Liu Junqi (2021) used the ESDA method to prove that in the context of aging, the increase in the scale of government spending can not only promote local economic growth, but also promote the economic development of neighboring cities. At the same time, when the whole society is showing an aging trend, the reduction of the working-age population will force enterprises to change their development models and promote the development of capital-intensive enterprises [12,13], thereby promoting the transformation of China's industrial structure and the development of the service industry. Although aging promotes the rise of labor-saving industries, whether aging promotes or inhibits China's economy depends on whether the technological substitution brought about by the reduction of the labor force can offset the negative impact of aging on economic growth [13].

In general, the view on the impact of aging on inflation is consistent, that is, aging inhibits inflation. But under different mechanisms, scholars have different views on economic growth. However, the existing research is limited to the pairwise relationship between the three, and the literature on predicting the contribution of aging to economic growth and inflation is still blank. The marginal contribution of this paper is to combine aging, economic growth and inflation. Predicting the economic impact of aging using the BVAR model system.

The structure of other parts of this paper is as follows. The third part is the research design, including data selection and data sources, and the fourth part is an empirical study, which uses the BVAR model, impulse response function and variance decomposition to predict the contribution of aging. The fifth part is the conclusion and discussion, which states and discusses the empirical results of the article.

### 3. Research Design

#### 3.1. Evaluation Index System

##### 3.1.1. Economic Indicators

GDP growth rate, abbreviated as GDPPC, select the national GDP growth rate from 1961 to 2020.

Rate of inflation, abbreviated as RI. In view of the completeness and availability of the data, the inflation rate based on the GDP deflator from 1961 to 2020 is selected as the evaluation index of the inflation rate in this paper (inflation measured by the annual growth rate of the GDP implied price deflator is shown) is the rate of change in prices

for the entire economy. The GDP-implied price deflator is the ratio of GDP in current local currency to GDP in constant local currency.

##### 3.1.2. Social Indicators

The Old Age dependency ratio, abbreviated as OA, is measured by the proportion of the national elderly population in the working-age population from 1961 to 2020.

The Aging Index is abbreviated as AI: the ratio of the population aged 65 and above to the population aged 0-14 in the existing literature is used as an indicator to measure the aging index [1].

Life expectancy is abbreviated as LE: it refers to the life expectancy at birth, that is, if the mortality pattern at birth remains unchanged in the future, the average number of years a newborn is expected to live.

#### 3.2. Data Sources

The population and economic data from 1961 to 2020 used in this article are all from the World Bank Development Indicators Database and the China Statistical Yearbook.

#### 3.3. Theoretical Model Setting

Considering the availability of data and the short time span of time series data, the article draws on the Bayesian vector autoregression (BVAR) method of Loprete Milena, Zhu Zhen (2020) to process the data. BVAR is developed on the basis of VAR, the ordinary VAR model requires a large amount of sample data when estimating parameters, while BVAR can obtain a good fitting effect in the case of overcoming a large number of parameters and a small sample size. The biggest advantage of BVAR is that it does not need to be distinguish endogenous and exogenous variables [5]. BVAR is divided into restricted VAR and unrestricted VAR, and this paper adopts unrestricted [that is, the explanatory variables in all equations are the same.] VAR model, the basic formula is as follows:

$$Y_t = c + A_1 y_{t-1} + A_2 y_{t-2} + \dots + A_p y_{t-q} + u_t \quad (1)$$

$t=1,2,3\dots n, c$  is an  $m$ -dimensional vector  
 $A_j, j = 1,2,3 \dots$ , are all  $M * M$

– dimensional coefficient matrices

The vector  $u_t$  is an  $m$ -dimensional white noise vector, that is,  $t=1,2,3\dots n$ , which is an  $m \times m$  positive definite matrix vector.  
 $q$  is the maximum number of lag periods

$Y(t)$  is the value of the  $N$ -dimensional random vector  $Y$  at time  $t$ , which is an endogenous variable in the model.

Rewriting equation (1) as a multiple regression equation can get:

$$Y = XA + U \quad (2)$$

The order of the matrix  $Y_t = (y_1, y_2, \dots, y_T)$  is  $T \times N$  (number of observations  $\times$  dependent variable)

$X = (X_1 \dots X_T)$ ,  $X_T = (1, y_{t-1} \dots y_{t-p})$ , The order of the matrix is  $T \times K$ , where  $K = NP + 1$  (number of observations  $\times$  lagged dependent variable)

$A = (c, A_1 \dots A_q)$ , The matrix dimension is  $k \times N$  (constant/autoregressive  $\times$  number of lagged dependent variables)

$U = (u_1, \dots, u_T)$ , Error term with dimension  $T \times N$  (number of errors  $\times$  dependent variable).

### 3.4. Descriptive Statistical Analysis

It can be seen from Table 1 that the average value of the aging index is 0.253, and the maximum value reaches 0.67. In the past 60 years, the aging index has increased from 0.093 to 0.676. It can be seen that the aging trend in China is developing rapidly. The dependency ratio has also increased from 6 in 1961 to 17 in 2020. The acceleration of the aging process has led to a decline in the relative proportion of the working-age population, resulting in an increase in the elderly

burdened by each working-age population and increasing the pressure on the society for pensions. With the development of economy, the life expectancy of China has increased from 43 years old to 77 years old, and the increase of life expectancy has promoted the acceleration of the aging process. China's GDP growth rate has fluctuated greatly in the past 60 years, with a maximum value of 16.050, a minimum value of -26.528, and a range of 42.578. The average inflation rate is 2.055, with large fluctuations between the maximum and minimum values.

**Table 1.** Descriptive statistical analysis of each variable

	AI	OA	RI	LE	GDPPC
Mean	0.253	9.260	3.523	67.109	6.727
Median	0.198	8.609	2.055	69.194	7.580
Maximum	0.676	17.020	20.67	77.000	16.050
Minimum	0.083	6.180	-3.793	44.051	-26.528
Observations	60	60	60	60	60

## 4. Empirical Research

### 4.1. Unit Root Test

In order to avoid spurious regression, all variables need to be tested for stationarity when doing BVAR regression. In this paper, the ADF unit root test commonly used in existing research is used to perform the stationarity test. The test results show that OA, AI, and LE all mirrors unstable trend,

in which LE is a relatively stable trend, so the non-stationary variables are subjected to differential processing, and it is found that the second-order difference of OA and AI is stable. Since the trend is stable is not equal to true stability, the first-order difference of LE is castrated, and the variable after the difference is 10 % is stable on the level, as the single integer order is not uniform, because the cointegration test cannot be carried out, the data variable names after the difference is stable are redefined as DDOA, DDAI, and DLE.

**Table 2.** ADF unit root test

variable	ADF statistic	critical level	critical level	critical level	conclusion
		1%	5%	10%	
AI	3.168	-2.610	-1.947	-1.613	unstable
OA	2.479	-2.610	-1.947	-1.613	unstable
RI	-3.431	-2.605	-1.946	-1.613	smooth*
LE	-4.978	-4.127	-3.490	-3.174	stable trend*
GDPPC	-3.513	-2.605	-1.946	-1.613	smooth*

### 4.2. Generalized Impulse Response Function

The time series data are stable at the 10% level after difference processing, so the BVAR model can be established. The generalized impulse response function does not depend on the order of the variables in the VAR model, while the result of the cholesky orthogonal decomposition method depends heavily on the order of the variables in the model. In order to avoid the influence of the variable ordering on the response results, this paper uses the generalized impulse response function instead. Ordinary impulse response functions are used to analyze the mutual impact of variables [6].

From the results of the generalized impulse response function in Figure 1 of the inflation rate, when the number of simulated periods is within 2 periods, the impact of the shocks

on RI is always negative and DDAI, DDOA, and DLE increase with the number of periods. After the second period, with the increase of the number of periods, the shock response of RI to DDAI, DDOA, and DLE is always negative but continuously increasing. It shows that in a very short period of time, the inhibitory effect of the aging index, life expectancy, and old-age dependency ratio on inflation continues to weaken, but in the long run, its inhibitory effect continues to increase, that is, it continues to promote deflation in the long run. The impact of GDPPC on RI was positive before the fifth period, and continued to promote inflation within the second period, but the promotion effect continued to weaken after the second period. The inhibitory effect increased with the increase of the number and tended to be stable. It can be obtained from the generalized impulse response function plot of GDP growth rate.

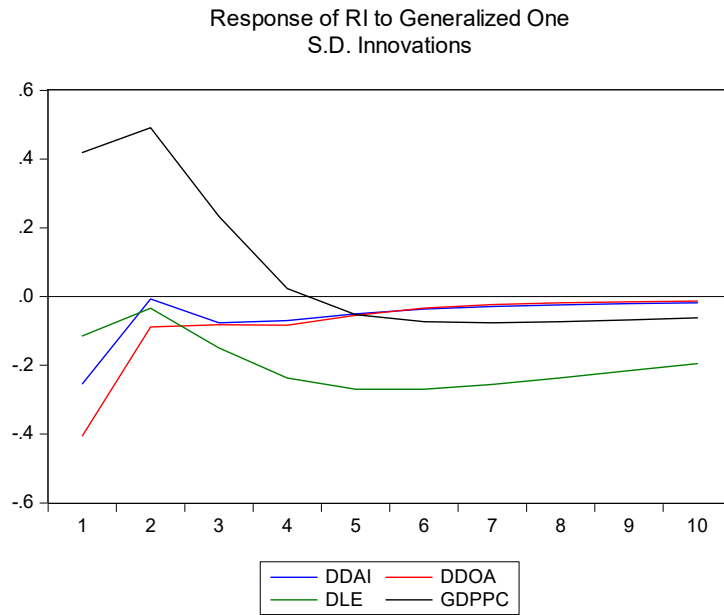


Figure 1. Generalized Impulse Response Plot of Inflation Rate

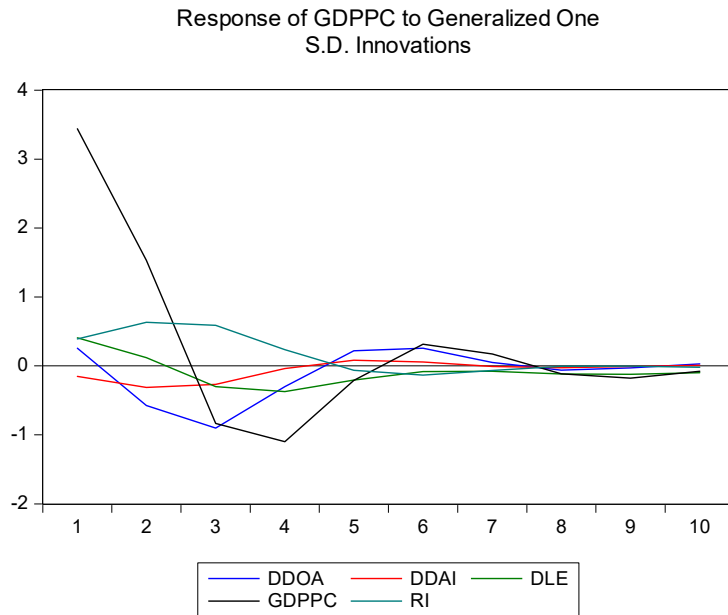


Figure 2. Generalized Impulse Response Plot of GDP Growth Rate

### 4.3. Variance Decomposition

In economics, variance decomposition is mainly used by scholars to study the contribution of each generalized shock to the variance change of endogenous variables, and to use the simulation results to judge the importance of different shocks to endogenous variables [6]. This paper uses Eviews9.0 software to decompose the variance of the studied variables to study the contribution ratio of each variable with the variance of other variables. It can be seen from the variance decomposition diagram of the inflation rate that the impact of RI itself has the largest contribution to the inflation rate, indicating that inflation mainly depends on its own inertia [7]. The contribution gradually weakened, from 98.365% in the first period to 93.407% in the tenth period. The contribution rate of the old-age dependency ratio DDOA to the variance of RI gradually increased. The contribution rate of the first period of simulation was 1.024%, and it increased to 1.033% in the 30th period. The contribution rate of life expectancy to

the inflation rate changed the most, increasing from 0.0229% in the first period of the simulation to 3.309% in the tenth period. As the number of periods increased, the contribution of DLE to RI increased year by year. DDAI's contribution to RI growth increased from 0.588% to 0.644%. According to the contribution rate, DDLE>DDOA>DDAI.

In the variance decomposition of GDP growth rate and the variance decomposition of the aging index, the contribution rate of DDAI itself is 100% when the simulation lags one period, the contribution rate is 92.426% for the fifth period, and 92.402% for the 10 period lag. DDOA The contribution rate is 2.226%, the DLE contribution rate is 0.309%, the GDPPC contribution rate is 0.854%, and the RI is 4.209%. It shows that the aging index and the inflation rate are mainly affected by their own inertia, and other factors have less impact on it. In contrast, the inflation rate has a greater impact on the aging index, followed by the old-age dependency ratio. The contribution rate of each factor is DDAI>RI>DDOA>GDPPC>DLE.

**Table 3. Inflation rate variance decomposition**

Period	DDOA	DDAI	DLE	GDPPC	RI
1	2.979	0.282	0.011	1.778	94.951
2	2.177	0.184	0.006	9.218	88.415
3	1.934	0.165	0.021	13.647	84.232
4	1.923	0.164	0.193	13.824	83.896
5	1.923	0.163	0.631	14.067	83.216
6	1.912	0.161	1.133	14.381	82.412
7	1.955	0.162	1.522	14.374	81.987
8	1.982	0.165	1.798	14.327	81.728
9	1.983	0.166	2.018	14.302	81.531
10	1.979	0.166	2.205	14.307	81.343

**Table 4. GDP growth rate variance decomposition**

Period	DDOA	DDAI	DLE	GDPPC	RI
1	0.549	0.617	1.374	97.460	0.000
2	2.671	0.561	1.404	94.572	0.793
3	7.335	0.548	1.471	88.167	2.479
4	7.266	0.545	2.006	87.312	2.871
5	7.478	0.540	2.308	86.827	2.847
6	7.757	0.547	2.354	86.425	2.916
7	7.751	0.550	2.387	86.366	2.946
8	7.760	0.550	2.451	86.297	2.942
9	7.747	0.548	2.527	86.242	2.936
10	7.745	0.548	2.583	86.190	2.934

**Table 5. DDAI variance decomposition**

Period	DDAI	DDOA	DLE	GDPPC	RI
1	100.000	0.000	0.000	0.000	0.000
2	95.239	1.701	0.277	0.272	2.510
3	92.958	2.175	0.294	0.782	3.791
4	92.551	2.207	0.297	0.791	4.154
5	92.456	2.209	0.298	0.833	4.203
6	92.440	2.216	0.298	0.843	4.203
7	92.422	2.225	0.300	0.846	4.206
8	92.408	2.226	0.304	0.853	4.209
9	92.404	2.226	0.307	0.854	4.209
10	92.402	2.226	0.309	0.854	4.209

## 5. Policy Suggestions

The experimental results show that population aging is always a negative impact on the inflation rate, and inflation undoubtedly has a negative impact on economic growth. Based on this, the following countermeasures are proposed.

Before the 1990s, the aging of the population was always regarded as a crisis of the society, and the elderly were regarded as a burden on the society, which brought huge challenges and pressures to the economy and society. However, after the 1990s, under the influence of various postmodern trends of thought and positive psychology, gerontological research gradually viewed the elderly from a positive perspective, focusing on the potential and self-development of the elderly, and proposed a series of new ideas about aging terms, including concepts such as healthy aging, successful aging, and productive aging. While the above concepts of aging have similarities, they each have their own emphasis. Compared with other concepts, productive aging focuses on the productivity or output of the elderly, and looks at the elderly from the perspective of advantage. It believes that the elderly are not necessarily the takers. On the contrary, the vast majority of the elderly are able and willing to continue to contribute to society. Therefore, it is

recommended to designate a flexible retirement system. The retirement age is determined by the elderly. The public can choose to retire early or retire late. They can get more pensions for late retirement. Promote the productive participation of population aging to encourage the elderly to participate in production. In this way, a negative impact of China's population aging on economic growth is alleviated.

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