

The Influence of the Change of Fertility Policy on the Preference of Individual Pension Responsibility

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Abstract

In order to control the excessive growth of the population, China implemented family planning nationwide in the 1970s and made family planning a basic national policy in 1982. This paper considers the influence of population age structure on population growth to construct a Leslie matrix, establishes the corresponding Leslie model, and uses MATLAB software to predict and analyze the problems facing China-aging and gender imbalance. The study found that under the family planning policy, the family savings rate has nothing to do with the child dependency ratio, but the child dependency ratio is inversely proportional to the family education investment rate. In addition, numerical simulations based on realistic and feasible parameters show that under the current life expectancy of the population, the relaxation of the family planning policy will lead to a decline in the economic growth rate. With increasing aging, the economic growth rate will decline further along with the relaxation of the family planning policy.

Keywords

Leslie Model; Aging; Changes in Fertility Policy; Individual Pension Responsibility.

1. Introduction

Since the late 1970s, China has encouraged late marriage and late childbirth, and advocated a couple to have one child. The implementation of this policy for more than 30 years has effectively controlled the excessive growth of China's population and has made a positive contribution to economic development and the improvement of people's lives. But its negative effects are also beginning to appear. For example, the number of primary school enrollment and the number of college registrations has decreased year by year, the absolute number of laborers has begun to enter a downward path, and the phase change of the population dependency ratio is about to come. These will have a series of impacts on economic and social health and sustainable development [1]. The attention of all sectors of society. Since the 18th National Congress of the Communist Party of China, the Party Central Committee with Comrade Xi Jinping at its core has focused on the transitional changes in population development and has made decisions and arrangements to gradually adjust and improve the birth policy and promote long-term balanced population development. In 2013 and 2015, the two-child policy and the comprehensive two-child policy were implemented successively. According to the data from the seventh national census, the proportion of children aged 0 to 14 has increased in the past 10 years. Due to policy adjustments, the country has a total of more than 10 million births with two children, and the proportion of births in the second child is 30% from before the policy adjustment. It has risen to about 50% in recent years. The sex ratio at birth dropped from 118 in 2013 to around 111 in 2020. The "Decision of the Central Committee of the Communist Party of China and the State Council on Optimizing the Fertility Policy to Promote the Long-term Balanced Development of the Population" was released on the 20th, making a major decision to implement the three-child policy and supporting support measures, opening a new stage of China's population development.

2. Establishment of Related Models

2.1. Symbol Description

$x_i(t)$ represents the number of people who have reached the age of i but not yet reached the age of $i+1$ at the t . d_i represents the annual death rate of the i age group population. s_i represents the proportion of the i age group that survived at $t+5$ and entered the $i+1$ age group (the survival rate of the i age group). b_i represents the annual fertility rate of women in the i age group. $\beta(t)$ represents the average number of births per unit time per woman of age at time t . $h(r,t)$ represents the sexual status of women of childbearing age that changes with age at time t (fertility pattern). m represents the longest life [2]. $N(t)$ represents the total population. $R(t)$ represents the average age. $S(t)$ represents the average life span. $\omega(t)$ represents the aging index.

2.2. Analysis of Influencing Factors

In the early days of the founding of the People's Republic of China in 1949, China became the most populous country in the world due to social stability, improved sanitation conditions, improved living standards, and a long-term lack of proper control over population growth. So in 1978, China made family planning a basic national policy [3]. While the population growth has been well controlled for more than 20 years, worrying problems have also arisen: the approaching ultra-low fertility rate, the aging population, the imbalance of the sex ratio at birth, and the disappearance of the demographic dividend. Based on the prediction model, these aspects are analyzed.

2.2.1. Fertility Rate Level

In the early 1970s, the Chinese government began to vigorously promote family planning, which led to a rapid transition from a high fertility rate to a low fertility rate in China. Since the implementation of the family planning policy in China, the fertility rate has been on a downward trend, and the fertility rate has almost always been below the low fertility rate of 2.14. Especially in recent years, the fertility rate has been lower than the ultra-low fertility rate of 1.5. However, the ultra-low fertility rate has accelerated the process of China's aging, which will cause great harm to society and is not conducive to social development.

2.2.2. Sex Ratio at Birth

Under the premise of strictly controlling the population in family planning, gender selection has become the second choice of people, which ultimately leads to the "artificial" destruction and imbalance of the sex ratio of the birth population. Since 1978, with the implementation of the nationwide birth policy, which focuses on controlling the number of births, the sex ratio of the birth population in China has increased significantly. Since 1985, except for a few years, the sex ratio of the birth population has exceeded 112, which clearly deviates from the normal sex ratio, and from the general trend, the sex ratio of men and women is still showing an increasing trend [4]. Serious social problems such as marriage squeeze, gender overdraft, and demographic imbalance caused by the imbalance of the sex ratio of the birth population have brought huge hidden dangers to population security and social stability, and affected the coordination and sustainable development of China's population and economy, society, resources, and environment. And even affect the prosperity of the nation and the long-term stability of society.

2.2.3. Demographic Dividend

China's economic "growth miracle" stems from many factors, among which the "demographic dividend" is the most important factor. When China was in the period of demographic dividend, the economy made tremendous progress. The so-called demographic dividend period refers to a period of relatively abundant labor resources formed before the fertility rate declines rapidly,

the child support ratio declines, the proportion of the working-age population in the total population rises, and the proportion of the elderly population reaches a relatively high level [5]. But how long can China's demographic dividend last or whether it has disappeared? According to the definition of demographic dividend, we use the change in the proportion of the working population in the total population to express the change in the demographic dividend to determine the trend of the demographic dividend.

3. Differential Model Establishment

First, establish a difference equation model, and then obtain the population growth status of each age group, and finally calculate the number of people aged 15-59 years old and the total number of people each year to calculate the ratio of the two. Draw a graph of the demographic dividend change through the ratio.

Remember the number of people in the age group $x_i(k)$, $k = 0, 1, 2, \dots, i = 1, 2, \dots, n$, the fertility rate of the i age group is b_i , the death rate of the i age group is d_i , and the survival rate is s_i , $s_i = 1 - d_i$. We assume that b_i and d_i do not change with time k . This assumption is reasonable under the circumstances. The changing law of $x_i(k)$ is derived from the following basic facts: the population of the first age group in period $k + 1$ is the sum of the number of births in each age group in period k , namely

$$x_1(k+1) = \sum_{i=1}^n b_i x_i(k) \quad (1)$$

The population of the $i + 1$ age group in period $k + 1$ is the number of people who survived in the i age group in period k , namely

$$x_{k+1}(k+1) = s_i x_i(k), i = 1, 2, \dots, n-1 \quad (2)$$

The distribution variables of population k in the time period by age group are:

$$x(k) = [x_1(k), x_2(k), x_3(k), x_4(k)]^T \quad (3)$$

A matrix of fertility rate b_i and survival rate s_i

$$L = \begin{bmatrix} b_1 & b_2 & b_3 & b_4 \\ s_1 & 0 & 0 & 0 \\ \dots & s_2 & 0 & \dots \\ 0 & \dots & s_3 & 0 \end{bmatrix} \quad (4)$$

Then (1) and (2) can be expressed as

$$x(k+1) = Lx(k), k = 0, 1, 2, \dots \quad (5)$$

When the matrix L and the initial distribution vector $x(0)$ by age group are known, it can be predicted that the distribution of population k by age group at any time is

$$x(k) = L^k x(0), k = 1, 2, \dots \quad (6)$$

The population data at $t=1$ can be used to obtain the population data of each age group in each year in turn, so that the number of working population aged 15-59 can be predicted. We divide the age into 4 groups, and divide the national population into 0-14, 15-49, 50-59, 60-90 four age stages, at this time there are

According to the China Statistical Yearbook, the birth rate b_i and death rate d_i were obtained from 2010-2018, and the survival rate s_i was obtained from the death rate.

Table 1. 2010-2018 birth rate and survival rate data

Years	2010	2011	2012	2013	2014	2015	2016	2017	2018
Bi	1.403	1.338	1.286	1.241	1.229	1.246	12.09	12.1	12.14
Di	93.55	93.57	93.59	94	93.58	93.49	93.19	93.07	92.94

In this way, we can get 15-59 year-old forecast data through 2010 data and Table 2 obtained through data fitting.

Table 2. The true and predicted values and average relative errors of the working population from 2010 to 2018

Years	2011	2012	2013	2014	2015	2016	2017	2018	Average error
Actual value	13807	14736	15204	15355	15536	15717	16080	16364	
Predictive value	13872	14181	15149	15661	15817	15871	16296	16695	0.0159

From the above table, we know that the average relative error is 0.0159, which shows that the model has a good effect and is in line with the law of population development. Therefore, we use the model to predict the population of each age group, and then get the number of laborers aged 15-59. , And the total population, calculate the ratio to get the annual demographic dividend data. The related calculation process is realized by MATLAB. The following figure is the predicted trend of future demographic dividend changes.

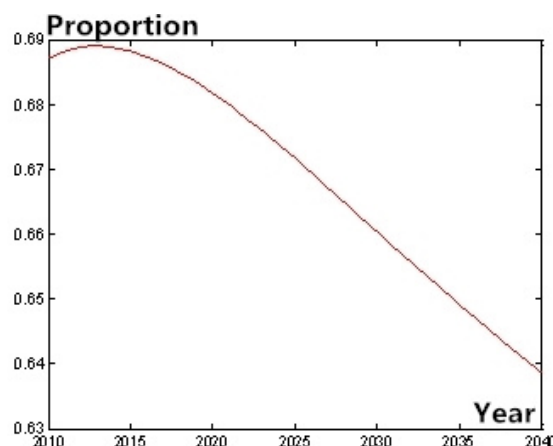


Figure 1. The predicted trend of the demographic dividend

Aging society refers to a demographic model in which the elderly population reaches or exceeds a certain proportion of the total population. According to the traditional standard of the United Nations, people over 60 years old in a region should reach 10% of the total population. The new standard is that people over 65 years old should reach 7% of the total population [6]. What is the current situation in China and the degree of aging? Let's use the proportion of people over 65 to the total number of people in recent years. According to the established dynamic difference equation model, the number of elderly population can be predicted, and then based on the predicted number of elderly population, the aging trend diagram (Figure 2) can be drawn for analysis.

Table 3. The proportion of the population over 65 in China from 2011 to 2021

Years	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Proportion	7.1	7.3	7.5	7.6	7.7	7.9	8.1	8.3	8.5	8.9	9.1

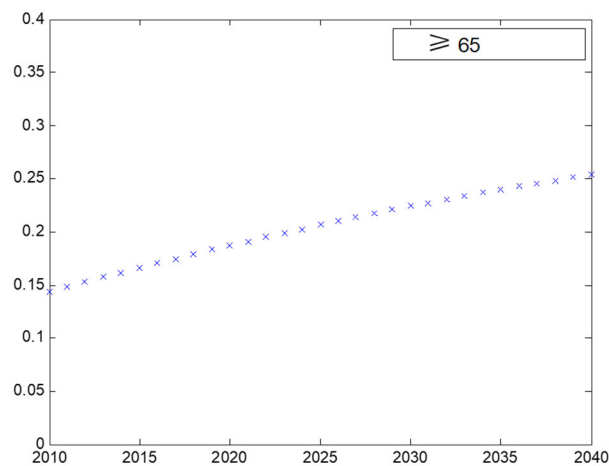


Figure 2. Aging trend chart from 2011 to 2040

According to the image or function expression, it can be seen that the population aging in China is increasing. It also predicts that China's aging population will exceed 20% by 2030 and will continue to grow. So China will become a highly aging country in 20 years.

4. Model Calculation and Verification

According to the physiological characteristics of people and the medical statistics of women's fertility, women's childbearing age range is generally 15 to 49 years old. Then it can be considered that when the age $r < 15$ years old, and when $r > 49$ years old, there is. Taking Beijing as an example, according to the data on the age composition of the permanent population in the middle of 3-5 years of the "Beijing Statistical Yearbook 2011", the total number of babies in 2021 can be calculated to be $1961.2 \times 0.748\% = 14.669776$ (10,000 people). Usually in a relatively stable environment, $h(r, t)$ can be regarded as not changing with time, that is, $h(r, t) = h(r)$. The distribution of Γ is usually used to approximate $h(r)$, that is

$$h(r) = \frac{(r - r_1)^{\alpha-1} e^{-\frac{r-r_1}{\theta}}}{\theta^\alpha \Gamma(\alpha)}, \quad r > r_1 \quad (8)$$

And take $\theta = 2, \alpha = n/2$, the peak baby age at this time $r_c = r_1 + n - 2$. The minimum childbearing age $r_1 = 15$ and the maximum childbearing age $r_2 = 49$. According to medical data, the best childbearing age for women is 25 to 30 years old. The fertility mode function is:

$$h(r) = \frac{(r-15)^6 e^{-\frac{r-15}{2}}}{2^7 \Gamma(\alpha)}, r > 15 \quad (9)$$

The image of $h(r)$ is shown in Figure 3:

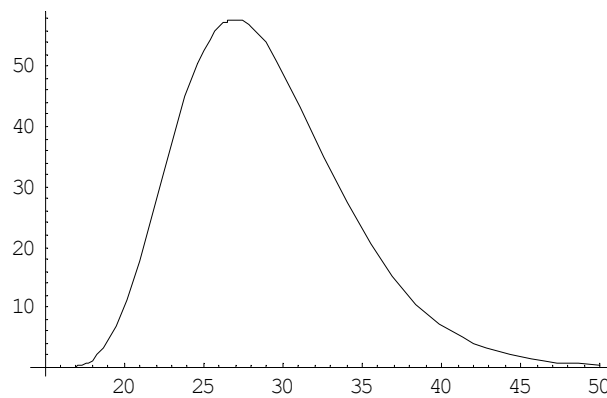


Figure 3. Fertility pattern $h(r)$ diagram

Combining the population data predicted by this model from 2010 to 2050, a curve chart of the population change trend in Beijing is shown in Figure 4 below.

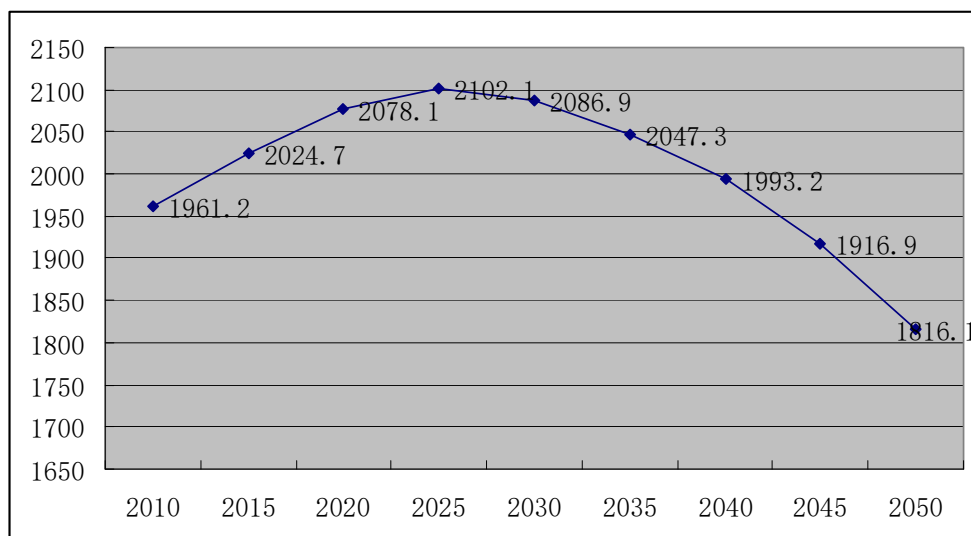


Figure 4. Newborn population

5. Analysis of the Pension Situation

There are several ways in which the life expectancy of the population will affect the family's savings rate. There is a linear relationship between pension and savings rate. First, with other factors unchanged, the representative actor expects to extend the life expectancy, and therefore will increase the family's savings to maintain the future. Second, the increase in life expectancy

will reduce the working hours, thereby reducing income in old age. Therefore, in anticipation of such an effect, representative households will increase their pension savings. The aging of the third life expectancy also increases the pension burden of representative actors. This will lead to a decrease in current income and consequently a decrease in savings resources. Fourth, because the extension of life expectancy reduces the accidental bequest from the father of the representative actor in the current period, thereby reducing his current income. This will also reduce the source of savings. In short, the aging caused by the increase in life expectancy in old age has an opposite effect on the savings of representative agents.

6. Conclusion

The above-mentioned numerical simulation results show that although my country's current state of population aging will lead to a decline in economic growth, if the contribution of human capital to material production and human capital production can increase, then economic growth will follow. The population is aging. Therefore, the implementation of family planning can have a downward trend in pension. Just liberalizing the three-child policy can reduce population aging, and the sex ratio tends to be balanced. Therefore, China's family planning policy is in urgent need of adjustment, which means that it is necessary to liberalize the three-child policy, which can effectively reduce the impact of pensions.

References

- [1] Wang, H., Huang, J., & Yang, Q. Assessing the financial sustainability of the pension plan in China: The role of fertility policy adjustment and retirement delay. *Sustainability*, Vol.11(2019) No. 3, p.883-899.
- [2] Hiilamo, H., Bitinas, A., & Chên, N. Extending pension coverage in Cambodia: The governance and investment challenges of the Social Security Investment Fund. *International social security review*, Vol. 73(2020) No. 4, p. 97-116.
- [3] Németh, A. O., Németh, P., & Vékás, P. Demographics, labour market, and pension sustainability in Hungary. *Society and Economy*, Vol.42(2020) No. 2, p.146-171.
- [4] Feng, Q., Yeung, W. J. J., Wang, Z., & Zeng, Y. Age of retirement and human capital in an aging China, 2015–2050. *European Journal of Population*, Vol.35(2019) No. 1, p.29-62.
- [5] Zhang, Z., Muthu, B., & Sivaparthipan, C. B. The necessary of constructing preventive health intervention policy under the trend of deep aging in China. *Journal of Ambient Intelligence and Humanized Computing*, Vol. 12(2021) No. 3, p.3539-3547.
- [6] Bai, C., & Lei, X. New trends in population aging and challenges for China's sustainable development. *China Economic Journal*, Vol. 13(2020) No. 1, p.3-23.