

The Prediction of Population and the Countermeasure Analysis Based on Stochastic Differential Equation

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Abstract

In consideration of the random factors everywhere and all the time, the following four aspects are mainly completed. Firstly, a stochastic differential equation model is constructed to predict the population. Secondly, the numbers of population in China from 2007 to 2015 are selected. The population of these nine years is calculated by the model, and the estimated value of the model is compared with the actual total population. From the residual test results, it is within the allowable range. Thirdly, the population of 2016-2025 is predicted to reach 1457.48 million by 2025. Finally, based on the relationship between population and economy environment, relevant countermeasures and plans are put forward.

Keywords

Stochastic differential equation; Population; Prediction.

1. Introduction

The early population prediction models in foreign countries all originated from the field of mathematics and statistics, mainly using manual calculation method for preliminary estimation. In 1789, Malthus, a British statistician, put forward the world-famous Malthus population model in the book of population theory [1]. In order to correct its defects, the logistic population model and its improved forms [2], that is, the model of blocking growth, came into being. The population probability prediction in the field of statistics began in the 1980s, and the prediction effect is good. At the same time, Ronald Lee, a population Department scholar at the University of California, Berkeley, introduced scenario prediction methods in 2011, and other such population prediction models and research methods have been adopted, innovated and used by scholars at home and abroad since their inception.

The research method of population prediction in China comes from the West. In the 1980s, Deng Julong [3], Professor of Huazhong University of science and technology, a famous scholar, put forward the grey system theory, which is widely used in the prediction, decision-making and evaluation of social economy, science and technology, population and many other fields in China. In 2009, Tu xiongling et al [4] established ARIMA model and exponential smoothing model based on population time series by combining statistical and mathematical methods. In 2012, based on the principal component analysis model and support vector machine model, Li Feiya et al. [5] used SPSS and MATLAB software to model. The well-known and commonly used population prediction method in academia is the scenario prediction method derived from the queue factor prediction method, which is widely used by many domestic experts, scholars and research institutions.

2. Model Construction and Analysis

Based on the classical differential equation population model, the population prediction model of stochastic differential equation (1) is constructed based on the stochastic factors existing in Brown motion simulation.

$$dP(t)/P(t) = \mu_t dt + \sigma dZ(t). \quad (1)$$

in which $P(t)$ denotes the total population in year t , μ_t is the natural growth rate of population in the t year, $Z(t)$ is a Brownian movement and $dZ(t) = \varepsilon(t) (dt)^{1/2}$.

The real population [6] of China from 2007 to 2015 (unit: 10000 people) is selected and the Simulated population is calculated, as shown in the following table, see [Table 1](#).

Table 1 The Real and Simulated Population from 2007 to 2015

Year	Real Population	Simulated Population
2007	132129	132179
2008	132802	132852
2009	133450	133500
2010	134091	134141
2011	134735	134689
2012	135404	135358
2013	136072	136026
2014	136782	136736
2015	137462	137416

According to the equation (1) and the data of real population in [Table 1](#), we can get $\sigma^2 = 0.0000012859$.

In [Table 1](#), it can be seen that the model (1) fits well. Taking the population in 2015 as the initial value for equation (1), we can predict the total population in 2015-2025 in China based on the model (1), see [Table 2](#).

Table 2 The Population from 2015 to 2025

Year	Population	Year	Population
2015	137462	2016	138144
2017	139032	2018	139822
2019	140669	2020	141495
2021	142340	2022	143182
2023	144033	2024	144887
2025	145748		

3. Countermeasures and Scheme Analysis

According to the above theoretical analysis, quantitative forms and conclusions on population, the following countermeasures and suggestions are proposed for population and economic problems.

3.1 Population Structure

According to the population, we should increase the investment and construction of education in a timely and appropriate way, mainly to increase the construction of basic education. For example, on the basis of the original, we can appropriately relax the age of enrollment to 5-8 years old, so as to alleviate the shortage of educational resources in each region, appropriately improve the educational

resources in each region, and make the distribution more even. Relevant departments should visit hospitals and primary schools in time to find out whether their infrastructure and teachers are reasonable and whether they can cope with the possible “baby boom”. In the short term, the problem of population aging can not be solved well, and will become more serious. At present, with the continuous improvement of science, medical technology and living environment, the life span of residents is extended, but the fertility level of the whole society will not rise rapidly in a short time. The overall trend of the society is that the fertility rate is basically unchanged or slightly increased, and the population aging speed is more rapid. Therefore, some measures should be taken to control the growth of population aging. The retirement age can be raised step by step, which can not only solve the problem of job vacancy, but also enable the retired elderly to continue to exert their residual heat, affirm their contributions and give them enough respect. We should support the innovation and Entrepreneurship of the masses, and encourage the retired elderly to give young entrepreneurs and innovators some experience. In order to prevent the aging of the population from deepening with the progress of the society, the government should increase the expenditure of endowment insurance, increase the positive leading role of social endowment fund, and increase the level of social welfare.

3.2 On the Adjustment of Fertility Policy

We should adhere to the strategy of developing economy through science and education, promote quality education, develop science and technology, promote the hierarchical training of blinking talents and technical talents, improve the quality of workers from multiple perspectives, levels and all-round aspects, and optimize the labor force structure. From the perspective of policy and purpose, we should change the concept of education so that education can serve the economy and the development and progress of society. Innovative and entrepreneurial talents in Colleges and universities are the essence of a large number of human resources, and are important reserve forces for the sustained, rapid, coordinated, healthy and orderly development of the economy and the overall social progress.

With the upgrading of economy, the construction of creative economic model is an important guarantee for the sustainable development of economy, and the cultivation of innovative and entrepreneurial talents is the basis for the construction of creative economy. China has a vast territory, abundant natural resources and many opportunities. If innovation and entrepreneurship education achieves certain results, it will achieve a win-win situation of economic development and benefit of talents in Colleges and universities. The flow of labor and professionals has both positive and negative effects. Targeted mobility is conducive to the increase of social capital and regional wealth.

In recent years, some provinces (northeast, northwest and other remote areas) have suffered serious brain drain with high professional titles and high academic qualifications. If we further optimize the policy of talent introduction and establish the policy of retaining talents, we can alleviate the contradiction to a certain extent.

3.3 Demographic Dividend

Some provinces (Northeast China, Northwest China and other remote areas) may consider liberalizing the birth policy in advance, reducing the age of marriage and childbearing, and solving the source problem of alleviating the increasingly unbalanced population problem. Tap potential economic development points of each province. For example, characteristic agriculture, characteristic tourism and characteristic industry should give full play to regional characteristics and inherent advantages. We will strengthen infrastructure construction, boost domestic demand, expand employment, and strive for state policy support. According to the characteristics of China’ vast land and vast territory, we should appropriately implement the form of centralized contracting, liberate and transfer part of the rural labor force, and fully tap the social value of this part of the surplus labor force. We will vigorously improve the awareness of innovation and entrepreneurship at all levels, especially among highly educated people.

4. Conclusion

Based on the stochastic differential equation, a model for predicting the population of China is constructed, which is verified to be effective according to the population of previous years. This model is applied to predict the population from 2016 to 2025. Based on the prediction results, the corresponding countermeasures and suggestions are given from the perspective of economy and population.

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