Forecast and Analysis of Population Growth in Hunan Province of China Based on ARMA Model

Changyi Bao[#1], Shan Huang[*2]

[#1] First.author:Hunan University of Humanities, Science and Technology, China

[*2] Corresponding Author:Hunan University of Humanities, Science and Technology, China

Abstract:

China's Hunan Province is located in the south, although the area is not wide, but the population is large. According to the data of the sixth national census, the resident population of Hunan Province in 2010 was about 56.8 million, accounting for 4.87% of the national total, ranking seventh in the country, and the population aging population in Hunan ranked sixth in the country. The problem of population size and population structure seriously restricts the sustainable development of Hunan's economy. Therefore, using the ARMA model to conduct an expected analysis of the future population of Hunan Province, the results show that the total population of Hunan Province is relatively stable in the next three years.

Keywords :*ARMA model, population, prediction*

I. INTRODUCTION

Contrary to the wide-ranging and sparsely populated situation in China's western region, Hunan Province has a small footprint, a large population, and a small per capita footprint. The population size and demographic structure have become increasingly prominent issues. The population problem has seriously affected the modernization process of Hunan Province and hindered the sustainable development of the economy.

According to the statistical yearbook data, Hunan Province entered an aging society in 1996, three years earlier than the national level. In the fifth national census, the population aged 65 and over in Hunan Province accounted for 7.47% of the total population of Hunan Province. The population aged over 60 (including 60 years old) accounts for 11.2% of all populations, both exceeding the national average and international standards. Until the sixth national census in 2010, the population of 65 years old (including 65 years old) in Hunan Province accounted for 9.77% of the total population, accounting for an increasing proportion, and the problem of population aging is intensifying.

The birth rate in Hunan Province is relatively high, but with the evolution of the population, the population ageing in Hunan Province has increased the total number of elderly people in Hunan Province. The proportion of elderly people aged 65 and over in Hunan Province is the proportion of the same age group in China. More prominent. As early as the fifth national census in 2000, there were 88.11 million people aged 65 years (including 65 years old), and the population of the same age group in Hunan Province reached 4.69 million, accounting for 5.32% of the country. Forefront of the provinces. In the sixth national census in 2010, there were 118.83 million people aged 65 and over nationwide, and 6.42 million people in the same age group in Hunan Province, accounting for 5.4% of the country. The proportion in the past 10 years has increased. From 2005 to 2015, the number of elderly people in Hunan Province increased continuously, from 6.4 million to 7.65 million, with an average annual growth rate of about 1.6%, but the national elderly population increased by 3.3%. Relatively low, in the country's elderly population, Hunan's proportion has gradually decreased, the proportion of data in 2011 decreased from 6.36% to 5.32%, except for a slight increase in 2006, 2009, 2012, the rest The years are basically declining, with the largest decline rate in 2009.

According to the main data bulletin of the national 1% population sample survey in 2015, the resident population of the province was 67.753 million, compared with the 65,867,700 people at the 6th national census at 0:00 on November 1, 2010. The increase was 2.0701 million, with a growth rate of approximately 3.15% and an average annual growth rate of approximately 0.62%. Among the resident population, the residential address is inconsistent with the address registered on the household registration and the number of people who have left the household registration for more than 6 months is 8,587,100. Compared with the sixth national census in 2010, it increased by 690,400 people, with a growth rate of about 8.74%.

The distribution of the resident population of the province is shown in Table 1.

Table 1
Distribution of permanent residents in Hunan Province

Area population	Population (10,000 people)	proportion(%)		The population density(person / square kilometer)
		year 2015	year 2010	
Total province	6775.38	100	100	320
Changsha City	741.16	10.94	10.72	627
Zhuzhou City	399.39	5.89	5.87	355
Xiangtan City	282.19	4.16	4.18	564
Hengyang City	733.18	10.82	10.87	479
Shaoyang City	725.46	10.71	10.77	348
Yueyang City	562.35	8.30	8.34	378
Changde City	584.17	8.62	8.70	321
Zhangjiajie City	152.32	2.25	2.25	160
Yiyang City	440.71	6.50	6.57	358
Quzhou City	472.48	6.97	6.98	244
Yongzhou City	542.26	8.00	7.89	243
Huaihua City	489.63	7.23	7.22	178
Loudi City	386.86	5.71	5.76	477
Xiangxi Autonomous Prefecture	263.22	3.88	3.88	170

II. Model Establishment and Analysis

This paper selects the total population data from 2005 to 2017 in Hunan Province as the research object. The data comes from the database of the National Bureau of Statistics of China, and the short-term prediction of the population of Hunan Province is established by establishing the ARMA model.

A. Stationarity Test

First, the trend chart of the total population of Hunan Province from 2005 to 2017 is shown, as shown in Figure 1.

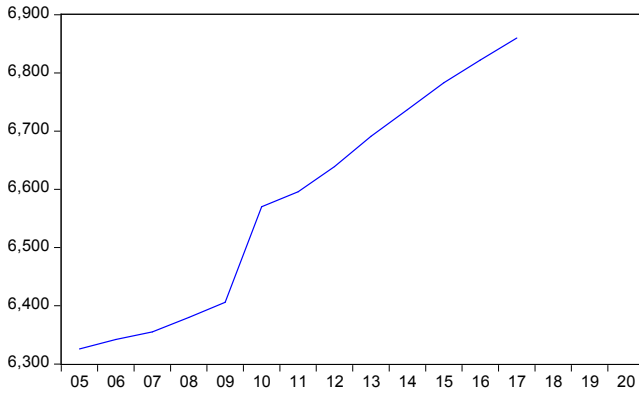


Figure 1:Hunan Province Population Chart

As can be seen from Figure 1, the population of Hunan Province is generally on the rise, so the ADF unit root test is required. The test results of Eviews7 are shown in Figure 2.

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.631634	0.2753
Test critical values:	1% level	-4.992279	
	5% level	-3.875302	
	10% level	-3.388330	

Figure 2:preliminary test

From the results of the test in Fig. 3, it is found that p is less than 0.05, that is, it can pass the test.

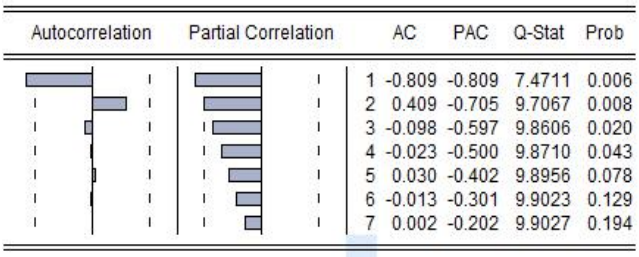
		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.221313	0.0364
Test critical values:	1% level	-7.006336	
	5% level	-4.773194	
	10% level	-3.877714	

Figure 3: differential post-test

From the results of the test in Fig. 3, it is found that p is less than 0.05, that is, it can pass the test.

A. Model Parameter Estimation

After the data in Fig. 2 is differentiated, the autocorrelation coefficient and the partial correlation coefficient are calculated, and Fig. 4 is obtained.



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.809	-0.809	7.4711	0.006
		2	0.409	-0.705	9.7067	0.008
		3	-0.098	-0.597	9.8606	0.020
		4	-0.023	-0.500	9.8710	0.043
		5	0.030	-0.402	9.8956	0.078
		6	-0.013	-0.301	9.9023	0.129
		7	0.002	-0.202	9.9027	0.194

Figure 4: sequence processing differential autocorrelation partial autocorrelation

It can be seen from the autocorrelation and partial correlation graphs in Fig. 4 that the partial autocorrelation smear and the time series autocorrelation are truncated, so the autocorrelation model is selected, and q can be selected as 1.

The AR(1) and MA(1) models are established. By comparison, the MA(1) model is the optimal model result as shown in Fig. 5.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	67.82087	31.81674	2.131610	0.0770
MA(1)	-4.626297	2.266937	-2.040770	0.0874

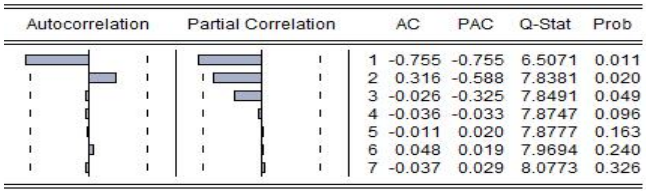
R-squared	0.964656	Mean dependent var	4.875000
Adjusted R-squared	0.958766	S.D. dependent var	453.0738
S.E. of regression	92.00212	Akaike info criterion	12.09382
Sum squared resid	50786.34	Schwarz criterion	12.11368
Log likelihood	-46.37527	Hannan-Quinn criter.	11.95987
F-statistic	163.7619	Durbin-Watson stat	3.186975
Prob(F-statistic)	0.000014		

Figure 5: MA(1) optimal model

The adjusted R2 of the MA(1) model is 0.9587 close to 1.

B. Model Checking

Figure 6 is obtained by model residual test.



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.755	-0.755	6.5071	0.011
		2	0.316	-0.588	7.8381	0.020
		3	-0.026	-0.325	7.8491	0.049
		4	-0.036	-0.033	7.8747	0.096
		5	-0.011	0.020	7.8777	0.163
		6	0.048	0.019	7.9694	0.240
		7	-0.037	0.029	8.0773	0.326

Figure 6 residual test chart

It can be seen from Fig. 6 that the p value is greater than 0.05, that is, the model passes the test. Then proceed to the next step to get the residual fit Figure 7.

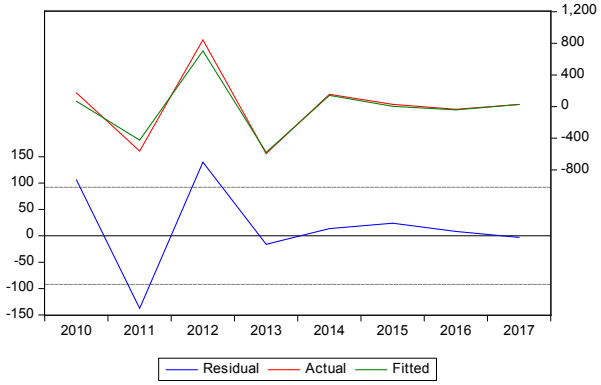


Figure 7: residual fit

C. Model Results

From the above optimal model analysis results, the estimated results of the model can be:

$$Y_t = 67.8208 - 4.6263\varepsilon_{t-1} + \varepsilon_t$$

31.8167 2.2669

D. Forecast

The MA(1) model was used to make a short-term forecast of the population of Hunan Province, and the future population of Hunan Province in 2018, 2019, and 2020 was predicted. The prediction results are shown in Figure 8.

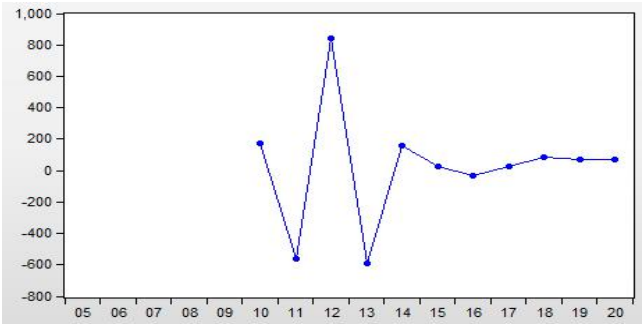


Figure 8: prediction results

The prediction result can be obtained from the prediction of Fig. 8, and the result is in a stationary state. The one-time random factor changes by one unit, and the Y value of this period is reduced by an average of 46,000. The random factors such as "family planning" policy, social and economic changes, and per capita GDP.

III. Conclusions and Recommendations

A. Conclusion

Based on the analysis of the population data of Hunan Province from 2005 to 2017, the MA(1) model is used to predict the population of Hunan Province in China. The results show that the one-stage random factor changes by one unit, and the Y value of this period decreases by an average of 46,000. people. The population growth in Hunan Province of China in recent years has been relatively stable, with no particularly large fluctuations.

B. Suggestions

1) Increase the ageing industry

As the number of elderly people continues to increase, the market demand will continue to grow, and the demand structure of the market will change. A series of new industries formed in recent years include the production of products and services for the physical and mental needs of all the elderly. The old-age industry is a novel, forward-looking industry

with a broad market and a bright future with unlimited potential. The government should encourage and support such industries in policy formulation, combine their needs with economic development, and create new economic development and growth points.

2) Ways to Change Economic Development

The phenomenon of "structural unemployment" and "difficult employment" reflects that the market demand relationship of labor is changing. As the proportion of the working-age population declines year by year, the series of benefits brought about by the early aging of Hunan's population have reached the extreme. The shortage of labor resources can be considered from the following aspects: First, create labor attraction methods, attract labor from other provinces and return labor from Hunan Province. In 2012, the number of people in Hunan Province who went out of the province for more than 6 months was 57.71 million, while the number of people from other provinces who came to Hunan Province was only 754,200, and the migrant labor force out of the province accounted for 90%. If we can return the labors from other provinces to introspection, formulate preferential policies for labor introduction, and attract labor from other provinces, then we can alleviate the contradiction between the supply and demand of labor in Hunan in the future. Second, change the methods of economic development and optimize the resources of the labor force. Improve development and efficiency, fully develop innovative technologies, and increase new industries to reduce the demand for labor, so that the shortage of labor can be buffered. Third, focus on cultivating the quality of the workforce. The labor force has quantitative and structural influences. The supply and demand of labor caused by the structural shortage of labor cannot meet each other. The shortage of labor force will force commercial enterprises to shift the promotion of labor "quantity" to "quality". Therefore, only the laborer's own quality can be increased to make up for the negative impact of the small amount of labor.

3) Adjust and improve the birth policy of "Comprehensive Second Child"

According to the communique of the Fifth Plenary Session of the 18th Central Committee of the Communist Party of China in October 2015, in order to promote the balanced development of the population, at the same time adhere to the basic national policy of family planning, improve the population development strategy, and fully implement a couple's fertility. The two-child policy actively responds to the aging of the population. Improve the level of public services such as reproductive health, maternal and child health care, and child care. This policy is the data obtained from the sixth census conducted in November 2010. The effective policy proposed by the aging population is also considered to be conducive to promoting the relaxation of China's population policy. In 2015, the per capita GDP of Hunan Province was 42,754 yuan, ranking 16th in the country; the local fiscal revenue was 251.543 billion yuan, ranking 13th in the country. Generally speaking, the economic development level of Hunan Province is relatively low, and there is a considerable gap compared with the first-tier cities with strong economic strength. Moreover, the characteristics of Hunan Province's "not getting rich first" are more obvious. The impact of society, family and other aspects has become more and more complicated. Therefore, an appropriate age structure can promote social and economic development. Facing the social problems brought about by the aging of the population, we must timely adjust and improve the "comprehensive two-child" policy to reverse the age composition of the population. At the same time, we can promote and encourage the elderly with working ability to carry out paid labor, and also contribute to the social and economic development to ensure the coordinated and sustainable development of society, economy, resources and environment.

REFERENCES

[1] 郭敏,田荟,张施伟. 我国人口出生率预测——基于 ARIMA 模型分析[J].现代经济信息,2018(19):4-6.

[2] 田艳君,周玉健,吴佳灏. 就业风险与就业身份选择——基于湖南省 2015—2016 年流动人口动态监测数据[J]. 调研世界,2017(09):14-19.

[3] Guangtao Zhou. The Influence of China's Population Aging on Economic Growth[A]. Institute of Management Science and Industrial Engineering. Proceedings of 2018 International Conference on Economics,Finance,Business,and Development(ICEFBD 2018) [C]. Institute of Management Science and Industrial Engineering:计算机科学与电子技术国际学会(Computer Science and Electronic Technology International Society),2018:4.