

## Studying on the Trend of the Ageing Population of Lanzhou City and Countermeasures

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### Abstract

This paper is based on the national census of population in Lanzhou as a study object, and uses the Logistic model for forecasting the number of ageing population in Lanzhou city, does further analysis of the characteristics and reasons of population ageing of Lanzhou city, seeks to fill the ageing research gaps in Lanzhou city and to provide a reference for policy-makers.

Keywords: Model Specification, Parameter Estimation, Grim Situation, Countermeasures and Suggestions

### 1 Introduction

Population ageing is a worldwide phenomenon. Throughout human history, it is up to more than 4 million years, production and reproduction of the population most of the time at a high birth rate, high mortality and low growth. In the middle of the 18th century, population mortality began to decline, but fertility decreases delay in mortality, the population gradually transferred to the high-born and low mortality rates, high growth phase. Between the end of the 19th century and the early 20th century, Western countries began to transition to the modern population as a whole, low mortality and low growth phase. In this process, due to the declining fertility and mortality decline, the ageing proportion of the total population is rising. And the Western developed countries had entered the aging society. Subsequently, the developing countries had been changes in population structure which is similar to the developed countries, and became the ageing society. In the late 1970 and the early 1980 of the 20th century, China made strong family planning policy, which has accelerated China's population to low birth, low mortality and low growth in structural changes. Meanwhile, the pace of population ageing to be above the original expected follow China formally entered an aging society in 2000. As the capital of Gansu province, Lanzhou population ageing problem is growing, the Government and the relevant departments should attach great importance to it.

### 2 Logistic model to predict the trend of population ageing of Lanzhou

#### 2.1 Data Source

Through a variety of ways, we get number of elderly population aged 65 and over of the Lanzhou city from 1982 to 2010, as shown in table 1.

**Table 1 Aged 65 and over population data from 1982 to 2010 of Lanzhou (million persons)**

Year	Population	Year	Population	Year	Population	Year	Population
1982	7.60	1989	9.72	1996	13.29	2003	20.89

1983	7.87	1990	10.15	1997	14.17	2004	21.73
1984	8.17	1991	10.63	1998	15.45	2005	23.13
1985	8.51	1992	11.06	1999	16.89	2006	26.35
1986	8.82	1993	11.48	2000	18.25	2007	28.10
1987	9.12	1994	11.85	2001	19.07	2008	29.70
1988	9.38	1995	12.26	2002	19.94	2009	31.12
						2010	31.70

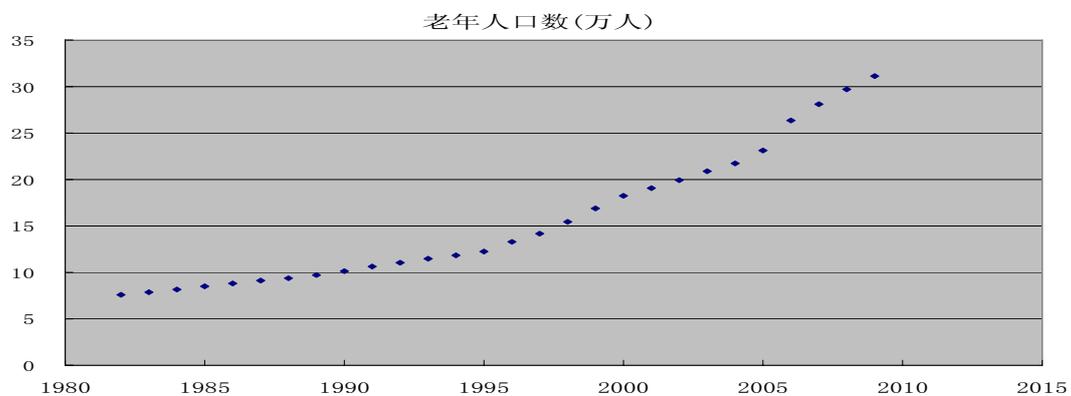
### 2.2 Model Assumptions and Theories

It assume that past patterns of population will continue into the future, such as national policies, birth rate, death rate, birth rate has maintained at current levels, is not considering moving out, moving into the demographic impact.

The population growth are subject to many limitations, such as space, food, resources, and so on, therefore, cannot be unlimited increase in population, but within a certain range of space and time grows to a certain level, there will be a limit, and then remained relatively stable or showing a downward trend. Change law of population more or less in line with Gompertz and Logistic models, curves of the two movements are similar, and its change trend of time series is the slow changes in the initial period, followed by a rapid growth phase, up to a certain extent, the rate gradually reduced and finally reach saturation point.

### 2.3 Model Specification and Estimation

The trend graph of ageing population of Lanzhou from 1982 to 2010 is shown in Figure 1.



**Figure 1. Trend graph of ageing population of Lanzhou from 1982 to 2010**

#### 2.3.1 Model Specification

We get initial judgement from figure 1, it is suitable for Gompertz curve or Logistic curve.

(1) The Gompertz curve model

The General form of the Gompertz model is 
$$y_t = ka^{b^t} \quad (1)$$

$y_t$  is ageing population,  $b$  represents the maximum possible relative growth rate,  $k$  is known as the limit parameter, the value of  $a$  determined by the saturation value  $k$  and initial values of the ratio,  $t$  is known as the time variable.

(2) The Logistic curve model

The most common expression is 
$$y_t = \frac{k}{1 + ae^{-bt}} \quad (2)$$

$y_t$  is ageing population,  $b$  represents the maximum possible relative growth rate,  $k$  is known as the limit parameter, the value of  $a$  determined by the saturation value  $k$  and initial values of the ratio,  $t$  is known as the time variable.

### 2.3.2 Model Estimation

#### (1) Gompertz curve estimation

We use the grouping method of parameter estimation to estimate the parameters in the Gompertz curve, the results are as follows:

$$b = 1.021355724$$

$$a = 9.635447956$$

$$k = 0.1391291577$$

Using the three parameters of the Gompertz curve as initial values and then using Nonlinear least squares estimation (NLS) method to estimate the results shown in table 2.

**Table 2 Estimation of Gompertz curve**

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.141705	8081.974	1.75E-05	1.0000
C(2)	9.635506	388906.3	2.48E-05	1.0000
C(3)	1.046332	404.9351	0.002584	0.9980
R-squared	-4.854976	Mean dependent var		155233.2
Adjusted R-squared	-5.323374	S.D. dependent var		71710.93
S.E. of regression	180326.6	Akaike info criterion		27.14388
Sum squared resid	8.13E+11	Schwarz criterion		27.28662
Log likelihood	-377.0144	Hannan-Quinn criter.		27.18752
Durbin-Watson stat	0.003944			

#### (2) Logistic curve estimation

Due to the  $k$  in function (2) is given before establishing model. According to Lanzhou ageing population number 2009 for 311,200 people, 2010 for 317,000 people, combined in recent years old population development speed, using Eviews, to give out of several take value of  $k$  following: 730,000 people, and 732,000 people, and 732,800 people, and 735,000 people. Taking above-4 different values of  $k$  into function (2), and using Eviews gradually Nonlinear least squares (NLS) estimated model parameters through the goodness of inspection, examination of comparative analysis, we get the peak number of ageing population in Lanzhou is 722,800. Eviews outputs see table 3.

**Table 3 EViews outputs when k=722,800**

View	Proc	Object	Print	Name	Freeze	Estimate	Forecast	Stats	Resids
Dependent Variable: Y									
Method: Least Squares									
Date: 11/25/12 Time: 21:41									
Sample: 1982 2010									
Included observations: 29									
Convergence achieved after 7 iterations									
Y=73.28/(1+C(1)*EXP(-C(2)*@TREND))									
		Coefficient	Std. Error	t-Statistic	Prob.				
	C(1)	11.74421	0.589492	19.92261	0.0000				
	C(2)	0.076626	0.002465	31.08634	0.0000				
R-squared		0.978367	Mean dependent var		16.08276				
Adjusted R-squared		0.977566	S.D. dependent var		7.655128				
S.E. of regression		1.146591	Akaike info criterion		3.177935				
Sum squared resid		35.49609	Schwarz criterion		3.272231				
Log likelihood		-44.08005	Hannan-Quinn criter.		3.207467				
Durbin-Watson stat		0.182070							

The standard model is 
$$y_t = \frac{73.28}{1 + 11.7442 \times e^{-0.0766t}} \quad (3)$$

t = (18.9226) (31.0863)  $R^2=0.9784$

## 2.4 Model Testing

### 2.4.1 Statistical Tests

By table 3 and function (3), it can be seen that under the 0.05 significance level, none of the coefficients by t test of Gompertz curve, and the coefficient of determination is negative, DW value is too small, so we discard Gompertz curve model. The coefficients of the Logistic curve model are significant under the 0.05 level, meanwhile, the coefficient of determination is high, so we use the logistic model to forecast the ageing population of Lanzhou city.

### 2.4.2 Autocorrelation Discussion

By the results of function (3) we can see, the coefficients of the model by t test and significance level is very high, and model fitting is very well. But DW=0.1719 means autocorrelation. We learn from Chen Yanguang "population and resource loading parameters Logistic model in the prediction of regression" method, which is based on difference sequences of binary linear regression. Using y to present population, taking into account the time step  $\Delta t=1$ , getting auto-regression function:

$$\Delta y = by_{t-1} - \frac{b}{k} y_{t-1}^2$$

Using  $y_{t-1}$  and  $y_{t-1}^2$  for independent variables, and using  $\Delta y = y - y_{t-1}$  for dependent variable, we can get a binary linear regression function.

Using the original series binary parameter estimates of nonlinear Autoregressive model, we can derive the 3 parameters  $a$ 、 $b$ 、 $k$  of Logistic model, in order to eliminate autocorrelation.

$$\Delta y = by_{t-1} + \frac{b}{k} y_{t-1}^2 \quad (4)$$

$$\Delta y = 0.0312y_{t-1} + (0.0014)y_{t-1}^2 \quad (5)$$

$$t = (2.02) \quad (1.97)$$

$$R^2 = 0.6619 \quad DW = 1.62$$

From  $b = 0.0312$ ,  $b / k = 0.0014$ , we can get that:  $k = 0.0312 / 0.0014 = 22.26$ ;  $a = (0.0312 / 7.5988) - 1 = 1.9296$

Based on the original we use ordinary least-squares to estimate function (5).

From the function (5), we know that autocorrelation has been eliminated. But there is another serious problem: the economic significance of  $k$  is failure, because the maximum value not only of the ageing population in Lanzhou is 222600, but Lanzhou's ageing population has reached 311,200 in 2009. Function (5) cannot be used to predict. It can be argued that function (3) is caused by the inertia of the ageing population development, which happens to be we're looking for law of inertia, and it can help us to get a more accurate forecast.

### 2.4.3 Unit Root Testing (ADF)

To further illustrate the reliability of model predictions, we can calculate the residuals of function (3) to do ADF tests. Test results showed that over the 1% ,5%and 10% of three distinct levels, MacKinnon threshold respectively is -2.656915 -1.954414 and -1.609329, t test statistic value is -3.159211 and less than the critical value, indicating that the sequence has no unit root model residual are stationary.

**Table 4 the residuals of function (3) ADF tests**

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-3.159211	0.0028
Test critical values: 1% level	-2.656915	
5% level	-1.954414	
10% level	-1.609329	

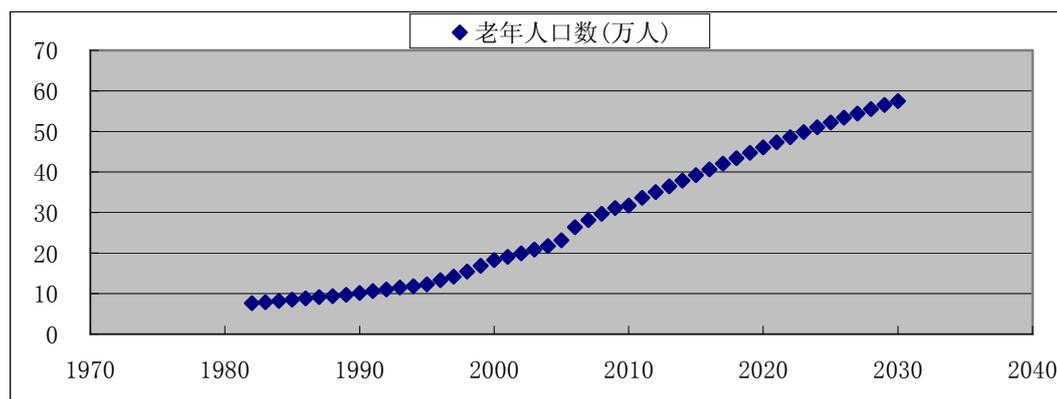
### 2.5 Model Prediction

Based on function (3), and combined with the known data for forecasting, we get the ageing population of Lanzhou from 2011 to 2030, as shown in table 5.

**Table 5 Ageing population in Lanzhou city forecasts results 10000 persons**

Year	Ageing population	Year	Ageing population
2011	33.63	2021	47.34
2012	35.03	2022	48.61
2013	36.43	2023	49.85
2014	37.84	2024	51.05
2015	39.24	2025	52.22
2016	40.63	2026	53.35
2017	42.01	2027	54.44
2018	43.37	2028	55.50
2019	44.72	2029	56.51
2020	46.04	2030	57.48

Combining the Forecast data and the actual data of ageing population of Lanzhou, we draw the trend graph are shown in Figure 2.



**Figure 2. Trend graph of ageing population of Lanzhou from 1982 to 2030**

### 3 Conclusions

Based on the above analysis and prediction of the results, combined with the relevant literature, The changing trend and law of the ageing population of Lanzhou from 1982 to 2030 are summarized as follows:

The slow increasing phase of ageing population is from 1982 to 2001. An average annual increase of the elderly population is 5730 in this phase. Trend of ageing depends not only on the population structure, but migration, birth rate, death rate, average life expectancy of all ages and other irregular changes. 50 's to the 80 's of the last century are population ageing phases after the World War II, this time limited by prevailing social conditions, the number of births and the survival rate of all age groups of the population are not very high. Coupled with the 60 's to the 70 's of the last century, due to irregular factors such as the Cultural Revolution, led to a massive increase in deaths of young adults, making the ageing population during a slow increase.

From 2002 to 2010, Lanzhou full into population ageing era. According the Gansu province population and family planning Committee "Lanzhou population ageing process speed up" reported in 2006, the ageing population of Lanzhou fully met or exceeded standards in 2002. By 2005, the city's ageing population aged 60 and over has reached 382,900, share of the total population rose to 12.28%, indicate that the ageing process faster. Sixth Population Census data of Lanzhou show 8.77% per cent of the population aged 65 and over in Lanzhou in 2010, Lanzhou has fully entered the age of aging population and ageing trend continues to accelerate. From 2002 to 2010, it has an accelerated growth in the number of ageing population in Lanzhou. Due to national economy of recovery and development, people life stability, medical conditions improved, and take encourages reproductive of approach, it makes population growth formed "high birth, and low death, and high natural growth" of mode, so makes 2004-2009 years of Lanzhou old population NET nearly 100,000 people, average annually increased 18,780 people, rendering out accelerated growth situation.

Lanzhou entered ageing continues to expanded stage after 2012. According to measuring, as October 2012, Lanzhou 60 ages and above has 505900 people, which 327,200 are in the city, rural elderly 178,700; 80 ages and the above are 35,300. It has empty nest ageing population 113,200 in city, accounted for city ageing population of 22.38%. After 2012 population ageing will continue, and social pressures will increase.

#### 4 Countermeasures

Establishing a group of elderly apartments, truly achieve a secure old age. With the development of Western welfare and senior-housing conditions improvement, many elderly apply of their own volition to live in elderly apartments. In Beijing and Shanghai, the elder apartments are very common, and low, medium and high grade ratings. Underdeveloped Gansu province, including the capital Lanzhou city, have no good elderly apartments, which became population ageing issues needed to be solved. Relevant government departments have planned a phased establishment of a group of elder apartments, proper arrangements for those older persons who need to stay in the elder apartments to really achieve a secure old age.

Establishing policies and laws to ensure the elder apartments reasonable and equitable to be used. There are some waste of resources in the fading old apartment, but really need elder apartments people are unable to stay. We recommend that the elderly and their children are bundled together, develop policies and laws to ensure that reasonable and equitable utilization of senior-housing in the long run. Can with the old evidence of relationships between children and parents, allow off-site senior-housing occupancy of residence parents to their children, and enjoy the local older people the same treatment, so as to meet the needs of older persons, and solved the problem of children visiting.

Relaxation of the birth control policy, delaying mandatory retirement age to reduce labour supply and demand pressures. The negative impact of population ageing on labour supply and demand from the relaxation of the birth control policies and postpone legal retirement age be improved in two ways. We recommend that the regional coordinated development on the basis of a planned relaxation of population control, in areas of high fertility is to strictly control the number of population, so as to achieve the demographic balance between regional development. In addition, extend the retirement age also contributed to years, delaying social security benefits to pay social security contributions, so as to reduce the financial pressure on the social security of population ageing was softened to some extent challenge the financial capacity to pay.

Operational "virtual home" building, which is to explore effective ways to crack the challenge of ageing. Compare with traditional method, "virtual home" is a "the nursing home without walls", less investment and wide range of services, does not have to live in nursing homes for the elderly in the passive services can be selected, access to specialized pension services at home. At present, Chengguan district, Lanzhou city, "virtual home" setting of care services including life, health, home economics, psychological comfort for the convenience, legal counselling, cultural entertainment 6 classes more than 40 services. Government service enterprises are given a certain financial subsidies, enterprise service price is lower than the market price for the elderly at least 20% and, therefore, improve and promote "virtual home" building can be an option.

The government should make early preparation and identify specific measures to deal with an ageing population. In many aspects of ageing population, the government should do more and earlier. Because the economic resources are concentrated in the hands of the Government, the Government does not, others can do. Ageing is a broad, and problems of the long road to go, you need to take to develop long-term, detailed and feasible policies and measures, consistent with the situation on the ground. Concrete can be considered the following problems. First, to increase resources integration configuration, it is recommended that every street and community have established a certain scale of activity in the elderly and aged Center, set old school, rehabilitation, health advice, sports, chat, entertainment, food and beverage services, computers and other forms

of broadband as one of the places, convenient to participate in and enjoy a wide range of services for the elderly. Second, the Community Neighborhood Committee usually have to intensify contacts with the elderly particularly the single elderly, regular interest and visiting the elderly. Interested parties to undertake periodic safety inspection of residence for the elderly, such as a gas leak, electric wires and aging, guarantee the safety of families living in the elderly. Frequently organizes health talks and health advice. Third, to adopt effective measures, attention to the spiritual life of the elderly, newspapers, television, and other media to add news and information on spiritual and cultural activities for older persons should enrich the spiritual life of the elderly; to further increase pensions for the elderly, senior-housing fees to retired old people can afford it. At last, to take effective measures to solve visiting doctor being difficult and expensive problem in the elderly. To devote major efforts to developing Street and community health, convenient medical care for the elderly.

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