# Problem E

# Spread and Development of Metropolitan Areas

The metropolitan area which our chose is Los Angeles.

The task of our team is to create a set of quantitative support models to evaluate the various impacts of the expansion of urbanization. First, we have defined important indicators and evaluation criteria: population and GDP per capita. We use GDP and population as the main indicators. Based on the increase in cancer population, the loss caused by the metropolitan area was evaluated. Finally, the impact of urbanization on food security is considered through the annual farmland output.

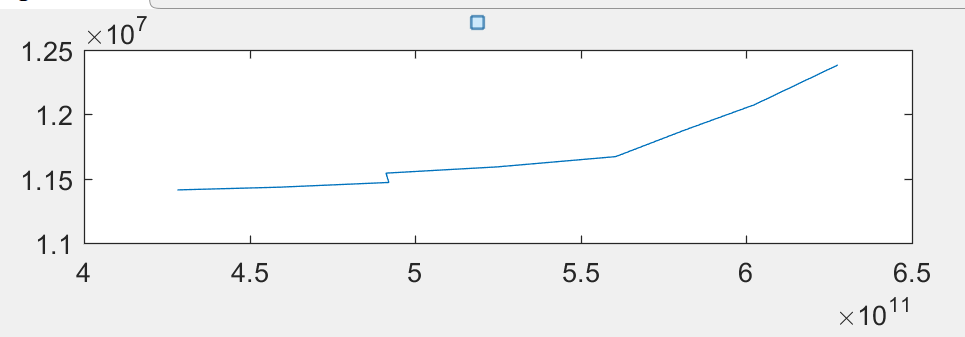
1.

Considering that the number of cars in a city is related to the city's population and the disposable income of residents, the data of Los Angeles population and per capita GDP from 2106 to 2019 are linearly fitted to its impact on the number of cars, and then the corresponding year is predicted Car ownership.

DATASET：

|  |  |  |  |
| --- | --- | --- | --- |
| DATE | CALOSA7POP(Thousand) | GDP per citizen | number of cars |
| 2010/1/1 | 9823.246 | 43594 | 11,412,659 |
| 2011/1/1 | 9876.482 | 46470 | 11,433,755 |
| 2012/1/1 | 9935.375 | 49525 | 11,470,565 |
| 2013/1/1 | 9992.484 | 49157 | 11,543,124 |
| 2014/1/1 | 10040.072 | 52272 | 11,591,690 |
| 2015/1/1 | 10085.416 | 55578 | 11,671,288 |
| 2016/1/1 | 10105.708 | 57538 | 11,878,573 |
| 2017/1/1 | 10103.711 | 59625 | 12,074,796 |
| 2018/1/1 | 10073.906 | 62300 | 12,383,481 |

Form 1



*Figure 1*

It can be observed through the *figure 1* that the relationship is slightly linear

The car ownership in a region is generally linearly related to the economic level of the region, so here we use the economic aggregate and car ownership to perform a linear fit by the least square method.

Define the relationship between economic aggregate and car ownership as followed:

Y=AX + B

Fitting result :

A = 4.51237444194451e-06

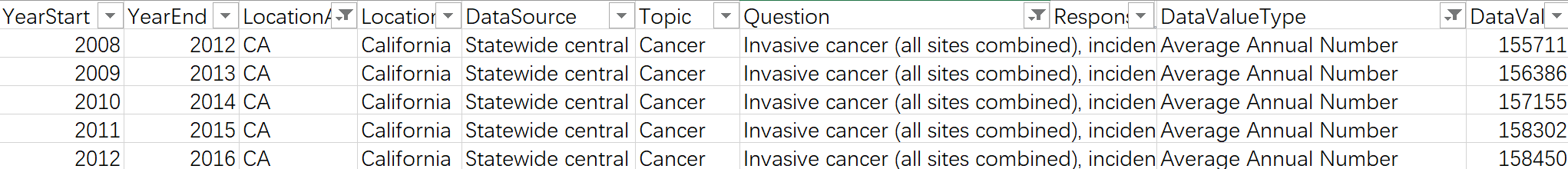
B = 9327571.92687742

Therefore, it is easy to know that the population growth brought about by the development of big cities and the economic aggregate growth will lead to the increase in the number of cars.

2.

The expansion of urban area and the increase of urban population will lead to increased living environment pollution of residents, such as air pollution and water pollution, and will lead to an increase in unhealthy eating rates. All of these will lead to an increase in the prevalence of chronic diseases among residents, which in turn will cause the government to increase expenditures on medical and environmental treatment and increase additional losses.

Here we use cancer expenditure to count the losses caused.



Form 2

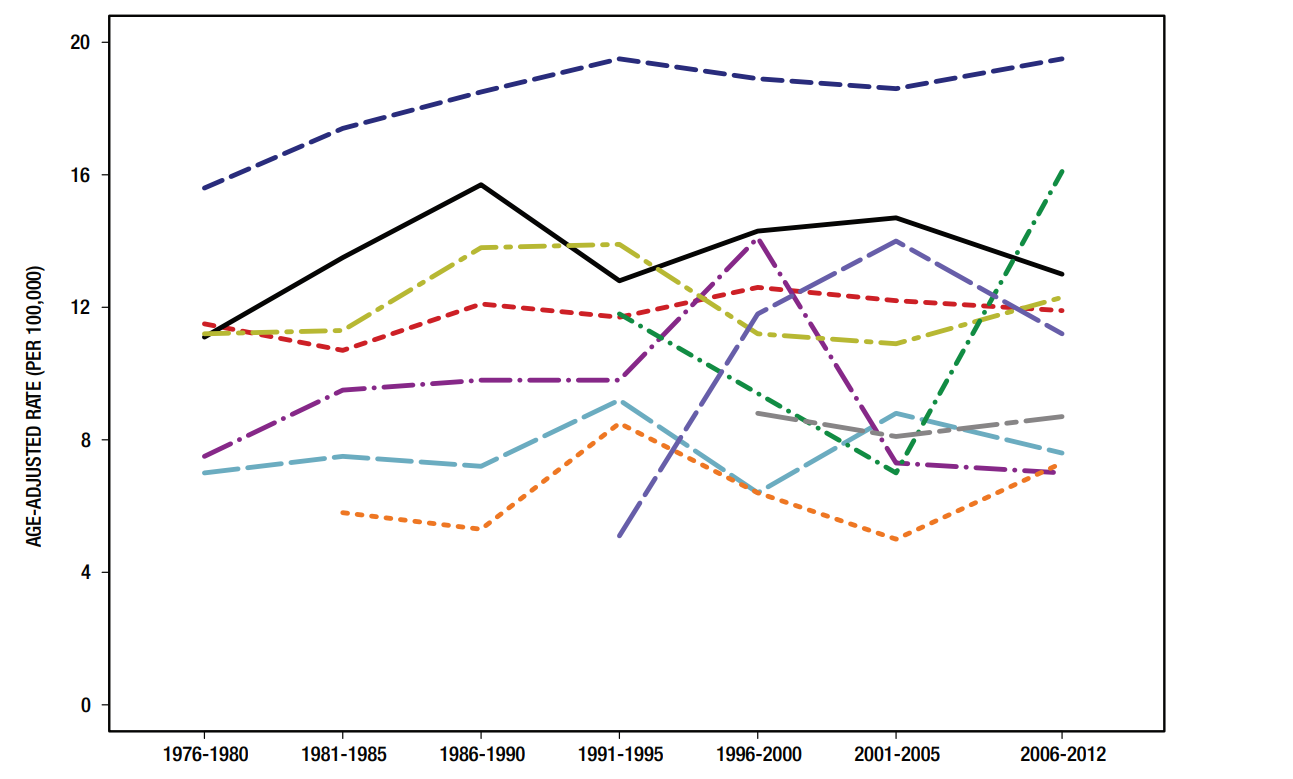


Figure 2

It shows that the proportion of cancer patients from 2008 to 2012 has increased year by year.

According to the statistical report of the U.S. Census Bureau, the average cost of cancer in the United States is $150,000.

In order to protect the privacy of residents, the CDC updates statistics on cancer every 5 years and then releases them uniformly. Therefore, there is not data about recent years.

Due to the small amount of data, it is more appropriate to adopt the GM(1,1) to estimate the loss in the short term. Forecast the growth of cancer call charges in the next five years

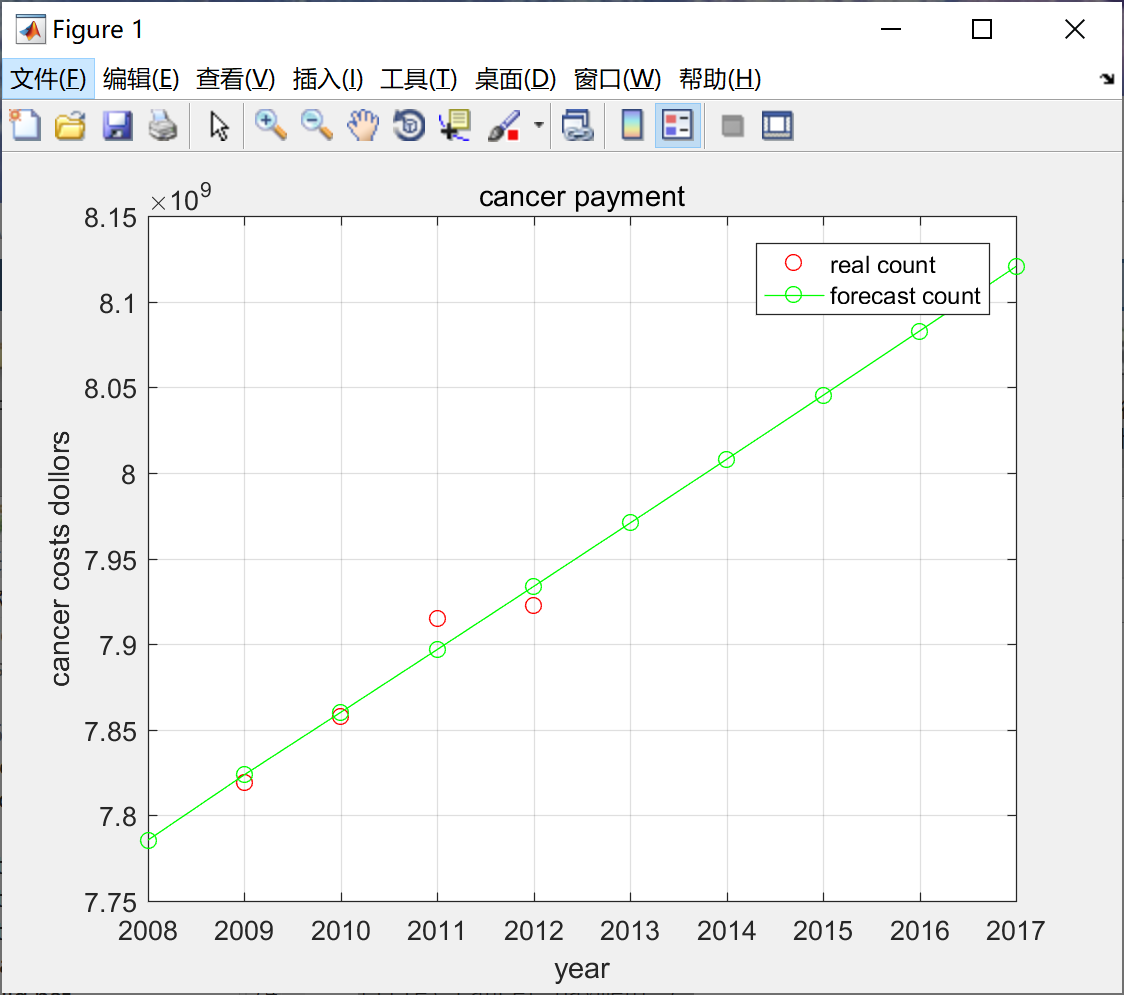


Figure 3

Relative residual Q=0.000920110933168094

Variance ratio C = 0.184849276621288

Probability of small error P=1

The prediction result is relatively accurate

It can be seen that the annual expenditure increases on an annual basis of 5\*10^7 dollars.