

# *Use Logistic Regression to Investigate Car Purchase Restrictions*

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**Keywords:** deregulation of purchase restriction policy, dual logistic regression, car purchase intention

**Abstract:** In order to investigate the opinions of Hangzhou citizens on the possible future release of the purchase restriction policy, four representative areas of Hangzhou-Jiangan District, Shangcheng District, Xihu District and Binjiang District were selected for field investigation. A binary logistic regression model was established for the influencing factors of car purchase intention and car purchase intention, and the model was applied to predict the car purchase intention of Hangzhou citizens, and the results were in line with the prediction. Based on the investigation, four suggestions were put forward to the relevant departments regarding the problems that may be encountered in the implementation of the policy of liberalizing the restriction on vehicles in Hangzhou.

## **1. Introduction**

Consumer demand is one of the core elements of industrial competition, and it is the ultimate driving force for economic growth. My country's auto market does not lack consumption potential, what it lacks is a smooth consumption mechanism and environment. Relevant places should relax or cancel the restrictions on the car market, and use big data and more refined city management and services to increase the city's reasonable value of car capacity, and realize the way of vehicle management and control from restricting purchases to guiding use.

The General Office of the State Council recently issued the "Opinions on Accelerating the Development of Circulation and Promoting Commercial Consumption" and proposed that regions that implement automobile purchase restrictions should explore the implementation of specific measures to gradually relax or abolish purchase restrictions in order to release the potential of automobile consumption. This has once again ignited people's expectations for more cities to liberalize car purchase restrictions.

Although the policy has been proposed, it still needs to be further investigated whether it can be truly realized and improve the auto industry and people's lives. Based on this, the survey team designed a questionnaire based on the basic information of residents' age, occupation, cultural education and other basic information and participation in automobile consumption. The survey was conducted in the above urban area, Xihu District, Jiangan District and Binjiang District as examples. After importing the questionnaire data, first test the reliability and validity of the questionnaire. After the test is passed, in order to establish a satisfaction evaluation system, a confirmatory factor analysis is carried out to construct a reasonable evaluation structure, which is

used to predict citizens' satisfaction with the liberalization of purchase restrictions. It is hoped that the conclusions and suggestions provided can play a minor role and provide reference for relevant parts.

## 2. Investigation method

In order to estimate the required sample size, we decided to use a preliminary survey to estimate the satisfaction of laborers in the pilot areas of the new urbanization with labor relations. First of all, according to the document issued by the Hangzhou Bureau of Statistics and Information on February 14, 2019 [1], our group learned that the population of Hangzhou's urban and rural populations were 7.59 million and 2.216 million, respectively, accounting for 76.4 of the total population, 23.6%, the ratio of urban to rural population is roughly 3:1. In order to ensure the comprehensiveness and rationality of the sample data, our group will select three representative urban areas in Hangzhou: Shangcheng District, Xihu District, and Jianggan District; and one rural area: Binjiang District.

Secondly, in order to ensure the scientificity and rigor of the sample data, we decided to first estimate the understanding of Hangzhou citizens on the policy of liberalizing car purchase restrictions. First of all, the following points system was established: 100 points represent a good understanding, 50 points represent some understanding, and 0 points represent no understanding at all. Then, a total of more than 100 Hangzhou citizens were consulted by sending messages or calling, They calculated the sample mean value of  $\bar{x} = 56.81$  points and the sample variances<sup>2</sup> = 1594.24. We require that the relative error of the estimate does not exceed 5%, which is  $r \leq 0.05$ , and the assumed confidence level is 95%, which is  $\alpha = 0.05$ . At this time, the t statistic is 1.96, the limit sampling error is  $e = r \times \bar{x} = 2.8405$ , and the initial sample size is calculated:

$$N_1 = \frac{t^2 s^2}{e^2} = \frac{t^2 s^2}{r^2 \bar{x}^2} = 586$$

Based on the permanent population of Hangzhou at 9.01 million, the overall size is revised:

$$N_2 = N_1 \frac{x}{x + N_1} = 586 \times \frac{9018000}{9018000 + 601} = 586$$

According to the estimated effective answer rate of the questionnaire, make final adjustments to determine the final sample size N:

$$N = \frac{N_2}{r} = \frac{586}{70\%} = 837$$

Through the above adjustment and calculation,  $N = 948$  is initially obtained. Since appropriately expanding the sample size can reduce the sampling error, in order to further ensure the estimation accuracy, we determined the final sample size to be 985.

Since we use a one-to-one question-and-answer survey, the questionnaire response rate is 100%. After screening and sorting out the questionnaires and data entry, it was determined that there were 985 valid questionnaires, and the questionnaire effective rate was 96.4%.

In the selection of sampling methods, simple random sampling is used. According to the number of people in the four districts of Hangzhou, the sample size of each district is determined by a proportional method. The specific distribution is as follows:

Table 1 Distribution of the proportion of people in each region

Area	population	Percentage	number of samples
jiangnan	78	32.82%	323
shangcheng	34.5	14.51%	143
xihu	86	36.18%	356
binjiang	39.2	16.49%	163
total	237.7	100%	985

According to the number of people in these four regions, we follow the number of people in Jiangnan District: Shangcheng District: Xihu District: Binjiang District = 7800: 3450: 8600: 3920, so that the number of questionnaires in these four regions accounted for 32.82%, 14.51%, 36.18% and 16.49%. A total of 985 questionnaires were distributed, including 323 in Jiangnan District, 143 in Shangcheng District, 356 in Xihu District, and 163 in Binjiang District.

### 3. Analysis and results of car purchase intention under the binary logistic regression analysis model

#### 3.1 Variable selection and assignment of the model

Taking into account the convenience of the later model establishment and the accuracy of the analysis, we analyzed the independent variables and dependent variables (car purchase intention) in the early stage through the contingency table, so as to select the significant factors related to the dependent variable as the independent variables of this regression model. Variable. We believe that "whether to buy a car after liberalizing the purchase restriction policy" has a certain significance for the quantitative description of whether Hangzhou citizens will buy a car after the liberalization of the car purchase restriction policy in the future. In connection with the characterization of the probability of choosing a car after the release of the purchase restriction policy, we decided to predict the binary logistic regression model of the probability of buying a car after the release of the purchase restriction policy by the citizens of Hangzhou. Whether to buy a car later" is the dependent variable. Through contingency analysis, we determined gender, age group, education level, work unit, monthly income, number of family members, number of cars at home, and travel mode as independent variables. The variables will be summarized, numbered and explained below. In the actual modeling process, we use the backward method for variable selection [3].

Using SPSS software, we get the result. Among them, we omit the specific variable selection process, and only show the final model selection results. We can see that the p-values of the significance test of each independent variable are all less than 0.05, indicating that the variables are all significant. We get the regression model as:

$$\begin{aligned} \ln \frac{P}{1-P} = & -42.254 + 21.524X_{31} + 22.157X_{32} + 20.545X_{33} + 21.157X_{34} + 23.176X_{35} + 17.214X_{61} \\ & + 18.245X_{62} + 21.254X_{63} + 22.147X_{64} + 22.541X_{65} \end{aligned} \quad (1)$$

#### 3.2 H-L test of car purchase intention model

Through the randomness table of the H-L test, compare the observed value with the expected value. The observed value in the table is roughly the same as the expected value. From this, it can be concluded that the model has a good fit [4].

## 4. The application of the model to predict people's purchase intentions after the car purchase restriction policy is released

### 4.1 Analysis of car purchase intention

Through the above model, we can analyze the car purchase intention of specific citizens.

1) Use this model to simulate the situation of a respondent whose age group is 20-25 years old and whose monthly income is less than RMB 2,000: At this time

$$\ln \frac{p}{1-p} = -42.254 + 21.524 \times 1 + 17.214 \times 1 = -3.516$$

This shows that the probability that citizens who meet the age group of 20-25 and whose monthly income is less than 2000 yuan will buy a car after the purchase restriction policy is released is  $p = 2.89\%$ .

2) Use this model to simulate the situation of a respondent who fits the age group of 26-31 years and has a monthly income of 2000-4000 yuan: At this time

$$\ln \frac{p}{1-p} = -42.254 + 22.157 \times 1 + 18.245 \times 1 = -1.852$$

This shows that the probability of a citizen who is 26-31 years old and has a monthly income of 2000-4000 yuan buying a car after releasing the purchase restriction policy is  $p = 13.56\%$

3) Use this model to simulate the situation of a respondent whose age group is 32-37 years old and whose monthly income is 4000-6000 yuan: At this time

$$\ln \frac{p}{1-p} = -42.254 + 22.157 \times 1 + 18.245 \times 1 = -1.852$$

This shows that the probability of a citizen whose age group is 32-37 years old and whose monthly income is 4000-6000 yuan releases the purchase restriction policy is  $p = 38.75\%$ .

4) Use this model to simulate the situation of a respondent who fits the age group of 38-43 and has a monthly income of more than RMB 8,000: At this time

$$\ln \frac{p}{1-p} = -42.254 + 21.157 \times 1 + 22.541 \times 1 = 1.174$$

This shows that the probability that citizens who meet the age group of 38-43 and have a monthly income of 8,000 yuan or more will buy a car after the purchase restriction policy is released  $p = 76.39\%$ .

We can find that with the increase of age and monthly income, the probability of citizens buying cars after the restrictions on purchases are lifted is also increasing. This is in line with reality. Young people have a low monthly income and do not have much savings. Therefore, it is not the purchase restriction policy that restricts them from buying cars, but the economic level. While the monthly income of middle-aged people increases, they also save more than young people. Coupled with the family's car needs, such as picking up children, etc., they have enough financial strength and willingness to buy a car. It is the purchase restriction policy that restricts their purchase of cars. Therefore, these people are more likely to buy a car after the purchase restriction policy is released.

### 4.2 Error Analysis

We substituted the sample data of the interviewees into formula (1) and analyzed the error of our model. See Appendix 4 for the results of back generation. We found that from the regression model,

the expected value of respondents who are willing to buy a car is 542, and the true value of the actual sample who is willing to buy a car is 520, and the overall error of the model is small.

On the other hand, we also considered the probability of errors for specific citizens. Among them, there are 5 people with errors in the age group of 20-25, accounting for 2.45% of the total number of people in the age group; The number of errors is 11, accounting for 2.78% of the total number of people in this age group; the number of errors in the age group is 32-37, which is 3 people, accounting for 1.51% of the total number of people in this age group; the number of errors in the age group is 38-43 There are 0 people, and the number of people with errors in the age group of 44-49 is 1 person, accounting for 1.67% of the total number of people in this age group. This shows that the binary regression model on whether you are willing to buy a car after the purchase restriction policy is released is very effective.

## 5. Suggestions

In view of the problems that may be encountered in the implementation of the policy of liberalizing vehicle restrictions in Hangzhou, we combine the information collected to propose the following countermeasures and suggestions.

(1) Reasonably plan road resources and formulate flexible and changeable measures.

We believe that the core of the problem of urban congestion is unreasonable urban planning, unclear regional functions, and imperfect infrastructure, which cannot be simply attributed to excessive car ownership. To solve a comprehensive problem, in the process of planning a city, it is necessary to organically integrate the working environment and living environment, and guide citizens to choose public transportation, and use the related fees to improve public transportation and improve the intelligent transportation management system, to further alleviate traffic congestion.

(2) Restrict the use of cars and vigorously develop public transportation.

On the one hand, automobile exhaust emissions do have an adverse effect on the environment. On the other hand, the dependent variable of environmental pollution is not the growth of the automobile market, but the increase in the number and frequency of automobile use. Therefore, we believe that the government's focus on environmental pollution control should be on car use rather than purchase. The best way is not to restrict the use, but to let people voluntarily give up the use of private cars and switch to public transportation.

(3) Enhance market consumption vitality and actively promote consumption renewal.

Efforts will be made to break down market barriers that restrict consumption, effectively safeguard the legitimate rights and interests of consumers, comprehensively apply various policy tools, and actively promote the renewed consumption of automobiles, home appliances, and consumer electronics. Resolutely remove barriers to passenger car consumption.

(4) Intelligent traffic command will improve the level of road operation and management.

It is necessary to introduce the concept of "only traffic management", develop a comprehensive command platform that integrates command, law enforcement, management, and service functions, and conduct networked joint control of the signal control system at intersections in the city, conduct real-time monitoring, coordination, and effectively Adopt traffic signal control such as countdown, high flat peak, green wave belt, etc., to balance traffic flow operation, so that the number of stops and delay time can be minimized.

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