Analysis on the Influencing Factors of Private Automobile Ownership in China

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Abstract

Since China entered the 21st century, people's living standards have been improving day by day, and private automobiles, once considered as luxury goods, have gradually become popular. By the end of 2019, there were 225,089,900 private automobiles in China, and the growth rate is about 10% every year. Although automobiles play a positive role in facilitating residents' life and improving residents' quality of life, they will inevitably bring about traffic jams, environmental pollution, parking space in short supply and other problems. This paper conducts an econometric study on the number of private automobile ownership and its main influencing factors in China from 2000 to 2019. It is found that the gross domestic product (GDP), the number of urban population and the per capita disposable income of urban residents significantly affect the number of private automobile ownership.

Keywords

Multiple Linear Regression Model; Model Test; Policy Suggestions.

1. Introduction

With the rapid development of science and technology, the price of automobiles has been continuously reduced, and the number of private automobiles in China has been rising. While the automobiles are convenient for residents and improve their living quality, they will inevitably bring about traffic jams, environmental pollution, and the shortage of parking Spaces. Especially under the background of the gradual scarcity of non-renewable energy such as petroleum, it is of great practical significance to study the private automobile ownership in China to improve the production process of the automobile industry, perfect the automobile industry policy and stimulate the development of the transportation industry in China.

2. Literature Review

A certain number of domestic scholars have analyzed the factors affecting the number of private automobile ownership in China. Among them, Wang Lu[1] (2017) using the gray correlation method based on the analysis of the private automobile ownership and highway mileage, gross domestic product, total operating automobiles etc. It is concluded that highway operating car ownership by far the most of the impact on the number of private automobiles, and GDP and disposable income of urban residents in our country also relatively obvious influence on the conclusion of private automobile ownership in China. Wang Yuhan et al. [2](2019) used multiple regression model to draw the conclusion that too much or too little private automobile ownership will affect social development. Zheng Xueqing[3](2017) found through the method of multiple linear regression that private automobile ownership in China was most affected by the total population at the end of the year, followed by GDP. Wang Luni et al.[4](2019) found that both population and economic factors and provincial and municipal construction factors would affect the change of private automobile ownership through principal component analysis.

In addition, some scholars have studied the influencing factors of private automobile ownership in provinces. Ge Guangjin[5](2017) analyzed the influencing factors of private automobile ownership in

Hebei Province through OLS method, and found that the increase of highway mileage in Hebei Province was negatively correlated with the private automobile ownership, and the increase of urban population density and urban per capita disposable income was positively correlated with the private automobile ownership in Hebei Province. Ma Luhan[6](2019) analyzed the influencing factors of private automobile ownership in Jiangsu Province through factor analysis, and found that economic development, urbanization rate of population and increase of per capita disposable income of urban families provide an excellent development environment for private car market in Jiangsu Province.

3. Construction of econometric model

3.1 Selection of explained variables

In this paper, the number of private automobiles in China (10 thousand units) is selected as the explained variable. With the continuous and rapid development of China's national economy, the price of automobiles has been declining and the per capita disposable income has been increasing, making it easier and easier for private automobiles to enter people's life.

3.2 Selection of explanatory variables

In this paper, GDP (100 million yuan), steel production (10 thousand tons), number of urban population (10 thousand people), per capita disposable income of urban residents (one thousand people), total population (10 thousand people) and total highway mileage (kilometers) were selected as explanatory variables for the study. The reasons are as follows:

(1) GDP (0.1 billion Yuan). GDP is the most direct indicator of economic development, and its growth will drive the development of all industries, including the automobile industry, which in turn will feed back into GDP.

(2) Steel output (10 thousand tons). As an important raw material of automobile body and parts, the output of steel is closely related to the output of automobile.

(3) Number of urban population (10 thousand people). Urban population is the main force of purchasing private automobiles. With the gradual acceleration of China's urbanization, the urban population is also increasing. Therefore, it is preliminarily believed that there is a strong correlation between the number of urban population and the number of private automobiles in China.

(4) Per capita disposable income of urban residents (yuan). The increase in the per capita disposable income of urban residents indicates that the economic level is improving and there is further demand for consumption, such as the purchase of private automobiles.

(5) Total population (10 thousand people). With the rapid development of China's economy, more and more people have a demand for private automobiles, and many rural people also have a certain consumption capacity for private automobiles.

(6) Total highway mileage (kilometers). As the main driving carrier of automobiles, the increase of the total mileage of highways will bring convenience to the travel of private automobiles, and the increase of the number of private automobiles will also promote the growth of the total mileage of highways.

The above variables are defined in Table 1.

Table 1. List of Variables, unit of measurement and symbols

Variables	Unit of measurement	symbol
Private automobile ownership	10 thousand units	y
GDP	0.1 billion Yuan	x_1
Steel output	10 thousand tons	x_2
Number of urban population	10 thousand people	x_3
Per capita disposable income of urban residents	yuan	x_4
Total population	10 thousand people	x_5
Total highway mileage	kilometers	x_6

3.3 Data sources and descriptive statistical analysis

The data used in this paper are from the National Bureau of Statistics. Variable data are shown in Table 2.

Table 2. Variables data

Year	y	x_1	x_2	x_3	x_4	x_5	x_6
2000	625.33	100280.14	13146.0	45906	6255.70	1267.43	16798.00
2001	770.78	110863.12	16067.6	48064	6824.00	1276.27	16980.00
2002	968.98	121717.42	19251.6	50212	7652.40	1284.53	17652.00
2003	1219.23	137422.03	24108.0	52376	8405.50	1292.27	18098.00
2004	1481.66	161840.16	31975.7	54283	9334.80	1299.88	18707.00
2005	1848.07	187318.90	37771.1	56212	10382.30	1307.56	33452.00
2006	2333.32	219438.47	46893.4	58288	11619.70	1314.48	34569.99
2007	2876.22	270092.32	56560.9	60633	13602.50	1321.29	35837.15
2008	3501.39	319244.61	58488.1	62403	15549.40	1328.02	37301.64
2009	4574.91	348517.74	69405.4	64512	16900.50	1334.50	38608.23
2010	5938.71	412119.26	80276.6	66978	18779.10	1340.91	40082.29
2011	7326.79	487940.18	88619.6	69079	21426.90	1347.35	41063.87
2012	8838.60	538579.95	95577.8	71182	24126.70	1354.04	423750.80
2013	10501.68	592963.23	108200.5	73111	26467.00	1360.72	43562.18
2014	12339.36	643563.10	112513.1	74916	28843.90	1367.82	44639.13
2015	14099.10	688858.22	112349.6	77116	31194.80	1374.62	45772.96
2016	16330.22	746395.06	113460.7	79298	33636.20	1382.71	46962.63
2017	18515.11	832035.95	104642.1	81347	36396.20	1390.08	47734.69
2018	20574.93	919281.13	113287.3	83137	39250.80	1395.38	48465.32
2019	22508.99	990865.11	120456.9	84843	42358.80	1400.05	50124.96

Source: National Bureau of Statistics

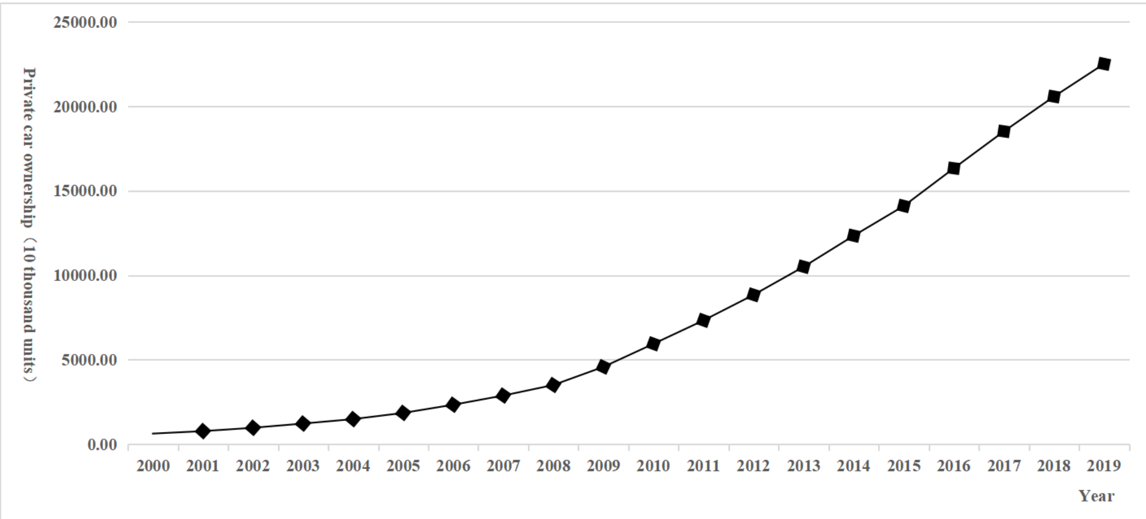

Figure 1. Private automobile ownership in China from 2000 to 2019

In Figure 1, the horizontal axis represents the year, and the vertical axis represents the number of private automobiles. As can be seen from Figure 1, the number of private automobiles in China has been growing continuously in the past 20 years. The growth from 2000 to 2008 was relatively flat, when China just entered the 21st century and was in the early stage of rapid development. From 2009 to 2019, China's private automobile ownership has maintained an average annual growth rate of 10%.

The number of private automobiles in China increased from 6.2533 million in 2000 to 225.0899 million in 2019, an increase of 36 times. China's GDP grew from 10.028014 trillion yuan in 2000 to 9.09086511 trillion yuan in 2019, an increase of nearly 10 times. Steel output increased from 13.1.46 million tons in 2000 to 1204.569 million tons in 2019, an increase of 9.2 times. It can be seen that the growth rate of private automobile ownership in China is obviously faster than the growth rate of GDP and steel output. This paper will use the method of multiple linear regression model to quantify the influence of each explanatory variable on the explained variable.

4. Model results and related tests

4.1 Estimation results of the basic model

Using Stata15.1 software rendering the explain and be explained variables correlation diagram (see figure 2), can be obviously found that private automobile ownership in China and gross domestic product (GDP), steel production, urban population, urban per capita disposable income, population and highway mileage are positively correlated relationship, and basic performance for linear correlation, so multiple regression model is established for analysis. In order to eliminate the heteroscedasticity of the model, logarithmic processing is carried out on x_1.

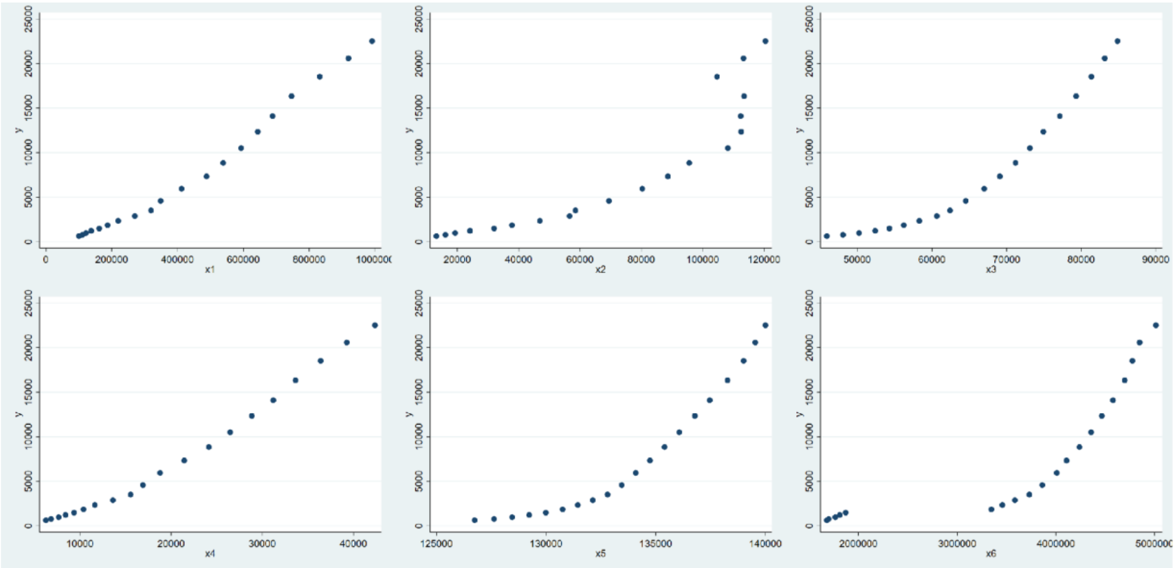

Figure 2. Correlation diagram of explanatory variables and explained variables

The preliminary model is as follows:

$$y = \beta_0 + \beta_1 Lnx_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 x_6 + u$$

Where$u$is the random error term.

Multiple linear regression was conducted for the model, and the results were shown in Table 3.

Table 3. Preliminary regression results

y	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Lnx_1	-6939.581	1488.171	-4.66	0.000	-10154.579	-3724.584	***
x_2	-0.0218	0.0115	-1.90	0.080	-0.04668	0.0029	*
x_3	0.6695	0.3632	1.84	0.088	-0.1151	1.4543	*
x_4	0.7664	0.0602	12.72	0.000	0.6362	0.8966	***
x_5	-1.0675	0.7545	-1.41	0.181	-2.6977	0.5625	
x_6	0.0002	0.0002	1.23	0.241	-0.0002	0.0075	
Constant	180008.6	89081.942	2.02	0.064	-12441.24	372458.43	*

Mean dependent var	7858.669	SD dependent var	7213.375
R-squared	0.9994	Number of obs	20.000
F-test	3729.315	Prob > F	0.000
Akaike crit. (AIC)	276.052	Bayesian crit. (BIC)	283.022

Note: *** p<0.01, ** p<0.05, * p<0.1

4.1.1 Model goodness of fit test results and analysis

As can be seen from Table 3, the determination coefficient is 0.9994, indicating that the fitting effect of the model is good. The F value is 3729.315, and the model as a whole passes the significance test.

4.1.2 Parameter significance test results and analysis

As can be seen from the results, the explanatory variable Lnx_1, P=0.000<0.01, passed the significance test with a significance level of 1%. The explanatory variable x_2, P=0.08<0.1, did not pass the significance test of 5%, but passed the significance test of 10%. Explanatory variable x_3, P=0.088<0.1, did not pass the significance test of 5%, but passed the significance test of 10%. The explanatory variable x_4, P=0.000<0.01, passed the significance test with a significance level of 1%. Explanatory variable x_5, P=0.181>0.15, did not pass the significance test. Explanatory variable x_6, P=0.241>0.15, failed the significance test. Next, the multicollinearity, autocorrelation and heteroscedasticity of the model were tested.

4.1.3 Test results and treatment of multicollinearity, autocorrelation and heteroscedasticity

(1) Multicollinearity test

Stata15.1 was used to test the multicollinearity of the explanatory variables of the model, as shown in Table 4. According to the test results, the model had serious multicollinearity, so the stepwise regression method was used to obtain more accurate results. The results are shown in Table 5.

Table 4. The results of linear correlation between explanatory variables

Variables	Lnx_1	x_2	x_3	x_4	x_5	x_6
Lnx_1	1.000					
x_2	0.990*	1.000				
	(0.000)					
x_3	0.994*	0.980*	1.000			
	(0.000)	(0.000)				
x_4	0.961*	0.947*	0.983*	1.000		
	(0.000)	(0.000)	(0.000)			
x_5	0.993*	0.977*	0.999*	0.978*	1.000	
	(0.000)	(0.000)	(0.000)	(0.000)		
x_6	0.966*	0.952*	0.947*	0.890*	0.951*	1.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	

Note:*** p<0.01, ** p<0.05, * p<0.1

Table 5. The results of stepwise regression method

y	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
LNx_1	-6687.875	903.425	-7.400	0.000	-8603.050	-4772.700	***
x_4	0.817	0.036	22.980	0.000	0.741	0.892	***
x_3	0.207	0.084	2.480	0.025	0.030	0.385	**
Constant	62827.530	6846.144	9.180	0.000	48314.350	77340.700	
		p = 0.2409 >= 0.0500	removing x_6				
		p = 0.3777 >= 0.0500	removing x_5				
		p = 0.1548 >= 0.0500	removing x_2				

Note: *** p<0.01, ** p<0.05, * p<0.1

As can be seen from Table 5, variables x_2, x_5, x_6 were eliminated by the stepwise regression method, variables LNx_1, x_3, x_4 were retained.

(2) Autocorrelation test

In this paper, the Dobin-Watson (D-W) test method was used to test the autocorrelation of the model. Given that the sample size n=20, the variable k=7, the D-W value of the model was 2.083. By looking up the D-W table, dl <2.083< du was obtained, so it was impossible to determine whether the model had autocorrelation.

Breusch-Godfrey LM was continued to be used to test the autocorrelation, and the original assumption was that there was no autocorrelation. The test results are shown in Table 6.

Table 6. The results of Breusch-Godfrey LM test

Lags(p)	Chi2	df	Prob>chi2
1	0.412	1	0.5212

According to the Breusch-Godfrey LM test results, P=0.5212>0.1, accepting the null hypothesis, that is, there is no first-order autocorrelation.

(3) Heteroscedasticity test

In this paper, the White test method was used to conduct heteroscedasticity test on the model, and its original assumption was heteroscedasticity. The test results are shown in Table 7.

Table 7. The results of White test

Source	chi2	df	p
Heteroskedasticity	20.000	19	0.395
Skewness	0.710	6	0.994
Kurtosis	4.820	1	0.028
Total	25.530	26	0.489

According to the test result of White test, P=0.395>0.05, the null hypothesis is accepted, that is, there is no heteroscedasticity in the model.

4.2 Estimated results of the improved model

The three explanatory variables of steel output (x_2), total population (x_5) and total highway mileage (x_6) can be omitted from the estimated results of 4.1. Multiple linear regression was conducted for the improved model, and the estimated results are shown in Table 8.

Table 8. The regression results of the improved model

y	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Lnx_1	-6687.875	903.425	-7.40	0.000	-8603.05	-4772.7	***
x_3	0.207	0.084	2.48	0.025	0.030	0.385	**
x_4	0.817	0.036	22.98	0.000	0.741	0.892	***
Constant	62827.528	6846.144	9.18	0.000	48314.351	77340.704	***
Mean dependent var	7858.669		SD dependent var		7213.375		
R-squared	0.9992		Number of obs		20.000		
F-test	6752.135		Prob > F		0.000		
Akaike crit. (AIC)	276.191		Bayesian crit. (BIC)		280.174		

Note:*** p<0.01, ** p<0.05, * p<0.1

As can be seen from Table 8, the determination coefficient of the improved model is 0.992, indicating that the fitting effect of the model is good. The F value is 6752.135, and the model as a whole has passed the significance test.

4.3 Analysis of key drivers based on regression results

According to the regression results of 4.1 and 4.2, the following regression equation can be obtained:

$$y = 62827.5 - 6687.875Lnx_1 + 0.207x_3 + 0.817x_4$$

The regression equation shows that the coefficient of Lnx1 is -6687.875, and its economic significance is that for every 1% increase in GDP, the number of private automobiles in China decreases by -668,79, which is contrary to the prediction at the beginning of the article. It is preliminarily believed that the selection of model form still needs to be improved, for example, the explained variables are also treated with logarithm. The coefficient of x3 is 0.207, and its economic significance is that for every 10 thousand increase in the urban population, the number of private automobiles increases by 2.07 thousand. The coefficient of x4 is 0.817, and its economic significance is that for every 1 yuan increase in per capita disposable income of urban residents, the number of private automobiles increases by 8.17 thousand.

Based on the regression results, it can be concluded that both the urban population and the per capita disposable income of urban residents have a strong promoting effect on the private automobile ownership in China, and the growth of GDP will reduce the private automobile ownership.

5. Conclusions and policy suggestions

5.1 Main conclusions

First, there is a close relationship between GDP and private automobile ownership, urban population and per capita disposable income of urban residents and private automobile ownership. The increase of urban population and per capita disposable income of urban residents significantly promotes the growth of private automobile ownership. The negative correlation between GDP and private automobile ownership may be attributed to the decrease in private automobile ownership as China's economy shifts to high-quality development and pays more attention to infrastructure construction, such as subway and high-speed rail.

Second, according to the regression results, there is also a close relationship between steel production and private automobile ownership, which can be further studied. In addition, the form of the mathematical model needs to be improved in order to obtain more acceptable regression results.

5.2 Policy suggestions

First, the government should increase the number of new energy vehicles. Regression model results show that the urban population and urban per capita disposable income will promote the growth of private automobile ownership, but too many automobiles will inevitably cause a series of social problems, and urbanization and enhance urban per capita disposable income is beneficial to the good, so the country should increase the number of new energy vehicles in order to balance the contradiction between the two.

Second, the government should vigorously develop infrastructure. Urban problems and environmental problems caused by automobile exhaust are difficult to be solved in a short term. The country should strengthen the development of infrastructure construction, and strengthen the education and popularization of "green travel". Reducing the ownership of private automobiles is to reduce carbon emissions to a large extent, so as to reach the goal of carbon neutrality in 2060 earlier in China.

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