Financial Engineering and Risk Management (2024)
Clausius Scientific Press, Canada
DOI: 10.23977/ferm.2024.070512
ISSN 2523-2576 Vol. 7 Num. 5

Quantitative analysis of private car ownership

Lejing Huang

College of Finance, Hunan University of Finance and Economics, Changsha, Hunan, 410205, China

Keywords: Private car ownership; economic development; data model

Abstract: This article adopts the least squares method and uses the relevant statistical data published in the Statistical Yearbook of the National Bureau of statistics of China from 2005 to 2020. Based on relevant literature research, econometric methods are used to construct a model of private car ownership in China. Using the EVIEWS econometric software, a multiple regression model of private car ownership with Gross Domestic Product, Consumer Price Index, urban population, and road mileage is constructed. Relevant tests and model revisions are carried out, which can be used to predict future private car ownership. The amount of private cars owned can indirectly reflect the extent of economic advancement in China. The rise in private car ownership in China is also propelling economic growth.

1. Introduction

With the increasingly strong comprehensive national strength of China, people's quality of life and material level have significantly improved. Since 2002, private car buying has become a very important part of China's automotive industry[1]. The automobile industry is an important industry that supports the national economy, and the surge in private car ownership mirrors the ongoing advancement of China's overall national and economic prowess. The quantity of private vehicles in different Chinese regions is growing annually, which not only provides convenience for people's lives but also brings certain risks. Predicting the ownership of private cars allows us to have a forward-looking view on future environmental protection, road infrastructure construction, and more. Moreover, current theoretical research on the automotive industry either analyzes it from the perspective of national industrial policies on industrial development, or uses statistical analysis based on economics to analyze the market structure and user composition of the automotive market. And this article mainly uses linear models for analysis.

2. Data Description

Numerous studies have shown that the continuous increase in income has a significant impact on the demand for private cars in China, and The Gross Domestic Product (GDP) serves as a barometer for a nation's economic health and income level[2]. Possession of luxury items, including personal vehicles, is evidently linked to an individual's financial standing. The consumer price index mirrors the pattern and magnitude of price fluctuations for goods and services acquired by residents both in urban and rural settings. Resident consumption will promote car sales, so an explanatory variable, the introduction of the Consumer Price Index (CPI) is anticipated to inversely affect private car ownership. As shown in table 1, this article selects the number of private cars owned (Y, unit: 10000 vehicles) as the dependent variable, Gross Domestic Product (X1, unit: 100 million yuan), Consumer Price Index (X2, last year=100), Urban Population(X3, unit: 10000 people), and Highway Mileage (X4, unit: 10000 kilometers) as the explanatory variables. A multivariate linear regression framework can be developed as $Y=\beta_0+\beta_1X_1+\beta_2X_2+\beta_3X_3+\beta_4X_4+u$.

Table 1: Private car data from 2005-2020

Year	The number of private cars owned(10000 vehicles)	GDP (100 million yuan)	CPI (last year=100)	Urban Population (10000 people)	Highway Mileage (10000 kilometers)
2005	1848.07	185998.9	101.8	56212	334.53
2006	2333.32	219028.5	101.5	58288	345.7
2007	2876.22	270704	104.8	60633	358.37
2008	3501.39	321229.5	105.9	62403	373.02
2009	4574.91	347934.9	99.3	64512	386.08
2010	5938.71	410354.1	103.3	66978	400.82
2011	7326.79	483392.8	105.4	69927	410.64
2012	8838.6	537329	102.6	72175	423.75
2013	10501.68	588141.2	102.6	74502	435.62
2014	12339.36	644380.2	102	76738	446.39
2015	14099.1	685571.2	101.4	79302	457.73
2016	16330.62	742694.1	102	81924	469.63
2017	18515.11	830945.7	101.6	84343	477.35
2018	20573.99	915243.5	103.1	86433	484.65
2019	22508.99	983751.2	102.9	88426	501.25
2020	24291.19	1008783	102.5	90220	519.81

3. Econometric analysis

3.1 Estimation of the model

Establish a multiple linear regression model with $Y=\beta0+\beta1X1+\beta2X2+\beta3X3+\beta4X4+u$, and use OLS method for estimation. Employing EVIEWS software as shown in figure 1, I crafted a series of correlation charts to illustrate the relationships between the dependent variable and an array of independent factors. Evidently, there's a distinct positive relationship between the proliferation of private cars in China and factors such as gross domestic product, urban population density, and the extent of road mileage. Conversely, as the consumer price index takes an upward turn, the correlation with private car ownership shows a discernible negative trend.

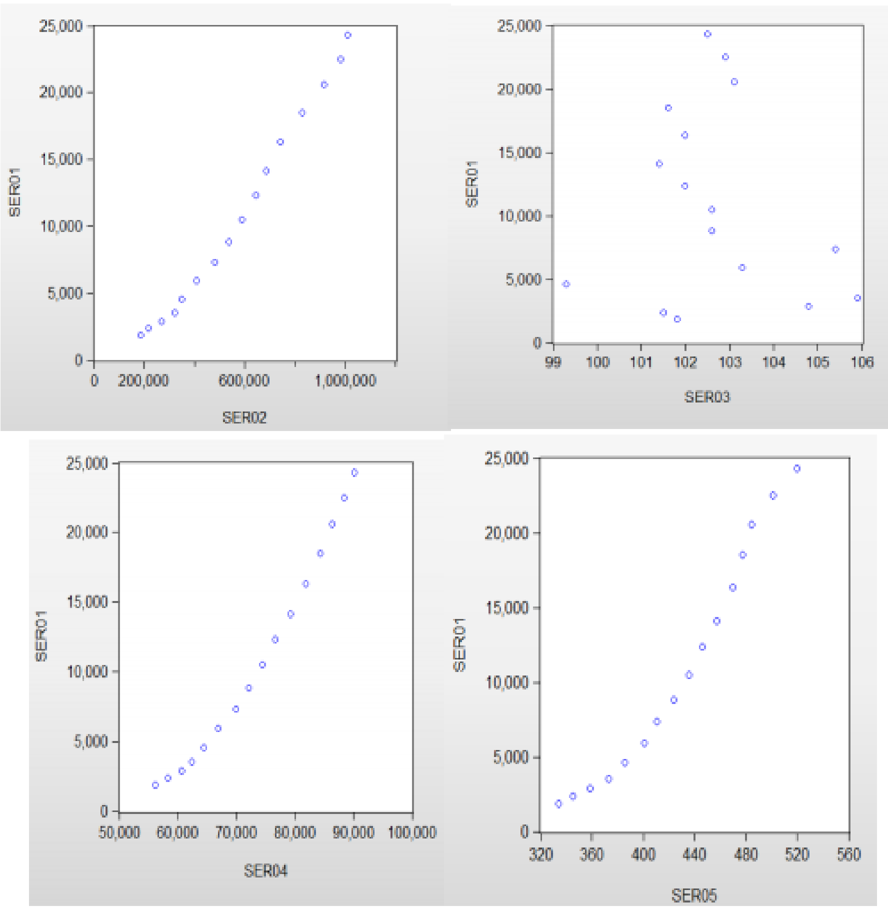

Figure 1: Multiple linear regression model

Perform multiple linear regression on the model, and the results are shown in the following table2.

Ser01 represents the ownership of private cars, ser02 represents GDP, ser03 represents the consumer price index for residents, ser04 represents urban population, and ser05 represents road mileage.

Table 2: Result of multiple linear regression on the model

Variable prob	Coefficient	Std. Error	t-statistic.	
C	40428.08	18406.66	2.196383 4.669913	0.0504
SER02 SER03	0.042709	0.009146	-1.926105	0.0007
SER04 SER05	-233.3363	121.1441	-0.262102	0.0803
	-0.094680	0.361234	-1.225946	0.7981
	-53.91178	43.97565		0.2458
R-squared	0.993077	Mean dependent var S.D.		11024.85
Adjusted R-squared	0.990559	dependent var Akaike info		7587.074
S.E. of regression	737.2015	criterion Schwarz criterion		16.29391
Sum squared resid	5978126.	Hannan-Quinn criter.		16.53534
Log likelihood	-125.3512	Durbin-Watson stat		16.30627
F-statistic	394.4484			1.251848
Prob(F-statistic)	0.000000			

3.2 Model validation and adjustment

3.2.1 Economic significance test

From the graph, it can be seen that the coefficient of determinability and the corrected coefficient of determinability reached 0.993077 and 0.99105, respectively, indicating that the model fitting effect is very good. Economic significance testing shows that the coefficient of ser05 is less than 0, which does not conform to economic significance**.**

3.2.2 F test

The F-value is 394.4484. F-test: Considering the null hypothesis H0 where β1, β2, β3, and β4 are all zero, and setting the significance threshold at α=0.05, we can reference the F-distribution chart to find that the critical F-value for a 4 and 11 degrees of freedom (k-1=4, n-k=11) scenario is 3.36. According to the above table, F=394.4484. Since F=394.4484>F α (4,11), the null hypothesis should be rejected. The regression equation is significant, indicating that variables such as "gross domestic product", "highway mileage", "consumer price index", and "urban population" combined do have a significant impact on "private car ownership"

3.2.3 T test

With a confidence level set at 95%, consulting a t-distribution chart reveals that for 11 degrees of freedom, which is calculated as n-k, with a critical value of tα/2 (11)=2.201. The t-statistics associated with β 1, β 2, β 3, and β 4 are 4.6699, -1.9261, -0.2621, -1.2259, respectively. The absolute values of the t-values corresponding to β 2, β 3, and β 4 are all less than the critical value, indicating that X2, X3, and X4 have no significant impact on Y, and the t-test and P-value test are not all passed. Therefore, it is believed that the result may be caused by multicollinearity.

3.2.4 Multicollinearity test

Preliminary testing using the simple correlation coefficient method in table 3. Employing the straightforward correlational coefficient analysis, it was revealed that the coefficients indicating the relationship among the various explanatory variables all exceeded the value of 0.8, indicating a high degree of correlation. The model is likely to have multicollinearity.

Table 3: Correlation coefficient method

	SER02	SER03	SER04	SER05
SER02	1	-0.1059245..	0.99655031...	0.99141262...
SER03	-0.1059245...	1	-0.1264889...	-0.1265362...
SER04	0.99655031...	-0.1264889..	1	0.99681088...
SER05	0.99141262...	-0.1265362..	0.99681088...	1

Table 4: Variance inflation factors

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
C	3.39E+08	9974.650	NA
SER02	8.36E-05	979.9397	170.1153
SER03	14675.90	4555.463	1.086500
SER04	0.130490	21095.17	446.4932
SER05	1933.858	10533.50	172.9974

Further testing using the variance amplification factor method. Using EViews, the variance amplification factor of the explanatory variable can be directly calculated as shown in the following table 4. It is found that X1, X3, and X4 are far greater than 10, indicating the existence of multicollinearity.

Stepwise regression method was used for correction. Initially, a straightforward regression analysis should be conducted, the dependent variable can be applied to evaluate each proposed independent variable. By comparing the values of R2, the regression model with the best fit can be selected, and this variable contributes the most to the dependent variable of the model. Then, the other explanatory variables can be introduced into the model one by one. If the previously introduced explanatory variables become less significant due to the newly introduced explanatory variables, it is considered that there is multicollinearity between them. After removing the introduced variables, it is considered that there is multicollinearity between them; If the introduction of a new variable does not markedly enhance its significance, it is also considered redundant and should be removed; If the introduction of a new variable substantially improves significance, it should be retained. After performing a logarithmic transformation and correcting multicollinearity, the model equation is: $\ln Y= \beta_0+ \beta_1 \ln X_1+ \beta_2 \ln X_2+u$. Using EViews software, the generated data is estimated using OLS method to obtain the regression findings depicted in the table 5:

Table 5: Result of the regression using OLS method

Dependent Variable: LNSER01
Method: Least Squares
Date: 01/05/23 Time: 17:07
Sample: 2005 2020
Included observations: 16

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.822484	3.186683	0.258100	0.8004
LNSER02	1.569811	0.020203	77.70084	0.0000
LNSER03	-2.682659	0.681579	-3.935945	0.0017

R-squared	0.997883	Mean dependent var	9.019875
Adjusted R-squared	0.997557	S.D. dependent var	0.848074
S.E. of regression	0.041914	Akaike info criterion	-3.339041
Sum squared resid	0.022838	Schwarz criterion	-3.194181
Log likelihood	29.71233	Hannan-Quinn criter.	-3.331623
F-statistic	3064.033	Durbin-Watson stat	1.205552
Prob(F-statistic)	0.000000		

The model's decision coefficient and the revised decision coefficient reached 0.99378 and 0.9975, respectively, with an F-test value of 3064.033, which is significantly higher. All coefficient estimates t-tests are highly significant, and all explanatory variable symbols are consistent with prior expectations. This case study shows that for every 1% increase in GDP, the mean private vehicle possession in China is projected to rise by 1.5698%; If the domestic consumer price index drops by 1%, the average private car ownership in China is predicted to rise by 2.682%.

3.2.5 Heteroscedasticity test

Given the chosen time series data, it's essential to conduct an autoregressive conditional heteroskedasticity (ARCH) test on the dataset. Under the condition of lag order p=2, the table clearly reveals the crucial threshold $X^2$0.05 (2)=5.9915. White's test method is used, and the test results are shown in the following table 6:

Table 6: Heteroskedasticity Test: White

F-statistic	1.193878	Prob. F(4,11)	0.3668
Obs*R-squared	4.843468	Prob. Chi-Square(4)	0.3037
Scaled explained SS	3.529241	Prob. Chi-Square(4)	0.4734

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 01/05/23 Time: 17:22
Sample: 2005 2020
Included observations: 16
Collinear test regressors dropped from specification

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.437780	3.522692	-0.124274	0.9033
LNSER02^2	-0.001676	0.002305	-0.727016	0.4824
LNSER02*LNSER03	-0.010615	0.122007	-0.087004	0.9322
LNSER02	0.091369	0.549918	0.166150	0.8711
LNSER03^2	0.008130	0.168966	0.048119	0.9625

R-squared	0.302717	Mean dependent var	0.001427
Adjusted R-squared	0.049159	S.D. dependent var	0.002190
S.E. of regression	0.002136	Akaike info criterion	-9.209646
Sum squared resid	5.02E-05	Schwarz criterion	-8.968212
Log likelihood	78.67716	Hannan-Quinn criter.	-9.197282
F-statistic	1.193878	Durbin-Watson stat	1.896629
Prob(F-statistic)	0.366808		

The chart clearly demonstrates that with nR^2 amounting to 4.8434, this figure falls beneath the established threshold of significance. Therefore, the null hypothesis can be accepted and the same variance hypothesis can be satisfied.

3.2.6 Sequence correlation test

DW inspection method. From the regression results above, it can be seen that DW=1.896628. Under the condition of a sample size of 16 and 2 explanatory variables, the table shows that dL=0.982, dU=1.539, 4-dU=2.461, 4-dL=3.018. It can be observed that if the DW value is between (1.539, 2.461), then there is no autocorrelation in the sequence, satisfying the basic assumption of no autocorrelation.

3.3 Interpretation of regression results

After conducting economic significance tests, statistical tests, multicollinearity tests, heteroscedasticity tests, and autocorrelation tests, the model $\ln Y = \beta 0 + \beta 1\ln X1 + \beta 2\ln X2 + u$ for China's private car ownership has been determined. The model reflects that there's a corresponding 1.5698% surge in the average ownership of private cars in China when the gross domestic product sees a 1% uptick, there's a corresponding 1.5698% surge in the average ownership of private cars in China.,; If the domestic consumer price index decreases by 1%, the average private car ownership in China will increase by 2.682%. In the initial model, a negative coefficient in front of the road mileage X4 indicates that the average road mileage is negatively correlated with the number of private cars, which is clearly not economically significant. After reflection and summary, I believe there are mainly two reasons: (1) The sample size is too small, and the calculated results are not representative. (2) In recent years, the country has increased investment in public transportation infrastructure, making public transportation such as buses, subways, and high-speed trains increasingly convenient. The public transportation system has become increasingly perfect, which to some extent alleviates the impact of population on the growth of car demand. However, when selecting model variables, these variables are included in the random error term, leading to coefficient bias. In addition, from an economic perspective, highway mileage also has an impact on the demand for private cars in China, but it was excluded in the test. I believe the main reasons are as follows: (1) GDP, as a statistical indicator reflecting the country's macroeconomic situation, is prone to multicollinearity with highway mileage. From some perspectives, GDP growth can also promote the growth of highway mileage; (2)Highway mileage is expected to significantly influence automobile demand, but it may be weakened by factors such as the swift growth of Chinese car manufacturing sector and the acceleration of China's automobile exports, which are beyond our assumptions in international trade.

4. Conclusion

With the increase of per capita income in our country, the demand for cars will inevitably increase year by year. However, numerous elements influence the possession of personal vehicles. Consumption is one of the "three carriages" of economic growth[3]. As an accessory of consumers, cars provide convenience for people's travel. As consumers, when purchasing private cars, we should combine our actual economic strength, be rational consumers, choose the right car model, and make our own contributions to economic development. There is a positive correlation between the ownership of private cars in China and the total national income. As the total national income increases, the ownership of private cars will inevitably increase, which is consistent with our understanding and reality. However, the increase in urban population cannot directly increase China's gross domestic product, so its relationship with the ownership of private cars is not significant. The Consumer Price Index mirrors the pattern and magnitude of fluctuations in the cost of goods and services acquired by inhabitants of both city and countryside areas. Resident consumption will promote car sales, so the introduction of an explanatory variable, the Consumer Price Index, and a rise in the Consumer Price Index is likely to result in a decline in the ownership of private vehicles[4].The government, as the "invisible hand" in the market economy, should always adhere to the principle of serving the people and being responsible to the people. Nowadays, the economic level is still a significant factor affecting the ownership of private cars. Enhancing China's GDP and per capita income remains the key objective. Although China has fully entered a well-of society, there is still room for progress compared to developed countries. We should adhere to economic construction as the center and vigorously develop our economy.

References

[1] Liuqin Wan Analysis of influencing factors on the ownership of private cars in China[J]. Knowledge economic, 2018(12): 70-71.

[2] Yuhan Wang, Guoqiag Gen, Jiaming Zhu Econometric analysis of private car ownership in China [J]. Journal of Science in Normal Universities 2019, 39(07):40-43.

[3] Yihang Sun. Prediction of Private Car Ownership in China.[J]. Quality and Market, 2022(19):181-183.

[4] Yueyue You, Qingmei Zhang. Research on the Development Status and Influencing Factors of Private Car Ownership in Luoyang City.[J]. Inner Mongolia Science and Technology and Economy, 2021(15):56-57.