Analysis of Factors Influencing Private Car Ownership in China: Integrating Psychological Perspectives

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Abstract: This study comprehensively and in-depth analyzes various factors affecting private car ownership in China by constructing a scientific and accurate econometric model. In terms of variable selection, factors from economic, social, technological, and other dimensions are comprehensively considered. A multiple linear regression model is established, parameter estimation is conducted, and the impact magnitude and direction of each factor are quantitatively explored. The multiple linear regression model in econometrics is adopted as the core analysis tool, and the powerful data processing and model estimation functions of EViews software are used to analyze relevant data. Multiple testing methods including economic significance, statistical, and econometric tests are applied to optimize and revise the model. According to the research results and tests of the model on China's data from 1995 to 2024, the impact degree and significance of various influencing factors on private car ownership vary. There is a strong positive correlation between per capita disposable income and private car ownership; a negative correlation exists between crude oil output and private car ownership; bank loan interest rates have no significant impact on car ownership; car output has little impact on car ownership, and an increase in car output does not directly lead to a significant change in car ownership. With the continuous advancement of economic and social development and science and technology, new factors that may affect changes in private car ownership may emerge in the future.

Keywords: Private Car Ownership; Influencing Factors; Consumption Psychology; Eviews Software; Revision Test

1. Introduction

1.1 Research Background

The ownership of private cars in China has shown an explosive growth momentum, becoming a notable phenomenon in the socio-economic field. According to relevant statistics from the National Bureau of Statistics, by the end of 2024, the national civil car ownership reached 336.18 million vehicles, among which the private car ownership was 309.89 million vehicles, an increase of 16.33 million vehicles compared with the end of the previous year. This growth trend began with the reform and opening-up policy and has become increasingly prominent over time. In recent decades, private cars, once luxury goods, have gradually become daily travel tools for ordinary families and are fully integrated into people's lives.

Given the prominent position of private car ownership in the economic and social fields and its extensive impacts, in-depth research on its influencing factors is of extremely critical practical significance. Through systematic analysis of these influencing factors, we can more comprehensively grasp the development laws and trends of the private car market, and provide strong decision-making basis for the government to formulate scientific and reasonable policies related to the automotive industry, traffic management, and environmental protection. For consumers, understanding the factors affecting the number of private cars helps them make more rational car purchase decisions. They can comprehensively consider whether to buy a car and which model to choose based on their own economic conditions, actual travel needs, and social environment, thereby achieving effective resource allocation and maximizing personal benefits.

1.2 Domestic and International Research Status

Huang L [1] conducted a quantitative analysis of private car ownership, laying a certain

quantitative foundation for subsequent research. Cao X and Huang X [2] found that the level of urban economic development, population size, and the construction of transportation infrastructure are key factors affecting private car ownership in Chinese cities. Economic prosperity increases residents' income, thereby enhancing their car-purchasing capacity; the expansion of population size leads to an increase in travel demand, promoting the growth of private car ownership; and improved transportation infrastructure creates favorable conditions for car use, further stimulating the growth of car ownership. Liao Z et al. [3] constructed a differential dynamic model of private car ownership in China, exploring its influencing factors and development laws from the perspective of dynamic changes.

In their work on predicting and analyzing private car ownership in China, Zhang D and Zhou S [4] comprehensively considered the role of various factors on its development trend. Liu B et al. [5] used an improved PCA-Logistic model to predict private car ownership in China. During the model construction stage, they screened and processed the influencing factors, which indirectly reflects the complexity and diversity of these factors.

When Zhang Shuxian [6] used ARIMA and ARIMAX models to predict private car ownership, although she focused on model methods, she also implicitly considered the relevant influencing factors behind the time series data. Guo Yanli [7] analyzed and predicted private car ownership based on the grey-generalized regression neural network. During the model construction process, it was necessary to screen and quantify the influencing factors to achieve accurate prediction. In his research on predicting private car ownership in China, Sun Yihang [8] also conducted a certain analysis and discussion on the relevant influencing factors.

Based on the panel data model, Wu Weiyi [9] conducted an empirical study on the influencing factors of private car ownership at the provincial level in China. The results showed that regional GDP and per capita disposable income are positively correlated with private car ownership, and the urbanization rate is also an important influencing factor. The urbanization process promotes changes in residents' travel demand, thereby boosting the growth of private car ownership. Xu Shanshan [10] also involved the discussion of relevant influencing factors in her research on private car ownership. Zheng Xueqing [11] empirically analyzed China's private car ownership and its economic influencing factors, clarifying the key role of economic factors in private car ownership. Wang Lu [12] analyzed the development status and influencing factors of private car ownership in China, exploring the factors affecting its development from multiple dimensions. In his research on predicting China's private car ownership based on extension clustering, Zhang Hongzhe [13] conducted relevant analysis on the influencing factors to assist the construction of the prediction model.

Su Yeping [14] comprehensively considered the influencing factors in the prediction and analysis of China's private car ownership based on the dynamic combination model to optimize the prediction effect of the model. Based on the partial least squares regression method, Su Yeping and Zhao Ling [15] analyzed the influencing factors of private car ownership in China, and deeply explored the relationship between various factors and private car ownership from a statistical perspective. Li Yeqin [16] conducted an econometric analysis of the influencing factors of private car ownership in China, further revealing the mechanism of action of relevant factors.

2. Theoretical Analysis of Influencing Factors

2.1 Economic Factors

2.1.1 Per capita disposable income

Per capita disposable income is an important reference indicator for measuring residents' purchasing power. When disposable income increases, purchasing power also rises accordingly. After meeting their basic living needs, people have more funds for consumption upgrading. Private cars themselves are durable goods that are widely accepted and popular for facilitating travel and improving the quality of life. With higher disposable income, people have a stronger willingness to consume cars. In addition, the improvement of current living standards has raised people's requirements for life. People are no longer satisfied with the basic operation of transportation, but want to further improve their travel experience and enjoy more comfortable and convenient means

of transportation. Under such circumstances, more and more people choose to own private cars.

It can be seen that with the continuous development and progress of China's economy and society, the per capita disposable income of urban and rural residents has been increasing, and the number of private cars has also been growing. According to statistical data: in 2013, the per capita disposable income of urban residents in China reached 18,310.76 yuan, and the private car ownership reached 10.50168 million vehicles; by 2024, the per capita disposable income of urban residents in China reached 41,314 yuan, and the private car ownership increased to 309.89 million vehicles. The two show a proportional relationship in quantity.

2.1.2 Bank loan interest rate

The loan interest rate of banking financial institutions is a price-based indicator in the market and has a certain impact on private car ownership. At present, China's automotive industry has become a sunrise industry in society, and buying a car on loan has become one of the most common ways for consumers to purchase cars. The level of loan interest rates of banking financial institutions is the most important factor determining consumers' choice to buy a car on loan, and even a key factor determining private car ownership.

Bank loan interest rates directly affect the cost of personal car loans, thus having a direct impact on private car ownership. From the perspective of factors influencing private car ownership, private car ownership is affected by bank loan interest rates, which is an economic factor that cannot be ignored. Changes in bank loan interest rates have important reference value for the policies of automobile manufacturers, the business development of financial institutions, and the decision-making of government departments.

2.2 Social Factors

2.2.1 Number of car drivers

The number of car drivers is closely related to private car ownership, and the two have an inseparable internal connection. According to data: the number of car drivers in China has also increased simultaneously. In 2010, the number of car drivers in China reached 151 million, and the private car ownership was 59.38 million vehicles; by 2024, the number of car drivers exceeded 506 million, and the private car ownership reached 399 million vehicles. Preliminary analysis shows that the relationship between the number of car drivers and private car ownership across the country presents a significant positive correlation. In economically developed and densely populated cities such as Beijing, Shanghai, and Guangzhou, the number of car drivers is large and the private car ownership is high; this phenomenon is largely related to the fast pace of life and diverse travel needs of local people, and owning a private car greatly improves people's quality of life.

The number of car drivers is one of the important social factors determining private car ownership. It directly determines the number of private cars owned and is also indirectly affected by various other factors, with a close positive correlation between the two. The development and changes of private car ownership need to consider the factor of the number of car drivers, and corresponding policies should be adjusted according to changes in the number of car drivers.

2.2.2 Automobile output

Automobile output is an important factor affecting private car ownership, and has a close supply-demand relationship and mutual influence mechanism with private car ownership. In terms of supply, the increase in automobile output provides sufficient supply for the private car market, which also gives sufficient room for growth in private car ownership. If automobile manufacturers expand their scale and increase output, there will be more and more car brands, models, and configurations in the market, allowing consumers to buy models that suit their preferences. In recent years, China's automotive industry has developed continuously, and automobile output has increased steadily. In addition to the continuous upgrading of domestic brands, more foreign brands have increased investment and production in China. These foreign automobile enterprises have successively expanded production and built factories, further promoting the development of domestic automobile enterprises. This situation provides people with more car choices, including domestic brands such as BYD, Geely, and Great Wall, as well as joint-venture brands such as Toyota, Volkswagen, and Honda. At the same time, there are various types of vehicles to

choose from, such as sedans, SUVs, and MPVs. The growth of automobile output will lead to a decrease in car prices, thereby increasing private car ownership. Under the action of the supply and demand theory in economics: the growth of automobile output -> the increase of supply -> supply exceeds demand -> price decreases -> more people can buy cars -> the increase of private car ownership. When market competition is fierce, automobile manufacturers will reduce prices and carry out preferential promotions to attract consumers in order to compete for market share. For example, some car brands will hold large-scale price reduction promotions, car purchase subsidies, and car loan interest subsidies during holidays or off-seasons to attract consumers to buy cars, thereby increasing the sales volume and ownership of private cars.

2.2.3 Crude oil output

Crude oil is the most common energy source for cars, and changes in crude oil output have a significant impact on private car ownership. Changes in crude oil output will cause changes in the supply and price of refined oil products such as gasoline and diesel, thereby leading to changes in the cost of using private cars and consumers' car-purchasing decisions.

In addition to the above-mentioned influencing factors, crude oil output can also be affected by many other factors, which in turn affect private car ownership. For example, changes in the international political situation and geopolitical conflicts can greatly affect crude oil production and supply; the Middle East, as one of the world's important oil-producing regions, will experience a decline in crude oil output if turmoil or war breaks out there, leading to changes in global oil prices; natural disasters and increased difficulty in oil field exploitation will also affect crude oil output; after long-term exploitation, some oil fields gradually become depleted, and the difficulty of exploitation increases, resulting in a decrease in crude oil output. These factors all lead to a reduction in crude oil output, which in turn affects the price of refined oil and the ownership of private cars.

3. Research Design

3.1 Variable Selection

In this study, private car ownership (Y) is used as the explained variable. This data directly reflects the scale and development of China's private car market, and provides key support for measuring the impact of various factors. The data is obtained from the annual statistical data released by the National Bureau of Statistics, ensuring its authority and accuracy.

For the explanatory variables, this study selects the following key factors:

- Per capita disposable income (X_1): Measured in yuan, it is a core indicator for evaluating residents' actual purchasing power and plays a crucial role in influencing private car ownership. When the per capita disposable income of residents rises, it means that after covering daily basic living expenses, they have more funds to purchase high-end consumer goods such as cars, thus greatly stimulating the consumer demand for private cars. With the continuous development of China's economy, the income level of residents has steadily increased, and more and more families have the ability to purchase private cars, leading to a continuous rise in the number of private cars. This study takes per capita disposable income as an explanatory variable to analyze its impact on private car ownership. The data is obtained from the annual statistical yearbooks of the National Bureau of Statistics.
- Bank loan interest rate (X_2): Measured in %, it is a key factor affecting the cost of consumers' car purchases on loan. Loan-based car purchase is a common method in car consumption. The level of loan interest rates directly affects consumers' repayment pressure and the total cost of car purchases. When bank loan interest rates decrease, the cost of buying a car on loan decreases, and consumers' willingness to buy cars strengthens, thereby promoting the increase in private car ownership; higher interest rates will inhibit consumers' car-purchasing demand. In some regions, after banks lower car loan interest rates, the car sales market becomes significantly more active, and the ownership of private cars increases accordingly.
- Number of private car drivers (X_3): Measured in 10,000 people, it reflects the scale of the potential private car consumer group. The larger the number of people with driving qualifications, the greater the potential demand for private cars. With the widespread popularization of car driver training in China and people's emphasis on driving skills, the number of car drivers has been increasing, which directly drives up the demand in the private car market. Many people who have just

obtained their driver's licenses will consider buying a private car in a short period of time to meet their travel needs.

- Actual automobile output (X_4): Measured in 10,000 vehicles, it reflects the supply of cars in the market. Sufficient automobile output can meet consumers' diverse car-purchasing needs, facilitate car sales, and promote the growth of private car ownership. When automobile manufacturers expand their production scale, provide more new models, and carry out promotional activities, the number of cars available for selection in the market increases, and consumers can easily find cars that match their needs and budgets, thus stimulating their willingness to buy cars. China's automobile output has been increasing continuously, and the number of private cars owned has also increased accordingly.
- Crude oil output (X_5): Measured in 10,000 tons, it indirectly affects the cost of using private cars and consumers' car-purchasing willingness by influencing the supply and price of fuel. Crude oil is the main raw material for car fuels such as gasoline and diesel. Changes in crude oil output will cause fluctuations in fuel prices, thereby affecting the cost of using private cars. If crude oil output decreases and fuel prices rise, the cost of using private cars increases, and consumers may reduce the frequency of car use or even abandon their car-purchasing plans; sufficient crude oil output and stable or falling fuel prices are conducive to promoting the growth of private car consumption. During periods of significant fluctuations in international crude oil prices, the demand in the domestic private car market is also significantly affected.

3.2 Model Specification

In the study of factors influencing private car ownership in China, this paper uses a multiple linear regression model for verification. In real life, there are many phenomena affected by the joint action of multiple factors; for example, China's private car ownership is determined by multiple factors such as per capita disposable income. By using this model, we can clearly understand the direction and degree of impact of each independent variable on the dependent variable, which is conducive to exploring the mechanism of action of each factor. From the perspective of economic theory, per capita disposable income, bank loan interest rates, the number of car drivers, automobile output, and crude oil output all affect private car ownership, and the multiple linear regression model can well represent the prediction results of the economic theory model.

Since there are relatively mature estimation and testing methods for the actual multiple linear regression model, we can use the least squares method to obtain the impact degree and mode of each factor on private car ownership. Finally, based on the statistical testing methods introduced earlier, including t-test, F-test, and goodness-of-fit test, we test the reliability and scientificity of this multiple linear regression model. The basic form of the multiple linear regression model constructed in this study is set as follows:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \mu$$

Where:

- Y represents the explained variable, i.e., private car ownership;
- X_1, X_2, X_3, X_4, X_5 are explanatory variables, representing per capita disposable income, bank loan interest rate, number of car drivers, automobile output, and crude oil output respectively;
- β_0 is the intercept term;
- β_1, β_2, β_3, β_4, β_5 are regression coefficients, which measure the impact degree of each explanatory variable on the explained variable respectively;
- μ is the random error term, used to capture the random impact of other factors not included in the model on private car ownership, and it reflects the part of the change in the explained variable that cannot be explained by the explanatory variables.

3.3 Data Source and Specific Values

All data required in this paper are obtained from official statistical data publicly released by the National Bureau of Statistics, various statistical yearbooks, and relevant authoritative industry survey reports. Among them, the data on private car ownership is derived from the annual statistical bulletins released by the National Bureau of Statistics over the years. The data is obtained from comprehensive and systematic statistical surveys on the actual national private car ownership, which is the most authoritative and accurate.

Table 1 below obtains data from the most authoritative and reliable channels, ensuring the reliability of the original data quality of this

study, thus making the research conclusions more accurate and credible, and facilitating the subsequent econometric analysis of the original data.

Table 1. Data of Influencing Factors from 1995 to 2024

Year	Private Car Ownership (Unit: 10,000 vehicles)	National Per Capita Disposable Income (Unit: yuan)	Bank Loan Interest Rate (Unit: %)	Number of Car Drivers (Unit: 10,000 people)	Automobile Output (Unit: 10,000 vehicles)	Crude Oil Output (Unit: 10,000 tons)
1995	249.96	2363.35	12.06	1673.39	145.27	15004.39
1996	289.67	2813.90	10.08	2100.74	147.52	15733.39
1997	358.36	3069.80	8.64	2619.25	158.25	16074.14
1998	423.65	3254.10	6.39	2974.06	163.00	16100.00
1999	533.88	3484.60	5.85	3361.12	183.20	16000.00
2000	625.33	3721.34	5.85	3746.51	207.00	16300.00
2001	770.78	4070.38	5.85	4462.68	234.17	16395.87
2002	968.98	4531.65	5.31	4827.08	325.10	16700.00
2003	1219.23	5006.69	5.31	5368.07	444.39	16959.98
2004	1481.66	5660.90	5.58	7101.64	509.11	17587.33
2005	1848.07	6384.73	5.58	8017.76	570.49	18135.29
2006	2333.32	7228.82	6.12	9317.24	727.89	18476.57
2007	2876.22	8583.54	7.47	10567.15	888.89	18631.82
2008	3501.39	9956.51	5.31	12276.80	930.59	19043.96
2009	4574.91	10977.50	5.31	13740.73	1379.53	18948.96
2010	5938.71	12519.51	5.81	15129.89	1826.53	20301.40
2011	7326.79	14550.75	6.56	17416.76	1841.64	20287.55
2012	8838.60	16509.55	6.00	20028.52	1927.62	20747.80
2013	10501.68	18310.76	6.00	21742.70	2212.09	20991.85
2014	12339.36	20167.12	5.60	24812.06	2372.52	21142.92
2015	14099.10	21966.19	4.35	28012.99	2450.35	21455.58
2016	16330.22	23820.98	4.35	30328.77	2811.91	19968.52
2017	18515.11	25973.79	4.35	31658.20	2901.81	19150.61
2018	20574.93	28228.05	4.35	36923.42	2782.74	18932.42
2019	22508.99	30732.85	4.35	39752.86	2567.67	19162.83
2020	24291.19	32188.84	4.35	41794.89	2532.49	19476.86
2021	26152.02	35128.10	4.35	44379.72	2625.70	19888.11
2022	27792.11	36883.28	4.35	46434.41	2713.63	20472.24
2023	29356.89	39217.97	4.35	48617.16	3009.89	20902.61
2024	30989.00	41314.00	4.35	50600.11	3155.93	21289.10

4. Empirical Results and Analysis

4.1 Descriptive Statistics

Before conducting in-depth model estimation and analysis, descriptive statistical analysis is first carried out on the selected variable data to fully understand the basic characteristics and distribution trends of the data. Table 1 (shown as Figure 1 in the text) presents the descriptive statistical results of the six variables: private car ownership (Y), per capita disposable income (X_1), bank loan interest rate (X_2), number of car drivers (X_3), automobile output (X_4), and crude oil output (X_5), as shown in Figure 1 below.

	Y	X1	X2	X3	X4	X5
Mean	9920.337	15953.99	5.806000	19659.55	1491.564	18675.40
Median	5256.810	11748.51	5.580000	14435.31	1603.030	18996.46
Maximum	30989.00	41314.00	12.06000	50600.00	3155.930	21455.58
Minimum	249.9600	2363.350	4.350000	1673.390	145.2700	15004.39
Std. Dev.	10406.69	12633.42	1.777225	16238.31	1110.833	1948.979
Skewness	0.750746	0.619966	1.995212	0.581325	0.048412	-0.295711
Kurtosis	2.084747	2.009249	7.084412	1.920862	1.339971	1.796751
Jarque-Bera	3.865209	3.148774	40.75739	3.145368	3.456337	2.246985
Probability	0.144771	0.207134	0.000000	0.207488	0.177609	0.325142
Sum	297610.1	478619.5	174.1800	589786.6	44746.92	560262.1
Sum Sq. Dev.	3.14E+09	4.63E+09	91.59732	7.65E+09	35784517	1.10E+08
Observations	30	30	30	30	30	30

Figure 1. Descriptive Statistics.

4.2 Model Estimation

With the help of EViews software, the least squares method is used to estimate the parameters of the established multiple linear regression model, and the results are shown in Figure 2 below.

Dependent Variable: Y
Method: Least Squares
Date: 04/25/25 Time: 16:59
Sample: 1995 2024
Included observations: 30

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	8202.944	1280.715	6.404972	0.0000
X1	0.944593	0.116049	8.139581	0.0000
X2	14.10122	49.05732	0.287444	0.7762
X3	-0.034118	0.091902	-0.371244	0.7137
X4	0.017436	0.232422	0.075020	0.9408
X5	-0.684845	0.070309	-9.740574	0.0000

R-squared	0.999196	Mean dependent var	9920.337
Adjusted R-squared	0.999028	S.D. dependent var	10406.69
S.E. of regression	324.3926	Akaike info criterion	14.57864
Sum squared resid	2525533.	Schwarz criterion	14.85888
Log likelihood	-212.6796	Hannan-Quinn criter.	14.66829
F-statistic	5964.340	Durbin-Watson stat	1.296138
Prob(F-statistic)	0.000000		

Figure 2. Regression Parameter Results

Thus, the regression equation is obtained as follows:

$Y = 8202.944 + 0.944593X_1 + 14.10122X_2 - 0.034118X_3 + 0.017436X_4 - 0.684845X_5 + \mu$

From the estimation results, the value of the constant term is 8202.944, which represents the base level of private car ownership when other explanatory variables are zero. However, in practical economic terms, there is no scenario where all explanatory variables are zero; therefore, the intercept term usually has little practical economic significance. The following analysis focuses on items with Prob. < 0.05.

The coefficient of per capita disposable income (X_1) is 0.944593. At the 5% significance level, the absolute value of the t-statistic is greater than the critical value ($t_{0.025}$ (24) = 2.064), and Prob. = 0.0000 < 0.05, indicating that this variable has a significant impact on private car ownership. Specifically, for every 1-yuan increase in per capita disposable income, the private car ownership increases by an average of 0.944593 ten thousand vehicles, reflecting the strong driving effect of the improvement of residents' income level on private car consumption. As residents' income level increases, their purchasing power rises accordingly, and their demand for private cars also increases.

The coefficient of crude oil output (X_5) is -0.684845. At the 5% significance level, the absolute value of the t-statistic is greater than the critical value ($t_{0.025}$ (24) = 2.064), and Prob. = 0.0000 < 0.05, indicating a significant impact. It means that under other unchanged conditions, for every 10,000-ton increase in crude oil output, the private car ownership decreases by an average of 0.684845 ten thousand vehicles, which shows that higher crude oil output will inhibit private car consumption.

4.3 Model Testing Multicollinearity Test

The Variance Inflation Factor (VIF) method is used to test the multicollinearity of the model, and the results are shown in Figure 3 below.

Variance Inflation Factors
Date: 04/26/25 Time: 11:18
Sample: 1995 2024
Included observations: 30

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
C	1640231.	467.6106	NA
X1	0.013467	1569.601	592.3565
X2	2406.621	25.22299	2.094829
X3	0.008446	1544.380	613.7471
X4	0.054020	52.63227	18.36992
X5	0.004943	496.6880	5.174712

Figure 3. Multicollinearity Test Results

The variance inflation factor is used to measure the degree of multicollinearity among explanatory variables. If VIF > 10, it indicates a serious multicollinearity problem. It can be seen from Figure3 that the VIF values of all parameters are greater than 10, indicating that there is a serious multicollinearity problem among the explanatory variables in the current model, i.e., the selected explanatory variables are not pairwise independent. The stepwise regression method can be used to correct this problem.

4.4 Model Revision

The stepwise regression method includes forward stepwise regression, backward stepwise regression, and bidirectional stepwise regression. Forward stepwise regression starts from a model containing only the constant term, and adds a new variable to the model each time. The added new variable can improve the goodness-of-fit of the model (e.g., increase the adjusted R-squared) and meet the significance requirements.

Starting from an initial model, the independent variable with the largest correlation coefficient with the dependent variable is selected as the initial variable of the model. Based on the forward stepwise regression method, independent variables are added sequentially, and significance tests and statistical index comparison analyses are conducted on the model after each addition. The independent variable that makes the model significant and improves the model's statistical indexes is retained.

After adding a new independent variable, the backward stepwise regression method is used to check whether there are independent variables in the existing model that have become insignificant due to the addition of the new variable. If such independent variables exist, they should be removed from the model.

This process is repeated: adding or removing one variable at a time until there are no significant new variables to add and no insignificant variables to remove. That is, all variables in the model are significant, and adding or removing any variable will not make the model better. The stepwise regression results are shown in Figure 4.

Revised results:

$Y = 8348.842 + 0.901071X_1 - 0.685617X_5 + \mu$

Dependent Variable: Y
Method: Variable Selection
Date: 04/26/25 Time: 11:17
Sample: 1995 2024
Included observations: 30
Number of always included regressors: 1
Number of search regressors: 5
Selection method: Stepwise forwards
Stopping criterion: p-value forwards/backwards = 0.05/0.05
Stopping criterion: Number of search regressors = 5

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
C	8348.842	766.1854	10.89663	0.0000
X1	0.901071	0.006985	129.0073	0.0000
X5	-0.685617	0.045275	-15.14339	0.0000

R-squared	0.999184	Mean dependent var	9920.337
Adjusted R-squared	0.999123	S.D. dependent var	10406.69
S.E. of regression	308.1055	Akaike info criterion	14.39340
Sum squared resid	2563083.	Schwarz criterion	14.53352
Log likelihood	-212.9010	Hannan-Quinn criter.	14.43823
F-statistic	16528.75	Durbin-Watson stat	1.228135
Prob(F-statistic)	0.000000		

Selection Summary

Number of selected regressors: 2
Added X1
Added X5

*Note: p-values and subsequent tests do not account for variable selection.

Figure 4. Stepwise Regression Results

4.5 Testing of Revised Results

4.5.1 Goodness-of-fit test

The coefficient of determination (R-squared) is used to measure the goodness-of-fit of the model to the sample data. The closer the value is to 1, the better the model fits the sample data. In this paper, the calculated R-squared is 0.999184, which is close to 1, indicating that the explanatory variables can well explain the changes in the explained variable (private car ownership), so the model has a high degree of fit to the sample data. That is, the selected variables can relatively comprehensively represent the main factors affecting private car ownership, so the model has a certain explanatory power.

4.5.2 F-test

The F-test is used to test whether the linear relationship between the explained variable and all explanatory variables in the model is significantly established overall.

- Null hypothesis (H_0): All regression coefficients are zero, i.e., the explanatory variables have no significant impact on the explained variable;
- Alternative hypothesis (H_1): At least one regression coefficient is not zero, i.e., the explanatory variables have a significant impact on the explained variable.

From the results, the value of the F-statistic is 16528.75, and the corresponding Prob (F-statistic) is 0.000000, which is much less than the given significance level (e.g., $\alpha = 0.05$). Therefore, H_0 is rejected and H_1 is accepted. That is, overall, these explanatory variables together have a significant impact on private car ownership, and the linear relationship of the model is significantly established.

4.5.3 T-test

The t-test is used to test whether each explanatory variable has a significant impact on the explained variable. For each explanatory variable:

- Null hypothesis (H_0): Its regression coefficient is zero;
- Alternative hypothesis (H_1): Its regression coefficient is not zero.

Based on the calculated t-statistic of each explanatory variable, combined with the critical value obtained from the table for the given significance level ($\alpha = 0.05$ in this case) and the Prob. value of the t-statistic, it can be seen that the absolute value of the t-statistic of per capita disposable income (X_1) is 129.0073, and the absolute value of the t-statistic of crude oil output (X_5) is 15.14339, both greater than the critical value ($t_{0.025}(27) = 2.052$). The corresponding Prob. values are both 0.0000, which are less than the given significance level ($\alpha = 0.05$). Therefore, under the condition that other explanatory variables remain unchanged, both have a significant impact on private car ownership and should be retained in the model.

4.5.4 Multicollinearity test

The Variance Inflation Factor (VIF) method is used to test the multicollinearity of the model, and the results are shown in Figure 5 below.

Variance Inflation Factors
Date: 04/26/25 Time: 11:29
Sample: 1995 2024
Included observations: 30

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
C	587040.1	185.5197	NA
X1	4.88E-05	6.302844	2.378649
X5	0.002050	228.3116	2.378649

Figure 5. Multicollinearity Test Results

The variance inflation factor is used to measure the degree of multicollinearity among explanatory variables. If the VIF value is greater than 10, it is considered that there is a serious multicollinearity problem. From the test results, the VIF values of all parameters in the model are less than 10, indicating that there is no multicollinearity problem among the explanatory variables in the model.

4.5.5 Heteroscedasticity test

The White test is used to test for heteroscedasticity.

- Basic idea: It does not require assuming the specific form of heteroscedasticity. Instead, it

tests whether the variance of the error term is related to these variables by adding the square terms and cross terms of the explanatory variables to the regression model, thereby judging whether heteroscedasticity exists.

• Specific method: After obtaining the residuals from the regression, an auxiliary regression model is established with the square of the residuals as the dependent variable and all explanatory variables, their square terms, and cross terms in the original regression model as the independent variables. Then, the overall significance of the auxiliary regression model (usually using the F-test) and whether the coefficients of each independent variable are significantly non-zero (usually using the t-test) are tested to judge whether heteroscedasticity exists. The results are shown in Figure 6 below.

Heteroskedasticity Test: White
Null hypothesis: Homoskedasticity

F-statistic	0.986880	Prob. F(5,24)	0.4462
Obs*R-squared	5.116124	Prob. Chi-Square(5)	0.4019
Scaled explained SS	5.906766	Prob. Chi-Square(5)	0.3154

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 04/26/25 Time: 00:04
Sample: 1995 2024
Included observations: 30

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-3571907.	7354630.	-0.485668	0.6316
X1^2	-0.000369	0.000948	-0.389840	0.7001
X1*X5	0.001948	0.009518	0.204626	0.8396
X1	-26.12924	148.2282	-0.176277	0.8616
X5^2	-0.010616	0.027608	-0.384519	0.7040
X5	393.6264	899.5357	0.437588	0.6656

R-squared	0.170537	Mean dependent var	85436.11
Adjusted R-squared	-0.002267	S.D. dependent var	146716.8
S.E. of regression	146883.1	Akaike info criterion	26.80952
Sum squared resid	5.18E+11	Schwarz criterion	27.08976
Log likelihood	-396.1428	Hannan-Quinn criter.	26.89917
F-statistic	0.986880	Durbin-Watson stat	1.314526
Prob(F-statistic)	0.446233		

Figure 6. Heteroscedasticity Test Results

The Prob. Chi-Square (5) value of the test result is 0.4019, which is greater than 0.05, indicating that there is no heteroscedasticity.

4.5.6 Autocorrelation test

The Breusch-Godfrey test is used to test for higher-order autocorrelation. It is a method for testing higher-order autocorrelation, applicable to linear regression models, and has no strict requirements on the distribution of the error term.

• Test steps: Similar to the Lagrange multiplier test, residuals are first obtained from the regression. Then, an auxiliary regression model is established, regressing the residuals on their lagged terms (e.g., RESID (-1), RESID (-2)), as well as the explanatory variables and their lagged terms in the original model. The LM statistic or F-statistic of the auxiliary regression model is calculated (using the same method as the Lagrange multiplier test statistic), and the corresponding distribution is used to judge whether to reject the null hypothesis, i.e., whether higher-order autocorrelation exists. The results are shown in Figure 7 below.

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 2 lags

F-statistic	2.349548	Prob. F(2,25)	0.1161
Obs*R-squared	4.746705	Prob. Chi-Square(2)	0.0932

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 04/26/25 Time: 11:30
Sample: 1995 2024
Included observations: 30
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-207.6255	780.1896	-0.266122	0.7923
X1	-0.001448	0.006910	-0.209484	0.8358
X5	0.012360	0.046124	0.267974	0.7909
RESID(-1)	0.424368	0.199213	2.130223	0.0432
RESID(-2)	-0.076141	0.208769	-0.364712	0.7184

R-squared	0.158224	Mean dependent var	-9.09E-13
Adjusted R-squared	0.023539	S.D. dependent var	297.2914
S.E. of regression	293.7716	Akaike info criterion	14.35449
Sum squared resid	2157543.	Schwarz criterion	14.58803
Log likelihood	-210.3174	Hannan-Quinn criter.	14.42920
F-statistic	1.174774	Durbin-Watson stat	2.017369
Prob(F-statistic)	0.345824		

Figure 7. Autocorrelation Test Results

The Prob. Chi-Square (2) value of the test result is 0.0932, which is greater than 0.05, so there is no autocorrelation problem.

4.6 Result Analysis

From the model estimation results and tests, the impact degree and significance of various influencing factors on private car ownership vary.

There is a strong positive correlation between per capita disposable income and private car ownership. This shows that as residents' income levels improve, their enthusiasm for buying private cars also increases. With the rapid development of the domestic economy, people's income levels have been continuously improving, and more and more families have the ability to purchase private cars, leading to a continuous increase in private car ownership. This not only conforms to the deduction of economic theory but also aligns with common sense in life. While improving residents' income levels, we should also consider the changes in demand in the private car market, plan the development of the private car market in advance, and make early plans and arrangements for transportation infrastructure and related policies to better meet the demand for private car ownership.

There is a negative correlation between crude oil output and private car ownership. Crude oil extraction and processing will produce a large amount of pollution. Against the background of global attention to environmental protection, higher crude oil output will lead to more stringent environmental protection measures. The government will restrict the production, sales, and use of traditional fuel vehicles, such as raising emission standards or levying environmental taxes, to suppress the sales of traditional fuel vehicles. In the long run, this will reduce car ownership and achieve the goal of curbing growth. A larger crude oil output may indicate that the economy of a region or country is dominated by the energy industry, meaning it is too dependent on crude oil exports for revenue, while other industries develop relatively slowly. When international crude oil prices fluctuate, the economy of this region is easily affected by external factors. As cars are the main means of transportation for residents, this will cause unstable fluctuations in residents' actual disposable income. At the same time, a single economic structure will also affect the development of other industries, leading to a reduction in the number of jobs, and people will not have extra funds to buy cars, resulting in a decrease in the number of people purchasing private cars.

Bank loan interest rates have no significant impact on car ownership. Many people focus on the brand and model of the car when buying a car and do not care much about the level of the loan interest rate. If they are sufficiently satisfied with a certain model, they will still buy it even if the interest rate is slightly higher than expected. Therefore, changes in bank loan interest rates have little impact on their decisions. In addition, there are diversified loan channels. In addition to bank loans, car purchase funds can also be obtained from many channels such as auto finance companies and financial leasing companies. Compared with banks, the loan interest rates of these non-bank financial institutions are slightly different, but their loan policies are more relaxed and the approval process is simpler. Due to these differences, people's choices of loan-based car purchases vary. Therefore, changes in bank loan interest rates do not play a decisive role in the overall car ownership.

There is no direct correlation between the number of car drivers and car ownership. With the continuous improvement of people's economic conditions and living standards, some families or individuals own two or more cars. When counting the number of car drivers, the number of people with driving licenses is mainly used as a reference, not everyone has the ability to drive a car, which results in a non-corresponding relationship between car ownership and the number of car drivers; moreover, some cars are not driven by their owners themselves due to infrequent use or long-term rental, which causes the actual car ownership to be greater than the number of people who need to use cars. Based on this, the number of car drivers has little direct impact on car ownership. In addition, in some developed countries or regions, especially in the busy areas of large cities, public transportation such as buses, subways, and trams is very developed. Under the sharing economy, there are various low-cost and convenient travel methods such as bicycles, shared cars, and online ride-hailing. In this case, many people may be unwilling to drive their own private cars due to low costs and time-saving convenience even if they have a driver's license. Therefore, an increase in the number of people with driver's licenses does not mean an increase in the number of cars people buy.

Car output has little impact on car ownership, and an increase in car output does not directly lead to a significant change in car ownership. If market demand is insufficient, even if car output increases, a large number of cars will remain unsold and overstocked, failing to contribute to the growth of car ownership. Moreover, there are many different models and brands in the car market, and consumers' preferences vary. An increase in the output of a certain model or brand may not meet consumers' needs, so it cannot be said that this increase in output is reasonable, and thus the increase in the output of this model or brand will not bring a significant change to car ownership. In addition, there is the factor of export and industrial internal circulation, i.e., a part of car output is exported to meet the demand of the international market. If a country's automotive industry is export-oriented, the domestic car output has little connection with its domestic car ownership. Furthermore, the industrial chain within the automotive industry structure includes car production, sales, and leasing. In this case, a part of car output

will be in the industrial internal circulation, such as being used in the leasing industry or for enterprise vehicle updates, rather than flowing to consumers. Therefore, car output is not directly related to car ownership.

5. Policy Recommendations

5.1 Recommendations for the Factor of Per Capita Disposable Income

5.1.1 Tax adjustment

Further improve the personal income tax system. With the development of the economy and society and changes in residents' income levels, timely improve and adjust the tax rate structure and tax deduction standards, reasonably raise the tax threshold for low- and middle-income groups, and use tax policies to regulate and reduce the personal income tax rate for low- and middle-income groups to increase their disposable funds. This will allow them to have more money to consider buying a car. Improve the construction of the social security system, increase the proportion of medical insurance reimbursement, expand the coverage of endowment insurance, reduce residents' expenditure pressure on medical care and elderly care, release more funds for car consumption, and make residents dare to invest their savings in buying a car.

5.1.2 Improve social security

Strengthen the construction of the social security system, increase investment in pensions, unemployment benefits, minimum living security funds, and appropriately raise the standards of relevant benefits to ensure the basic life of low-income groups. Expand the coverage of social security and include more employed people in the social security system, especially more flexible employees and migrant workers, to enhance the income stability and sense of security of this group. In addition, develop supplementary insurance, such as enterprise annuities and commercial health insurance, to provide more protection for low- and middle-income groups, reduce their other living pressures, and increase the disposable funds of this group for car purchases.

5.1.3 Create diverse income-increasing opportunities

Strive to promote the coordinated development of various industries and support the growth of emerging industries. For example, increasing investment in the R&D and manufacturing of new energy vehicles will not only create a large number of high-paying jobs such as engineers and technical workers, directly promoting the increase of practitioners' income, but also drive the development of upstream and downstream industries such as battery production and parts processing, create more jobs, and increase the income of more residents. Promote the digital transformation of traditional industries, increase production efficiency and benefits, maintain the stability of employees' salaries and generate additional dividends, laying an economic foundation for residents to buy cars.

5.1.4. Promote rural economic development

Increase investment to improve rural infrastructure for production and living; develop rural characteristic industries such as characteristic agriculture, rural tourism, and rural e-commerce, promote the integrated development of rural industries, and increase farmers' income; implement the rural revitalization strategy, improve agricultural production efficiency and farmers' organizational level through land transfer and agricultural industrialization management; allocate rural education and medical resources properly, improve the overall quality and health level of the rural population, narrow the income gap between urban and rural residents, and expand domestic demand for car consumption.

5.2 Recommendations for the Factor of Crude Oil Output

5.2.1 Formulate a scientific phased production reduction plan

When implementing the crude oil production reduction plan, the government should avoid "one-size-fits-all" large-scale production reduction. This radical approach is likely to cause sharp fluctuations in international oil prices, disrupt the stable order of the global energy market, and may even trigger an economic recession. To prevent excessive impact on the economy, it is necessary to formulate a long-term production reduction plan of 5-10 years, adopt a gradual approach, and control the annual production reduction scale within 3%-5%, giving the market sufficient time to adjust and adapt. OPEC+ countries have repeatedly adopted a gradual production reduction strategy, which takes into account their own interests while maintaining the stability of the energy market and society.

5.2.2 Accelerate the transformation of

automotive energy structure

Establish a special R&D fund. The government will invest in the establishment of a fund for new energy vehicle R&D, mainly supporting the optimization of battery technology, the exploration of high-efficiency motors, and the breakthrough of intelligent driving technology. Further deepen the cooperation between industry, universities, and research institutions, build a collaborative innovation platform among universities, research institutions, and enterprises, accelerate the rapid transformation and implementation of scientific and technological achievements, and realize industrial application. Strengthen the incentive mechanism, and provide financial rewards and policy preferences to enterprises and individuals that have made outstanding achievements in the R&D of new energy vehicles to stimulate innovation momentum.

5.2.3 Implement supporting economic stimulus measures

The crude oil industry is the lifeblood of some regions. Direct crude oil production reduction will lead to a decline in fiscal revenue and an increase in unemployment. The government should take a two-pronged approach to promote the diversified development of the economy, increase investment in renewable energy, manufacturing, digital economy, and other related fields, and create new economic growth points and jobs. Saudi Arabia's "Vision 2030" is a successful example. During the process of reducing its dependence on oil, the country actively supported the development of new energy, tourism, and technology industries to reshape its economic structure. Support affected groups, establish a special fund to provide subsidies to oil workers who have lost their jobs due to production reduction and affected communities, and carry out targeted reemployment training. When the oil industry in Alberta, Canada, was in recession, it adopted a worker transformation program to help a large number of unemployed people successfully enter the clean energy industry.

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