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The Effects of the Global Financial Crisis on Automobile Demand in China

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Abstract

This paper examined the factors influencing Chinese auto demand from 2001 to 2013, using multi-regression analysis. This study also investigated the effects of the recent global financial crisis on Chinese automobile demand, and compared the results with those found for three different periods of time. According to the empicral results, the main factors influencing the quantity of Chinese automobile demand before the global financial crisis were the price of automobiles, the price of gasoline, the lending rate and the personal disposable income. The main factors of influencing the Chinese auto demand during the global financial crisis were the price of automobiles, the lending rate and the personal disposable income. Only one main factor influenced Chinese auto demand after the global financial crisis, and this was the personal disposable income. The income elasticity of the demand was 0.270, 0.928 and 0.243 before, during and after the global financial crisis, respectively. The results show that automobiles are a normal good and that the personal disposable income is a very important factor in people's decisions whether or not to purchase an automobile in China. Moreover, automobiles were almost a luxury good during the global financial crisis, with the influence of personal income rising more three-fold during this period. Furthermore, the effects of the global financial crisis on Chinese automobile demand has been very significant.

Keywords: automobile demand, multi-regression analysis, the global financial crisis, the income elasticity of demand

1. Introduction

In recent years almost all major automobile companies have seen a growth in sales, with some figures even hitting record highs. In addition to the fact that the European economy has been gradually improving, the main contributor to this trend has been the strength of economic growth in the BRIC countries (Brazil, China, India, Russia), and other emerging markets. The automobile industry is the dominant industry in the economies of China. In addition, an investigative report from The Boston Consulting Group stated that the BRIC countries would play a very important role in the global automobile industry and account for around one third of total sales in the following four years, with annual growth rates of 3-15%. While Chinese automobile sales accounted for 61% of the sales in BRIC countries in 2014, its annual growth rate slowed to 5%, down from the 20% to 40% seen in previous years. A German automotive market research consultancy, published a research report suggesting that by 2015 the total demand for automobiles in BRIC countries will increase to 20 million, and that within a decade demand will double. The Park company stated that due to the rapid economic development of these countries, and thus the substantial increases in income and purchasing power of many of their citizens, there has been a significant growth in the demand for automobiles.

Although there are many papers that have examined automobile demand, such as Carlson (1978), Carlson and Umble (1980), Arguea, Hsiao, and Taylor (1994), Wojcik (2000), Kobos, Erickson, and Drennen (2003), and Shepherd, Bonsall, and Harrison (2012), these have concentrated mainly on American and European markets. Moreover, as yet there are no papers which analyze the demand for automobiles in China for the years 2001 to 2013. Therefore, this study investigated the effects of the recent global financial crisis on Chinese automobile demand, and compared the results with those found for three different periods of time. China, with its growing economy and large population who have yet to purchase an automobile, is an attractive target for study. That is

why this paper examines the factors influencing auto demand in the period from 2001 to 2013.

The China Association of Automobile Manufacturers (CAAM) indicated that Chinese national auto sales were 21,984,100 units in 2013, exceeding the record of 20 million and thus creating a new benchmark for the world record. The CAAM further predicted that Chinese auto sales would go rise from 23.74 to 24.18 million in 2014, an increase of 8%-10%.

Table 1 shows the rise in sales in the Chinese automobile industry and its ranking among automobile-purchasing nations. It can thus be seen that this market has developed very rapidly in recent years, and thus is of considerable interest to the global auto industry, as well as to other international enterprises.

Table 1. Automobile sales and rankings in China

Year	2001	2002	2003	2004	2005	2006	2007
Total auto sales	237.1	324.8	451.5	520.3	591.8	721.6	881.7
World ranking	7	4	3	3	2	2	2
Year	2008	2009	2010	2011	2012	2013	
Total auto sales	938.05	1364.48	1806.19	1850.51	1930.64	2198.41	
World ranking	2	1	1	1	1	1	

Source: China State Information Center (in Chinese).

Note. Sales are in tens of thousands of vehicles.

1.1 Research Objectives

This study inspects monthly data for the span of 2001-2013. The data was analyzed by using multi-regression, based on economic theory and relevant research, to develop a model of Chinese automobile demand. This paper analyzes which factors have influenced automobile demand in China. and investigate if the global financial crisis affected automobile demand in China. Furthermore, this paper calculates the income elasticity with regard to automobiles during the three different time periods in China. Based on the income elasticity of demand, this study will determine which product category automobiles fall into in China (normal, luxury or inferior).

1.2 Research Contributions

The contributions of this study are as follows:

(a) This study is the first to explore the effects of the recent global financial crisis on Chinese automobile demand.

(b) This paper provides a calculation of automobile income elasticity in China, and determines which product category automobiles fall into in this country (normal, luxury or inferior). It is also the first study to examine the changes in automobile income elasticity in different periods of time.

2. Literature Review

This section reviews some studies that have examined the demand of automobiles. Carlson (1978) adopted a multi- equation to clarify automobile demand in US from 1965Q1 to 1975Q2. The results indicated that the disposable income is the most important decisive factor of auto demand. Carlson and Umble (1980) used quarterly data from the US for 1967 to 1978 to forecast automobile demand over the next five years, and to analyze the demand for different sizes of automobiles. Disposable income was given the greatest weight among all the factors used in their model to predict demand, and the results showed that price was a significant factor when automobile sales were depressed. Arguea, Hsiao, and Taylor (1994) developed a demand function using the data of automobile characteristics to estimate US automobile demand from 1969 to 1986. They used least-squares estimates to calculate price elasticity and income elasticity, and found that income has a significant influence on the car demand. Abu-Eisheh and Mannering (2002) used a number of variables, including the GDP, changes in employment, fuel prices and exchange rate, and so on, to forecast automobile demand. They found that much of the growth in automobile ownership was driven by the GDP. Kobos, Erickson, and Drennen (2003) presented a scenario analysis of the Chinese passenger vehicles market to explore variations in key parameters. They drew the conclusions that steady per capita income growth resulted in the rapid growth of passenger vehicle sales in China. All these studies indicated that income is the crucial factor influencing automobile demand. They also displayed the calculation of price and income elasticity. Furthermore, they analyzed which factors affect the automobile demand.

Marazzo, Scherre, and Fernandes (2010) explored the relationship between air transport demand and economic growth from1966 to 2006 in Brazil. Hensher (1986) studied the demand for automobiles from 1981-1988 in Australia, while Abu-Eisheh and Mannering (2002) forecasted automobile demand in the West Bank from 1971-1998, using 3SLS to construct a simultaneous-equation system. Filho, Zebende, and Moret (2008) studied the demand for vehicles by adopting the ferry-boat system between Salvador City and Itaparica Island in Brazil. DePelsmacker (1990) estimated the demand for new cars in Belgium from 1973 to 1986. Pierdzioch, Rulke, and Stadtmann (2011) analyzed forecasts of American car sales and Japanese car registrations. Shepherd, Bonsall, and Harrison (2012) constructed a model for the take-up of electric vehicles in the UK in order to analyze the market for the next 40 years. Li, Liu, and Zhang (2011) examined the link between the prevalence of being overweight and obese and vehicle demand in the US from 1999 to 2005. Fouquet (2012) estimated income and price elasticity trends (1850-2010), and made some predictions with regard to transport use in the UK. The results showed that the income elasticity of passenger transport demand was very large in the mid-nineteenth century. Bonilla, Schmitz, and Akisawa (2012) estimated gasoline demand for three vehicle sizes from1980 to 2008, as well as vehicle sales, new car fuel economy changes and vehicle stocks.

The above review shows that most prior studies about China were conducted before the country's entry into the WTO at the end of 2001, and no works have yet examined the effects of the recent global financial crisis on automobile demand in this market. Moreover, much of the research in the auto industry has concentrated on American and European markets, with much less attention being paid to China.

3. Empirical Methods and Model

3.1 Samples and Data Sources

The monthly data used in this study is from January, 2001 to December, 2013. The final sample consists of 936 observations for China, divided into three groups. The first group contains 468 observations before the recent global financial crisis (from 2001 Q1 to 2007 Q2). The second group contains 180 observations from during the crisis (from 2007 Q3 to 2009 Q4), while the third group contains 288 observations from after the crisis (from 2010 Q1 to 2013 Q4). Following Berger and Bouwman (2013), The period of the recent global financial crisis is from 2007 Q3 to 2009 Q4. The Chinese data sources are listed in Table 2, below.

Table 2. Data sources for the variables in the Chinese model

Variable	Source
QUAN	China Association of Automobile Manufacturers (CAAM)
PRICE_AUTO	National Bureau of Statistics,China
PRICE_GAS	National Bureau of Statistics,China
PRICE_TRA	National Bureau of Statistics,China
RATE	People's Bank of China
INCOME	National Bureau of Statistics,China.

Source: Created for the purposes of this study.

3.2 Variables

(a) QUAN symbolizes the quantity of automobile demand in China.

The real numbers of automobile sales are used to stand for the quantity of Chinese automobile demand.

(b) PRICE_AUTO represents the price of automobiles.

According to the economic law of demand, there is a negative correlation between the demand for a product and its unit price, assuming that all other factors influencing demand remain unchanged. However, data on the prices of automobiles is unavailable, although they are very important durable goods in China. For these reasons the price of durable goods is used as a proxy variable for the price of automobiles in China.

(c) PRICE_GAS represents the price of gasoline.

Based on the earlier study (Beresteanu & Li, 2011), and the fact that the main complemental good of automobiles is gasoline, the price of gasoline is also included in the demand model. Furthermore, Jun (2012) used oil prices to forecast the demand for cars. According to economic theory, there is a negative correlation between the demand for a product and the unit price of the complementary product, assuming that all other factors influencing demand remain unchanged.

(d) PRICE_TRA represents the price of transportation.

The main substitute goods of automobiles are scooters, public transportation, mass transportation, and so on. The price index of transportation is thus used to represent the price of substitute goods in the model. According to economic theory there is a positive correlation between the demand for a product and the unit price of the substitute product, assuming that all other factors influencing demand remain unchanged.

(e) INCOME represents the level of personal disposable income in China.

Income is a very important determinant of whether a consumer buys an automobile or not. Following Carlson and Umble (1980) and Arguea, Hsiao, and Taylor (1994), personal disposable income is thus included in this study's model. Assuming that all other factors influencing demand remain unchanged, there is a positive correlation between the demand for a product and personal disposable income.

(f) RATE represents the lending rate

Many people need a loan to buy automobiles, and thus the charge of borrowing influences demand. The main factor influencing the borrowing cost is the bank lending rate, and thus there is a negative correlation between this and automobile demand. Therefore, the bank lending rate is included in the model.

The definitions of the variables in the Chinese model are summarized in the Table 3.

Table 3. Definition of the variables in the model

Variable	Definition	Expected sign
Dependent variable QUAN	the quantity of Chinese automobiles demand	
Independent variable		
PRICE_AUTO	the price of automobiles	−
PRICE_GAS	the price of gasoline	−
PRICE_TRA	the price of transportation	+
RATE	the lending rate	−
INCOME	personal disposable income in China	+

Source: Created for the purposes of this study.

3.3 Empirical Methods

A regression model was adopted in this study. The assumptions of the classical linear regression model (CLRM) were employed, and the Ordinary Least Square (OLS) estimators had to be of the best linear unbiased estimator (BLUE) kind. The model was modified to better suit the context of this study. First, Klein's method was used to conduct a multicollinearity test to check if any collinear relationships existed among the variables. Second, a significance test (the nested hypothesis test) was used to decide whether or not to delete the collinear variables. Third, an autocorrelation test (the Durbin-Watson Test) was used to check whether autocorrelation existed among the variables. Fourth, White's Heteroskedasticity test was used to examine if there was any heteroskedasticity in the model. Finally, an Ordinary Least Square (OLS) test was used to determine the best estimators.

3.4 The Establishment of the Empirical Model

The model for Chinese automobile demand can be noted as follows:

$$QUAN_t = \beta_0 + \beta_1 * PRICE\_AUTO_t + \beta_2 * PRICE\_GAS_t + \beta_3 * PRICE\_TRAN_t + \beta_4 * RATE_t + \beta_5 * INCOME_t + \mu_t \quad (4)$$

Where, QUAN＝Chinese demand for automobiles.

PRICE_AUTO＝the price of automobiles.

PRICE_GAS＝the price of gasoline.

PRICE_TRAN＝the price of transportation.

RATE＝the lending rate.

INCOME＝personal disposable income.

μ＝the stochastic disturbance item.

4. Empirical Results

This section discusses the results of the data checking using four tests (i.e., the multicollinearity, nested hypothesis, autocorrelation and heteroskedasticity tests). After some amendment, the conclusive regression model is also presented.

4.1 The Results before the Global Financial Crisis (from 2001 Q1 to 2007 Q2)

4.1.1 Empirical Results of the Multicollinearity Test

Klein's method was used to test for multicollinearity. The criteria for omitting variables are as follows:

1). By using OLS, $Y = \alpha+\beta_1 X_1 +\beta_2 X_2+\ldots\ldots +\beta_K X_K$ produces the result of Ry^2.

2). By using OLS, $X_i = \alpha+\beta_1 X_1 +\ldots\ldots +\beta_K X_K$ produces the result of Ri^2.

3). If $Ri^2 > Ry^2$, then we omit X_i.

The empirical outcome of the multicollinearity test are presented in Table 4.

Table 4. The empirical results of the multicollinearity test in the Chinese automobile demand model before the global financial crisis

Variable	Ri^2	Ry^2	Multicollinearity
PRICE_AUTO	0.799218	0.780490	Yes
PRICE_GAS	0.432306	0.780490	No
PRICE_TRA	0.777188	0.780490	No
RATE	0.625549	0.780490	No
INCOME	0.371288	0.780490	No

Even though Table 4 shows that multicollinearity is an issue for PRICE_AUTO, it is not appropriate to omit this variable from the model only because of this (Gujarati, 2006). Therefore, the nested hypothesis test was used to decide whether or not to exclude this variable from the conclusive model.

4.1.2 Significance Test

In the context of the nested hypothesis test, an F-test is the basis for any final decisions. If the calculated F statistic is smaller than the critical value, then the variable is omitted. The results are shown in Table 5.

Table 5. The results of the nested hypothesis test in the Chinese auto demand model before the global financial crisis

Variable	F value	Whether to omit the variable or not
PRICE_AUTO	F = 88.08501	Retain

Note. 1) At the 5% level of significance. 2) The critical value of F (1, 72) is 3.984;
df for numerator = 1, df for denominator = 72.

Table 5 shows that PRICE_AUTO was retained.

4.1.3 Autocorrelation Test

The D-W value of automobile demand model in China was 1.280124 (K= 5, n=78, $d_L = 1.491$, $d_U = 1.7708$, at the 5% level of significance), located in the positive autocorrelation area. We thus used the Cochrane-Orcutt (C-O) process to deal with the problem of autocorrelation. After using the C-O process, a D-W value of 1.927041 was obtained, located in the area that showed no autocorrelation, thus indicating that this is not a problem.

4.1.4 Heteroskedasticity Test

The White heteroskedasticity test was performed with Eviews, and this was done to ensure that there were the same variances as BLUE.

The P value was 0.3, with a 5% level of significance, and thus heteroskedasticity is not an issue in the regression model.

4.1.5 Empirical Multiple Regression Model

After conducting the multicollinearity, significance, autocorrelation and heteroskedasticity tests, the remaining variables were used to run a regression analysis, following the OLS method, to construct a model for Chinese

automobile demand. The results are shown in Table 6.

Table 6. Regression results for the Chinese automobile demand model before the global financial crisis

Independent variable	Estimated Coefficient	Std. Error	t-Statistic	Probability	Expected sign
intercept	-48.274	16.560	-2.915	0.005	
Log(PRICE_AUTO)	+17.858	2.732	6.536***	0.000	—
Log(PRICE_GAS)	-0.437	0.210	2.079**	0.041	—
Log(PRICE_TRA)	-4.480	4.559	-0.983	0.329	+
Log(RATE)	-2.539	0.679	-3.740***	0.000	—
Log(INCOME)	0.270	0.142	1.907*	0.061	+
AR(2)	-0.003	0.117	-0.022	0.982	
Dependent variable: Log(QUAN)					
R-squared = 0.791857, Adjusted R-squared = 0.773757					
D-W value =1.927041					

Note. *** signifies that the t-value is statistically significant at the level of 1%; ** signifies that the t-value is statistically significant at the level of 5%; * signifies that the t-value is statistically significant at the level of 10%.

The revised model can be written as follows:

$$Log(QUAN)= -48.274 + 17.858 \times Log(PRICE\_AUTO) - 0.437 \times Log(PRICE\_GAS) -4.480 \times Log(PRICE\_TRA) -2.539 \times Log(RATE)+ 0.270 \times Log(INCOME) +(AR(2)= -0.003) \quad (5)$$

Table 6 shows that the t-values of Log(PRICE_AUTO), Log(PRICE_GAS) and Log(RATE) were significant at the 5% level in the conclusive model, while the t-value of Log(INCOME) was significant at the 10% level. The adjusted R-squared was 0.773757. Therefore, the model had good overall explanatory potential.

Table 6 also shows that the relationship between Log(QUAN) and both Log(PRICE_AUTO) and Log(INCOME) was positive and the relationship between Log(QUAN) and all Log(PRICE_GAS), Log(PRICE_TRA) and Log(RATE) was negative. The coefficients for Log(PRICE_GAS), Log(RATE) and Log(INCOME) were of the expected signs, while those for Log(PRICE_AUTO) and Log(PRICE_TRA) were not. In summary, the table indicates that the principal factors influencing the Chinese automobile demand before the global financial crisis were the price of automobiles, the price of gasoline, the lending rate and the personal disposable income.

4.2 Results during the Global Financial Crisis (from 2007 Q3 to 2009 Q4)

4.2.1 Empirical Results of Multicollinearity Test

The empirical results of the multicollinearity test are showed in Table 7.

Table 7. The empirical results of the multicollinearity test in the Chinese automobile demand model during the global financial crisis

Variable	Ri^2	Ry^2	Multicollinearity
PRICE_AUTO	0.710789	0.883352	No
PRICE_GAS	0.617834	0.883352	No
PRICE_TRA	0.649209	0.883352	No
RATE	0.763592	0.883352	No
INCOME	0.414904	0.883352	No

Table 7 shows that multicollinearity was not an issue for any of the variables, and thus they can all be included in the model.

4.2.2 Autocorrelation Test

The D-W value of Chinese automobile demand model is 2.22306 (K= 5, n=30, d_L= 1.071, d_U= 1.833, at the 5% level of significance), located in the indecision zone. The Cochrane-Orcutt (C-O) process was thus used to deal with the problem of autocorrelation. After using the C-O process, a D-W value of 2.044239 was obtained, located in the area that showed no autocorrelation, and thus autocorrelation was not an issue in this model.

4.2.3 Heteroskedasticity Test

The White heteroskedasticity test was performed with Eviews to ensure that we had the same variances as

BLUE.

The P value was 0.23, with a significance level of 5% or higher, and thus heteroskedasticity is not an issue in the regression model.

4.2.4 Empirical Multiple Regression Model

After conducting the multicollinearity test, significance test, autocorrelation test and heteroskedasticity tests, the remaining variables were used to run a regression analysis in accordance with the OLS method to construct a model for Chinese automobile demand. The results are shown in Table 8.

Table 8. Regression results for the Chinese automobile demand model during the global financial crisis

Independent variable	Estimated Coefficient	Std. Error	t-Statistic	Probability	Expected sign
intercept	51.183	17.453	2.933	0.008	
Log(PRICE_AUTO)	-14.566	1.891	-7.702***	0.000	−
Log(PRICE_GAS)	-0.394	0.285	-1.383	0.181	−
Log(PRICE_TRA)	4.898	4.395	1.114	0.277	+
Log(RATE)	0.701	0.229	3.067***	0.006	−
Log(INCOME)	0.928	0.235	3.949***	0.001	+
AR(1)	-0.147	0.220	-0.667	0.511	
Dependent variable: Log(QUAN)					
R-squared =0.860022, Adjusted R-squared = 0.821846					
D-W value = 2.044239					

Note. *** signifies that the t-value is statistically significant at the level of 1%.

The revised model can be written as follows:

$$Log(QUAN)=51.183 - 14.566 \times Log(PRICE\_AUTO) - 0.394 \times Log(PRICE\_GAS) + 4.898 \times Log(PRICE\_TRA) + 0.701 \times Log(RATE) + 0.928 \times Log(INCOME) + (AR(1)= -0.147) \quad (6)$$

Table 8 indicates that the t-values of Log(PRICE_AUTO), Log(RATE) and Log(INCOME) were significant at the 5% level in the conclusive model. This also satisfied the BLUE requirements. The adjusted R-squared was 0.821846. The model thus had good overall explanatory potential.

Furthermore, Table 8 indicates that the relationship between Log(QUAN) and Log(PRICE_TRA), Log(RATE) and Log(INCOME) was positive and the relationship between Log(QUAN) and both Log(PRICE_AUTO) and Log(PRICE_GAS) negative. The coefficients for Log(PRICE_AUTO), Log(PRICE_GAS), Log(PRICE_TRA) and Log(INCOME) were of the expected signs. Nevertheless, the Log(RATE) coefficient was positive, and thus opposite to the expected sign. The table indicates that the principal factors influencing the Chinese automobile demand during the global financial crisis were the price of automobiles, the lending rate and the personal disposable income.

4.3 Results after the Global Financial Crisis (from 2010 Q1 to 2013 Q4)

4.3.1 Empirical Results of Multicollinearity Test

The empirical results of the multicollinearity test are presented in Table 9.

Even though Table 9 shows that PRICE_AUTO, PRICE_GAS, PRICE_TRA and RATE had a multicollinear relationship, it is not appropriate to omit these variables from the model simply because of this (Gujarati, 2006). Therefore, we use the nested hypothesis test to decide whether or not to exclude these variables from the conclusive model.

Table 9. The empirical results of the multicollinearity test in the Chinese automobile demand model after the global financial crisis

Variable	Ri^2	Ry^2	Multicollinearity
PRICE_AUTO	0.907532	0.264981	Yes
PRICE_GAS	0.516274	0.264981	Yes
PRICE_TRA	0.413155	0.264981	Yes
RATE	0.908591	0.264981	Yes
INCOME	0.109860	0.264981	No

4.3.2 Significance Test

In the context of the nested hypothesis test, an F-test is the basis for the final decision. If the calculated F statistic is smaller than the critical value, then the variable is omitted. The results are shown in Table 10.

Table 10. The results of the nested hypothesis test in the Chinese auto demand model after the global financial crisis

Variable	F value	Whether to omit the variable or not
PRICE_AUTO	F = 0.142183	omit
PRICE_GAS	F =2.482456	omit
PRICE_TRA	F =0.012504	omit
RATE	F =0.025696	omit

Note. 1) At the 5% level of significance. 2) The critical value of F (1, 42) is 4.008;
df for numerator = 1, df for denominator = 42.

Table 10 shows that PRICE_AUTO, PRICE_GAS, PRICE_TRA and RATE were omitted.

4.3.3 Autocorrelation Test

The D-W value of Chinese automobile demand model was 2.105483 (K= 1, n=48, d_L= 1.492, d_U= 1.577, at the 5% level of significance), located in the area that shows no autocorrelation.

4.3.4 Heteroskedasticity Test

The White heteroskedasticity test was performed with Eviews to ensure that there were the same variances as BLUE.

The P value was 0.5903, with a level of significance of 5% or higher, and thus heteroskedasticity is not an issue in the regression model.

4.3.5 Empirical Multiple Regression Model

After conducting the multicollinearity test, significance test, autocorrelation test and heteroskedasticity tests, the remaining variables were used to run a regression analysis in accordance with the OLS method to construct a model for Chinese automobile demand. The results are shown in Table 11.

Table 11. Regression results for the Chinese automobile demand model after the global financial crisis

Independent variable	Estimated Coefficient	Std. Error	t-Statistic	Probability	Expected sign
intercept	12.179	0.569	21.395	0.000	
Log(INCOME)	0.243	0.066	3.710***	0.001	+
Dependent variable: Log(QUAN)					
R-squared =0.230272, Adjusted R-squared = 0.213539					
D-W value = 2.105483					

Note. *** signifies that the t-value is statistically significant at the level of 1%.

The revised model can be noted as follows:

$$Log(QUAN)= 12.179+ 0.243 \times Log(INCOME) \quad (7)$$

As shown in Table 10, we deleted PRICE_AUTO, PRICE_GAS, PRICE_TRA and RATE after performing both the multicollinearity and nested hypothesis tests. Table 11 further shows that the t-value of Log(INCOME) was significant at the 5% level in the conclusive model. This also satisfied the BLUE requirements. The adjusted R-squared was 0.213539.

Table 11 shows that the relationship between Log(QUAN) and Log(INCOME) was positive, and the coefficient for Log(INCOME) was of the expected sign. The table indicates that the principal factor influencing the Chinese automobile demand after the global financial crisis was only the personal disposable income.

5. Conclusions

5.1 Before the Global Financial Crisis (from 2001 Q1 to 2007 Q2)

As the results in Table 6 show, the income elasticity of the demand was 0.270, implying that if personal disposable income enhanced by 1 percent, the automobile demand would enhance by 0.270 percent, which is to say that the automobile sales would enhance by 0.270 units when disposable income enhances by one RMB. According to economic theory, Chinese automobiles were a normal good before the global financial crisis, and thus more that personal disposable incomes increases, the greater the demand for automobiles.

The cross-price elasticity of the demand is -0.437, implying that if the price of gasoline increased by 1 percent, the demand would decrease by 0.437 percent. This illustrates that automobiles and gasoline are complemental goods, the higher the gasoline price, the lower the automobile demand.

The price elasticity of demand is 17.858, implying that if the price of automobiles enhanced by 1 percent then the demand would enhance by 17.858 percent, which contradicts standard economic theory. Personal disposable income increased during the period studied, which indicates that the higher the price of automobiles, the greater the Chinese automobile demand.

The coefficient of the lending rate variable demonstrates that a 1 percent decrease in the borrowing cost(i.e., the lending rate) results in a 2.539 percent increase in automobile demand. Consequently, we can recognize that significant changes in this variable may have had a great effect upon Chinese automobile demand before the global financial crisis.

5.2 During the Global Financial Crisis (from 2007 Q3 to 2009 Q4)

As the results in Table 8 show, the income elasticity of the demand during the global financial crisis was 0.928, implying that if personal disposable income enhanced by 1 percent, the automobile demand would enhance by 0.928 percent, which is to say that the automobile sales would enhance by 0.928 units when disposable income enhances by one RMB. Conventional economic sense grasps that Chinese automobiles were a normal good during the global financial crisis, and thus the more personal disposable incomes increases, the greater the Chinese automobile demand. The income elasticity of the demand was 0.270 and 0.928, before and during the recent global financial crisis, respectively. From this we can know that the disposable income is a crucial factor of influencing automobile demand during the global financial crisis.

The cross-price elasticity of the demand is -0.394, implying that if the gasoline price enhanced by 1 percent, the demand would decrease by 0.394 percent. This demonstrates that automobiles and gasoline are complementary goods, and the higher the gasoline price, the lower the automobile demand.

The price elasticity of demand is -14.566, implying that if the automobile price enhanced by 1 percent, the demand would decrease by 14.566 percent, as expected by economic theory.

The coefficient of the lending rate variable demonstrates that a 1 percent increase in the borrowing cost (i.e., the lending rate) leads to a 0.701 percent increase in automobile demand. It is inverse with the normal situation. Most of auto purchasers were in financial difficulties during the global financial crisis, so they need to buy automobiles by loan. Consequently, the higher the lending rate, the higher the automobile demand. Therefore, we can take it for granted that the global financial crisis had an impact on Chinese automobile demand in this period of time.

5.3 After the Global Financial Crisis (from 2010 Q1 to 2013 Q4)

As the results in Table 11 show, the income elasticity of the demand after the global financial crisis was 0.243, implying that if personal disposable income enhanced by 1 percent, the automobile demand would enhance by 0.243 percent, which is to say that the automobile sales would enhance by 0.243 units when disposable income enhances by one RMB. Conventional economic sense grasps that Chinese automobiles were a normal good after the global financial crisis, and thus the more personal disposable income increases, the greater the automobile demand.

The results show that there is only the variable of disposable income to affect the automobile demand. As we can know that the economic circumstances is very poor after the recent global financial crisis, the buying depression is all over the world. It is very consistent with the true economic situation.

5.4 Summary

The income elasticity of the demand was 0.270, 0.928 and 0.243 before, during and after the global financial crises, respectively. The results thus show that automobiles are a normal good and that personal disposable

income is a very important factor in people's decisions whether or not to purchase an automobile in China. Moreover, automobiles were almost a luxury good during the global financial crisis, with the influence of personal income rising more three-fold during this period. In addition, the results indicate that Chinese automobile demand was only affected by income after the global financial crisis, and thus the impact of this crisis on Chinese automobile demand has been very significant.

The three different periods of results were assembled into comparative table. The results are shown in Table 12.

Table 12. The comparison of empirical results of the three different periods in the Chinese automobile demand model

item	before FS	during FS	after FS
main factors of influencing auto demand	the price of automobiles the price of gasoline the lending rate the personal disposable income	the price of automobiles the lending rate the personal disposable income	the personal disposable income
the income elasticity	0.27	0.928	0.243
the price elasticity	17.858	–14.566	
the cross-price elasticity	-0.437	–0.394	
the coefficientof the lending rate	-2.539	0.701	

Note. FS represents the global financial crisis.

In summary, as income changes, so does the demand for automobiles in China. The relationship between automobile demand and income is positive in the current study, and this is consistent with many previous works (e.g., Carlson & Umble, 1980; Depelsmacker, 1990; Abu-Eisheh & Mannering, 2002), manifesting that income is a very crucial factor in Chinese automobile demand.

Due to the lack of data on automobile prices, only a proxy variable could be used in this study. However, since the price of automobiles is a crucial factor of affecting purchase decisions, future studies would obtain more accurate results if they could obtain data on this.

Automobiles can be divided into several kind of vehicles, and studying these is another direction for future research, In addition, other variables could also be used to investigate automobile demand, such as macroeconomic variables and the number of consumers.

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