

Price, Consumer Expectations, Policy Impact on the Automobile Industry in the United States

—Empirical Evidence from 2005 to 2020

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Abstract: Automobiles are good partners for the American people to live and work with, and the automobile industry has made remarkable contributions to the economic development of the United States. In this paper, the development level of the automobile industry is measured by the annual sales volume. With the help of economic demand determination theory, through the combination of qualitative analysis and quantitative analysis, it is found that prices, policies, and consumer expectations will impact automobile sales volume and then affect the development level of the automobile industry. This paper can provide a reference for the decision-making of government, automobile enterprises, and consumers.

Keywords: automobile industry, market demand, prices, policies, consumer expectations

1. Introduction

The United States is a significant country in automobile manufacturing and use. Automobiles play an irreplaceable role in American households. As of 2019, 91.3% of households reported owning at least one car [1]. Automobiles are the most common non-financial asset American households hold, and almost every American family depends on an automobile. In most cases, a car exists not as a luxury but as a prerequisite for the opportunity. The automobile is not only a vehicle to get people from point A to point B but also the fundamental survival of the American people. The prosperity of the American economy depends on the automobile. By 2021, U.S. auto and parts dealers had \$1.53 trillion in revenue. The auto industry accounts for 3% of the U.S. GDP [2].

The automobile is an essential commodity, and the development level of the automobile industry is subject to the influence of market demand, which is the sum of all consumers' needs, according to N. Gregory Mankiw [3], in economics, demand means that consumers have both the willingness to buy and the ability to pay. Consumers tend to consider many factors when deciding to buy a new automobile, including their affordability of prices, expectations of social and economic conditions, and policies.

2. Literature Review

2.1. Automobile Industry Development Level

Although there are many indicators to measure the development level of the automobile industry, as shown by the famous statistics website STATISTA, the revenue, production, and sales volume of the automobile industry are all worthy of our attention. Many scholars around the world have also researched the above indicators. The author of this paper is well inspired by Sky Ariella [4] and Mathilde Automobilelier [5].

However, because of inflation, conversions are required to measure income between years. If an industry produces a lot of goods, but consumers do not buy them, it is hard to say that the industry's development level is high. The study argues that the number of automobiles sold to consumers is easy to count and persuasive.

2.2. Price

According to Mankiw [3], for general goods, as the price goes up, the demand for it goes down. This principle holds for most automobiles. After buying a car, consumers still need to pay for daily use expenses such as fuel. So, the price of the automobile itself and the cost of energy are factors that need to be considered by consumers.

Research by J.B. Maverick [6] suggests that oil prices affect the cost of producing automobiles, and analysis by William Brazil [7] indicates that oil prices affect the price consumers pay for fuel.

This study explores the influence of two factors on demand through the oil price level. This may be a more innovative reflection of this research than earlier scholars.

2.3. Consumer Expectations

According to Mankiw's description in microeconomics [3], consumers' future expectations affect their demand for goods in the present. If a consumer expects prices to fall in the future, he may be reluctant to buy at today's prices. Conversely, if a consumer expects prices to rise in the future, he will be inclined to buy goods today. In a modern economy, the price is the money paid in exchange. In this study, it is possible to include the loan interest borne by the consumer and the purchase of the automobile in the price.

According to Delvin Davis [8], affordability and sustainability of auto financing are central concerns for American families. The author also found in their study in 2009 consumers who buy automobiles through dealerships will pay more than \$25.8 billion in interest rate mark-ups over the life of the loan. From this, it can be concluded that how much the interest rate on a loan affects consumers' decision to buy an automobile.

However, due to the different characteristics of the financial programs provided by dealers in different regions, and because this study also needs to analyze the influence of other factors on the development level of the automobile industry, sorting out the total loan interest rate in the regression equation may not be conducive to focusing on the analysis of the core explanatory variables, which will be improved in this study.

2.4. Policy

As a typical consumer product, many policies implemented by the federal government will affect the demand for automobiles.

Clement Automobilebonnier [9] provides visual evidence of tax shifting and empirically measures the distribution of the sales tax burden between consumers and producers. Anna Alberini [10] studied

the effect of the Swiss government's attempt to control the sales of high-displacement automobiles through fuel tax, which also reflected the influence of policies on the development of the automobile industry to a certain extent. Charles Stuart [11] discusses the social welfare costs of taxes the United States government levied.

Inflation reduces the value of money [12]. Inflation makes it harder for automobile buyers to pay the fees without equal or higher wage increases. Higher inflation also means it costs more to buy a new automobile, further adding to buyers' troubles. Rabiul Islam [13] also pointed out in their research that the inflation rate is negatively correlated with the automobile sales volume in Malaysia.

It seems that most current research results point to the adverse effects of taxation on the development of the automobile industry. Still, the author of this paper believes that more consideration should be given. High taxes may reduce consumer surplus and limit consumer demand for automobiles. Tax increases with low price elasticity of demand will minimize consumer surplus, and heavy tax is not conducive to promoting consumption. According to the laws of each state in the United States, consumers should pay the purchase, consumption, and other taxes when buying an automobile. The fuel consumed in the daily use of the automobile also includes the fuel tax. Automakers also pay various taxes during operations, such as corporate income tax. Automobiles are a relatively flexible commodity in the United States, and the tax is quickly passed on from manufacturers to consumers. At the same time, the federal government can use tax money for social security so that people who otherwise cannot afford automobiles can buy them, thus stimulating demand for automobiles.

It seems that most studies at present believe that the level of inflation is negatively correlated with the development level of the automobile industry. But the author of this article can't quite agree. When the Federal Reserve implements a loose monetary policy, the additional money will help stimulate people's consumption of automobiles, but inflation will somewhat reduce people's purchasing capacity. The connotation of inflation is fixed, but the socio-economic situation of the United States and Malaysia is different. Whether the inflation level is negatively correlated with the development level of the American automobile industry from 2005 to 2020 needs to be further verified.

2.5. Workers' Choice Preference for Work Income and Leisure

The labor force participation rate refers to the ratio of the economically active population (including the employed and unemployed) to the working-age population, which measures the status of people's participation in economic activities. According to the economic theory and the experience of various countries, the labor participation rate reflects the preference of potential workers for job income and leisure. Some studies believe a country's high unemployment rate means lower purchasing capacity and automobile demand [12]. However, Lacey Plache [14] points out that rising unemployment may mean more workers can buy automobiles in the future. Anyway, both employed and unemployed people with a stronger preference for income from their jobs are more likely to need a car to commute to work or search for a job.

2.6. Travel Service Level

Travel services mean transportation, accommodation, or other travel arrangements, including but not limited to air, rail, bus passenger transport, hotel accommodation, and automobile rental services [15]. Automobile rentals play a vital role in the tourism industry and provide temporary use of automobiles and other similar vehicles.

According to statistics on transportation construction in the United States by Statista [16], there were 4.17 million miles of highways in the United States in 2020. The developed highway system makes the automobile an essential means of transportation. Not only do tourists choose cars for short

trips, but they sometimes drive them across the east and west coasts. For example, many tourists choose to rent automobiles for long or short trips, and rental companies buy more new cars to meet the demand of tourists. If travel flourishes, it is likely to boost the automobile industry.

3. Theoretical Framework and Research Hypothesis

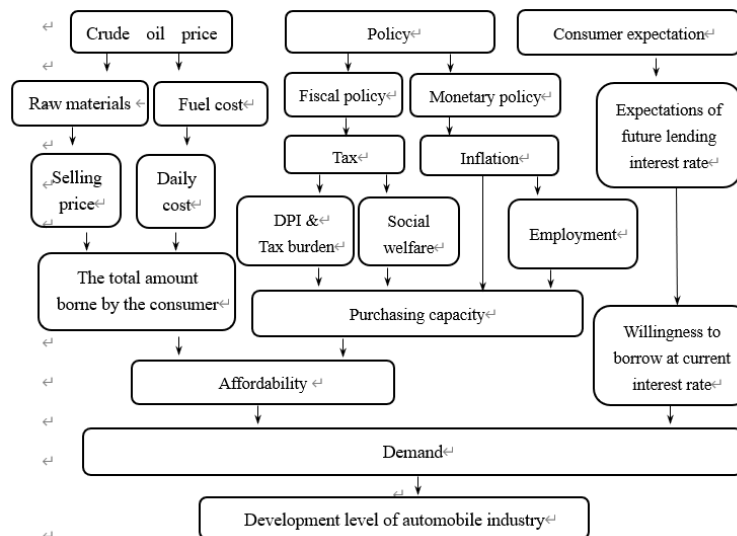


Figure 1: The influence mechanism of price, consumer expectations, and policy on the automobile industry.

3.1. H1: Price

Crude oil affects the price of raw materials for automobiles and, ultimately, the price manufacturers can charge for cars. The cost of crude oil affects the fuel price and, finally, the price consumers pay for daily use. This study speculated that these two factors would affect the automobile market demand so that the annual sales volume would change. Therefore, this paper hypothesizes that the price will affect the automobile industry's development level.

3.2. H2: Consumer Expectations

Changes in the interest rate affect the amount of money the borrower assumes so that interest rate changes can be approximately equivalent to price changes.

When consumers expect interest rates to change, they can approximate the expected price change at the same price. Consequently, consumer expectations will affect automobile demand, changing the annual sales volume. Therefore, this paper hypothesizes that consumer expectations will impact the automobile industry's development level.

3.3. H3: Policy

To begin with, fiscal policy will affect the level of taxation. The increase in tariff will reduce consumers' disposable income and increase their tax burden, which may reduce consumers' purchasing capacity and thus restrain the demand for automobiles. At the same time, the government will use tax revenue to support social welfare, which has the opposite effect. On the other hand, monetary policy affects inflation, which affects purchasing capacity and, ultimately, car demand. Therefore, this paper hypothesizes that the policy will influence the development level of the automobile industry.

4. Econometric Model and Data Description

4.1. Model Construction

$$Y=B_1+B_2X_1+B_3X_2+B_4X_3+B_5X_4+B_6X_5+B_7X_6+\acute{\epsilon}$$

Y: Annual automobile sales in the United States from 2005 to 2020

X₁: WTI Crude Oil (USD)

X₂: Lending interest rate (%)

X₃: Tax revenue (% of GDP)

X₄: Annual inflation rate (in%)

X₅: Labor force participation rate, total (% of total population ages 15+) (modeled ILO estimate)

X₆: Travel services (% of commercial service exports)

ε: Error Term

4.2. Description of Variables

4.2.1. Explained Variable

In this research, the explained variable is the development level of the automobile industry in the United States, which is measured by annual sales.

4.2.2. Core Explanatory Variables

The core explanatory variables include price, consumer expectations, and policy. The price is measured by crude oil price (WTI). Lending interest rates measure consumer expectations. The procedure is measured by tax revenue and annual inflation rate.

4.2.3. Control Variables

The control variables include workers' preference for work income and leisure and travel service level.

Table 1: Variable description.

Variable character	Variable name	Variable symbol	Variable definitions
Explained variable	Automobile industry development level	Y	Annual automobile sales in the United States from 2005 to 2020
Explanatory variables	Price	X ₁	Crude oil price (WTI)
	Consumer Expectation	X ₂	Lending interest rate (%)
	Policy	X ₃	Tax revenue (% of GDP)
		X ₄	Annual inflation rate (in%)
Control variable	Workers' choice preference for work income and leisure	X ₅	Labor force participation rate, total (% of total population ages 15+) (modeled ILO estimate)
	Travel service level	X ₆	Travel services (% of commercial service exports)

4.3. Data Source

The source of annual automobile sales data is the U.S. Bureau of Economic Analysis. (<https://www.bea.gov/>). This paper cites the data which

GOODAUTOMOBILEBADAUTOMOBILE processes. (Overall U.S Auto Industry Sales Figures | GCBC (goodautomobilebadautomobile.net)) This data captures both truck and passenger automobile sales. The source of lending interest rate, tax revenue, labor force participation rate, and travel services is THE WORLD BANK. (United States | Data (worldbank.org)) The data on inflation is cited from STATISTA. (<https://www.statista.com/statistics/1342636/real-nominal-interest-rate-us-inflation/?locale=en>). The data on the crude oil price is cited from MACROTRENDS. (<https://www.macrotrends.net/1369/crude-oil-price-history-chart>)

5. Empirical Test and Result Analysis

5.1. Data Analysis Techniques

5.1.1. Basic Regression Analysis

Table 2: Descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
Y	16	15340177	2256422.5	10347715	17500719
X1	16	93.237	29.141	44.589	136.61
X2	16	4.461	1.663	3.25	8.05
X3	16	10.278	1.031	7.904	11.75
X4	16	1.981	1.155	-.4	3.8
X5	16	63.035	1.418	60.88	65.12
X6	16	22.917	3.554	10.29	25.743

Table 3: Linear regression.

Y	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig	
X1	-14026.489	11330.94	-1.24	.247	-	39658.855	11605.877	
X2	755800.97	279185.94	2.71	.024	124238.48	1387363.4	**	
X3	737673.2	314384.4	2.35	.044	26486.295	1448860.1	**	
X4	229923.81	279518.23	0.82	.432	-	402390.35	862237.98	
X5	-1203706.6	320751.86	-3.75	.005	-	1929297.8	478115.52	***
X6	240308.79	70736.657	3.40	.008	80291.354	400326.22	***	
Constant	75606473	20182712	3.75	.005	29950008	1.213e+08	***	
Mean dependent var	15340177.063		SD dependent var		2256422.530			
R-squared	0.926		Number of obs		16			
F-test	18.829		Prob > F		0.000			
Akaike crit. (AIC)	484.806		Bayesian crit. (BIC)		490.214			
*** $p < .01$, ** $p < .05$, * $p < .1$								

$$Y=75606473-14026.49 X_1+ 755801 X_2+ 737673.2X_3+229923.8X_4 -1203707 X_5+240308.8X_6$$

Table 4: Basic regression results.

Explanatory variables	1	2	3	4
X1	-34783.2853*	-35923.4455*	-26800.2928*	-14026.4887
	(-1.8813)	(-2.0134)	(-1.8948)	(-1.2379)
X2		449156.8748	-69501.6413	755800.9655**
		(1.4364)	(-0.2640)	(2.7072)
X3			1646148.842***	737673.2046**
			(4.4165)	(2.3464)
X4			171252.3674	229923.8123
			(0.3944)	(0.8226)
X5				-1203706.6375***
				(-3.7528)
X6				240308.7896***
				(3.3972)
R ²	0.2018	0.3111	0.7719	0.9262
N	16	16	16	16
VIF				3.21
BP				0.5110
Ljung-Box				0.4476
Q				1.8951
DW				

Note: The values in parentheses are t values.
 *Significance at the significance level of 10%.
 **Significance at the significance level of 5%.
 ***Significance at the significance level of 1%.

This study selected time series data from 2005 to 2020, with a sample size of 16. When the confidence level is 95%, the decision coefficient is 0.926, indicating that the regression model explains the Y variation at a ratio of 92.6. Therefore, it can be preliminarily believed that there is a robust linear relationship between the explanatory variable and the explained variable in this study, and the sample regression is a good fit for the population regression function.

5.1.2. Multicollinearity

Multicollinearity means that multiple explanatory variables are highly correlated, making distinguishing their influences on the explained variable difficult. Variance Inflation Factor is used in this study to test whether multicollinearity exists. The maximum VIF tried was 5.16, and the average VIF was 3.21. Since its value is less than 10, multicollinearity does not live.

5.1.3. Heteroscedasticity

Overall, the presence of heteroscedasticity will reduce the efficiency of OLS. The Breusch-Pagan test is used in this study to test whether the explanatory variable on the right side of the equation is heteroskedasticity. The test result shows that the p-value is 0.5110, and the p-value is more significant than 0.05, so the null hypothesis of homoscedasticity cannot be rejected. The results show no heteroscedasticity in this study's regression equation, which is also supported by the residual plot.

5.1.4. Autocorrelation

The existence of the autocorrelation phenomenon will increase the fluctuation amplitude of the regression line estimated based on sample data and reduce parameter estimation accuracy. The result of the Durbin-Watson d-statistic is 1.8951, close to 2, indicating that autocorrelation is unlikely. The p-value of Lung-Box Q test was 0.4476, more significant than 0.05, and the null hypothesis of autocorrelation could not be rejected. The test result of residual graphs also proves this conclusion.

5.2. Regression result analysis

5.2.1. Core Explanatory Variables

5.2.1.1. Price

The p-value of X_1 is 0.247, more significant than 0.05. Suppose p is greater than the significance level. In that case, there is no good reason to think that X_1 is significantly related to Y. Therefore, from a statistical point of view, making a strict interpretation of the true significance of the X_1 coefficient is not convincing.

From a theoretical point of view, the price of crude oil will likely affect the automobile industry's development level. As the key to modern industry, crude oil can produce industrial raw materials such as plastics and refined fuel such as gasoline.

Plastics are lightweight, corrosion-resistant, and malleable, providing manufacturers greater design freedom than metals and meeting consumer demands for greater fuel efficiency. So plastic, a raw material derived from petroleum, plays a vital role in automobile manufacturing. If oil prices rise, manufacturers will incur higher raw material costs. To ensure profits, automobile makers are likely to raise prices.

The main component of fuel is derived from crude oil, and the price of crude oil affects fuel prices. According to AAA research [17], an automobile is typically the second most expensive purchase in a person's lifetime. After depreciation, fuel costs can be one of the highest spending categories in annual driving costs. If crude oil prices rise, consumers' daily fuel costs will increase.

Demand is defined as the price consumers can bear and the willingness to buy. The above two points constitute the total amount consumers need to pay when buying and using automobiles, which directly affects consumers' ability to bear the price. If consumers find it challenging to maintain the higher cost of cars and oil prices caused by higher oil prices, demand will be somewhat depressed. Finally, the reduced demand in the automobile market will also hurt the development of the automobile industry.

5.2.1.2. Consumer Expectation

The p-value of X_2 is 0.024, less than 0.05, which indicates that the probability of the difference between samples caused by sampling error is less than 5%. It can be believed that the level of loan interest rate is significantly correlated with the development level of the automobile industry for relatively sufficient reasons. Provided that other conditions are invariant, a 1% increase in lending rates increases annual automobile sales by about 755,800 vehicles.

Consumer expectation is the consumer's propensity to consume after judging the market, economy, and other conditions. When the consumer expects the need to be active, the income to increase, and the price to rise, the consumer will have a stronger propensity to consume at current prices. If interest rates rise, that means consumers are paying more interest. In this case, the increase in the total cost borne by the consumer can be approximately equivalent to the rise in price.

The change in borrowing rate is affected by many factors, such as the affordability of auto financing products by auto companies, the supply, and demand of borrowing funds in the macro market, the international economic environment, the policies of the federal government, etc. Interest rates do not move unchecked and are likely to rebound once they reach a certain point. However, it is difficult for consumers to accurately judge the inflection point of interest rate change among various uncertain factors. Consumers may expect interest rates to go up further when interest rates go up. They may think they can save money by buying an automobile sooner, so rising interest rates will encourage consumers to purchase cars.

According to the consumer expectations principle, when consumers expect interest rates to rise, they will be more willing to borrow to buy an automobile with the current lending interest rate. As a result, the interest rate will be positively correlated with the development level of the automobile industry.

5.2.1.3. Policy

The P value of X_3 is 0.044, less than 0.05. This indicates that the probability of the difference between samples caused by sampling error is less than 0.05. Thus, there are sufficient reasons to believe that the tax level is significantly correlated with the development level of the automobile industry. If other conditions are invariant, for every 1 percent increase in the tax-to-GDP ratio, annual automobile sales rise by about 737,673 vehicles.

Both fiscal and monetary policy are part of U.S. government policy. Taxation is one of the tools of fiscal policy. Taxes come at a cost [3]. The federal government's largest source of revenue is the personal income tax, which accounted for 43% of federal revenue in 2011[17]. The largest source of revenue for state and local governments is sales taxes, which accounted for 22% of state and local government revenue in 2011. When the federal government increases the personal income tax, it reduces consumers' disposable income. Less disposable income means less purchasing capacity, dampening demand for automobiles. When state and local governments raise taxes [3], whether sales or corporate taxes, prices paid by consumers go up, and fees paid by automobile makers go down. Because of the importance of automobiles in the work and life of Americans, the tax burden will be shifted more to consumers, resulting in a decline in consumer purchasing capacity. So rising taxes are likely to dampen demand.

At the same time, taxes bring social benefits that cannot be ignored. The largest federal spending category is income security, which consists mainly of transfer payments, including Social Security payments to the elderly and disabled, unemployment insurance payments to the unemployed, and welfare payments to the poor. In 2011, it accounted for 33 percent of federal spending. The above groups are likely to lack the purchasing capacity of automobiles before they receive social welfare. The existence of taxes makes it possible for people who cannot afford the expenses to buy cars for employment or enjoy retirement life.

In addition, in the United States, the tax system tries to ensure that everyone contributes their fair share to the functioning of the government and the national economy. Higher-income groups pay a larger share of taxes, and lower-income groups pay a smaller percentage. High-income groups are likely to have enough purchasing capacity after paying taxes and fees, and a lower share of surcharges and fees will not seriously affect the purchasing decisions of low-income groups. So, taken as a whole, the tax may not dent consumers' purchasing capacity as much as previously thought.

The result of the regression equation shows that the tax is positively correlated with the development level of the automobile industry. From a macro perspective, taxes may boost purchasing capacity more than they hinder it.

The P value of X_4 is 0.432, more significant than 0.05. Suppose p is greater than the significance level. In that case, there is no good reason to believe that X_4 is significantly related to Y . Therefore,

from a statistical point of view, making a rigorous interpretation of the practical meaning of the coefficient of X_4 is not convincing. However, in theory, the level of inflation is likely to affect the development level of the automobile industry.

The change in the level of inflation is one of the manifestations of the federal government's monetary policy. The Federal Open Market Committee states that the inflation rate, in the long run, is primarily determined by monetary policy.

It is commonly believed that inflation reduces the value of money. Inflation makes it harder for automobile buyers to pay the fees without equal or higher wage increases. Higher inflation also means it costs more to buy a new automobile, further adding to buyers' troubles. Rabiul Islam [13] also pointed out and confirmed in his research on Malaysia that the inflation rate is negatively correlated with automobile sales. However, theoretically, this answer is wrong. When prices rise, although buyers pay more for the goods they buy, sellers also get more for the goods they sell [3]. Since most people earn their income by selling their services, inflation keeps pace with price inflation. Consequently, inflation itself does not reduce the actual purchasing capability of consumers.

Rising inflation means more people have jobs. Wages can increase their purchasing capacity, and commuting to work requires driving or taking an automobile. The Phillips curve shows that inflation is negatively correlated with unemployment [3].

This study cannot determine the quantitative relationship between the level of inflation and the level of development of the automobile industry because X_4 in the regression equation does not meet the requirement of statistical significance. Nevertheless, it can be inferred that there is probably a correlation between the two.

5.2.2. Control Variables

The p-value of X_5 is 0.0045, and that of X_6 is 0.0079, indicating that the probability of the difference between samples caused by sampling error is less than 0.01. It can be believed that the labor force participation rate and travel service expenditure significantly impact the automobile industry's development level. Therefore, it can be considered that the control variables selected in this study effectively ensure the objectivity of the empirical research.

6. Conclusions and Recommendations

6.1. Conclusion

Prices, consumer expectations, and policies will affect people's demand for automobiles, and changes in market demand will be reflected in the development level of the automobile industry.

The price of oil affects the cost of raw materials and fuel for automobiles and the price that consumers have to pay when they can buy it and the price of oil moves in the opposite direction to market demand.

When consumers expect loan rates to rise, they tend to show more robust demand for automobiles, so when loan rates rise, so makes market demand.

Policies affect tax levels and inflation levels. First, in this paper, it is found that tax level and market demand move in the same direction. On the one hand, the tax reduces the disposable income of consumers, and the need for automobiles is constrained. On the other hand, social welfare brought by tax increases purchasing capacity. The latter outweighs the former. Second, the inflation level moves in the same direction as the market demand. That may be because inflation, which is negatively correlated with unemployment, has not changed the purchasing capacity of consumers. Thus, more people can afford cars through their wages.

6.2. Policy recommendations

6.2.1. Consumer

Consumers should be aware that their expectations may differ from future reality. It is unnecessary to make decisions immediately when prices or interest rates on loans are rising.

6.2.2. Automobile Enterprise

The overall goal is to mitigate the impact of volatile oil prices. Production has reduced the use of plastics and other petrochemicals to keep costs affordable to consumers when oil prices rise. The automobile enterprise should attach importance to the research, development, and application of new energy, seek technological breakthroughs, further improve the energy saving of new energy vehicles, control the production cost of batteries and other parts to reduce the terminal selling price, to provide consumers with more choices when the oil price rises.

6.2.3. Government

It is feasible for the government to prudently regulate monetary policy and fiscal policy prudently, fully considering the two sides of policy effect, to maximize the overall benefits of consumers by weighing.

6.3. Limitations and Prospects

There are many factors affecting the development level of the automobile industry. This study may have the problem of missing variables, which also leads to the fact that the oil price and inflation variables in the regression equation do not meet the statistical significance requirements. At the same time, the development level of the automobile industry is not only reflected in the market demand. It can be studied from the supply side in the future.

The influence of policies on the automobile industry is not limited to tax and inflation. In future studies, it would be beneficial to focus on the impact of policies on the development level of the automobile industry.

With the rapid development of energy and material technology and people's increasing desire for environmentally sustainable growth, price factors such as oil, batteries, and chips can be considered in future research.

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