The Purchase Behavior of New Energy Vehicle in Carbon Trading Market

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ABSTRACT

To address global climate change and promote global sustainable development, China is committed to economic transformation at the stage of social and economic development. Under the carbon peak goal, China's energy transition faces challenges in economic and social development stage, related mechanisms of energy low-carbon transition, and technological development. Compared with traditional cars, new energy vehicles have excellent performance in saving and scheduling, but there is a high degree of inconsistency between consumers' attitudes and behavior s in the purchase of new energy vehicles. Based on empirical analysis from the perspective of carbon trading market, this paper investigates the consumers' purchase prospects when faced with problems such as the lack of safety and protection of new energy vehicles, the density of after-sales service outlets and maintenance prices, as well as the convenience of parking places and energy replenishment in the use of new energy vehicles. Besides, the impact of consumer behavior s on the purchasing prospects of new energy vehicles under the goal of carbon peak in China are also discussed. According to the analysis, compared with the prospect of future energy conversion, the intensity of government subsidy policy is the key factor affecting consumers' purchase intention of new energy vehicles. Overall, these results shed light on exploring views of consumers on new energy vehicles and pave a path for further development for the industry.

Keywords: Carbon peak, Energy transformation, Carbon trading market, Purchase decision, interfering factor.

1. INTRODUCTION

Contemporarily, most literatures are limited to qualitative discussion of barriers and preferential policies for the promotion of new energy vehicles in China, but there is a lack of empirical research on consumer psychology and consumption behavior of new energy vehicles. Therefore, in order to further explore the relationship between the carbon trading market and consumers' purchasing desire, it is necessary to conduct a quantitative study on consumers' willingness to buy new energy vehicles and the decision-making factors that affect consumers' purchasing new energy vehicles [1].

"Carbon trading" is short for "carbon emission trading" first appeared in the Kyoto Protocol signed in Tokyo, Japan in December 1997, which proposed that carbon dioxide emissions can be traded similar to ordinary commodities. Kyoto Protocol identifies six kinds of gases as greenhouse gases. As carbon dioxide occupies an absolute dominant position among all greenhouse gases, the trading of greenhouse gas emission rights is referred to as "carbon trading". The market engaged in such emission trading is called "carbon trading market" [2], and carbon emission trading is generalized to the trading of various greenhouse gas (GHG) emission rights. Unlike ordinary commodity trading, carbon trading is essentially the trading of carbon emission rights. Emission rights are the limited right to use environmental capacity resources, which are scarce resources. This power was first recognized by the government. All kinds of emissions of greenhouse gases (including carbon dioxide) can be allocated initially in some acceptable way (e.g., with the definition of the property rights, relevant enterprises in the carbon trading market for free distribution of carbon dioxide emissions

trading) through market competition determine the price of permits. Then, one can realize the optimal allocation of environmental capacity resources [3].

Carbon trading market is a kind of macro-control led by the government to limit carbon emissions and implement sustainable development and environmental protection. As the world's second largest carbon emission industry, the automobile industry faces serious energy consumption and environmental pollution problems. It is predicted that problems (e.g., energy security, environmental protection and traffic pressure) will become more prominent in the future [4]. Developing new energy vehicles is an important breakthrough for the automobile industry to deal with energy security, climate change and structural upgrading. Under the environment of government policy support, relevant industries can make profits in the carbon trading market and the new energy vehicle market at the same time, which promotes the development of new energy vehicles and is the advantage of industrial development.

According to the National Development and Reform Commission "New energy vehicle carbon quota management measures" requirements, all fuel vehicle scale enterprises of new energy vehicle production and sales must reach a certain proportion, otherwise they must buy the corresponding quota from the carbon market. According to Ref. [5], as carbon prices rise, the price of petrol cars will rise and sales will fall. The price of new energy vehicles will fall and sales will increase. The difference between the two is gradually narrowing, and the profit contribution rate of new energy vehicles will gradually increase. In this way, it is urgent for manufacturers to develop the industrial chain of new energy vehicles. Meanwhile, the impact of carbon price on the price of the two products has nothing to do with the range of new energy vehicles. When the range of new energy vehicles is low, the carbon price has a relatively large impact on the output and profit of the two models. In the context of low carbon consumption and carbon neutrality, new energy vehicles are being pushed and pushed to develop, which seems to be expected by all.

Tesla delivered 936,000 vehicles globally in 2021, including 308,000 in the fourth quarter of 2021, according to official figures released by the company on Jan 3. [6]. New power enterprises focusing on the domestic market will also have a good performance in 2021. Among them, "Wei Xiaoli" (Weilai, Xiaopeng Automobile and Lixiang Automobile) three auto companies have all delivered more than 90,000 vehicles in the whole year, approaching the 100000 marks. Thereinto, the deliveries of Weilai, Xiaopeng, Lixiang and Nezha continued to break the 10,000-unit mark in December 2021. The above data can show that the development of the new energy vehicle industry is good.

However, in the meantime, according to the investigation in Ref. [7], China's new energy vehicle industry are with obvious disadvantages, which includes prominent core technology bottlenecks, insufficient market demand and disorderly competition within the industry, serious shortage of relevant supporting facilities, and few policies that directly benefit consumer groups, etc.

In terms of policy, government subsidies have been playing a crucial role in promoting the industrialization development of new energy vehicles. In order to promote the application of new energy vehicles nationwide, the central government provides subsidies for the purchase of new energy vehicles under the GSP system. The subsidy target is consumers, and the subsidized products are pure electric vehicles, plug-in hybrid electric vehicles and fuel cell vehicles included in the "New energy vehicle promotion and application Project recommended model catalog". In addition to state subsidies, there are also local subsidies. Some cities provide subsidies according to the national subsidy standard of 1:1. In addition to enjoying financial subsidies, the purchase of new energy vehicles also enjoy exemption from vehicle purchase tax etc. [8].

In other investigations, scholars draw the conclusions based on empirical studies as follows [9, 10]. (1) Consumers' perceived risk will negatively affect their purchase intention of new energy vehicles, where financial risk, physical risk and functional risk have a greater impact on purchase intention. (2) Consumers' involvement in new energy vehicles has a positive impact on their purchase intention, while consumers' product knowledge and symbolism of new energy vehicles have a positive impact on their involvement. (3) Consumers with different demographic characteristics have significant differences in perceived risk, degree of involvement and purchase intention.

To sum up, based on the above research, the questionnaire of this paper mainly covers living area, annual income level, satisfaction with preferential policies, demand for supporting facilities, main considerations when buying motor vehicles, and understanding of carbon trading market, which is distributed to people with purchasing power. On top of this inquiry, we will investigate whether carbon trading market positive affects consumers' desire to consume, which is the larger impact on it, what kind of people will be based on environmental awareness and knowledge of carbon trading market to increase its purchase, investment desire, how should we improve their consumption desire, etc.

The rest part of the paper is organized as follows. The Sec. 2 will introduce the content framework. Subsequently, the Sec. 3 will discuss the methods. Afterwards, the Sec. 4 will present the results according to the methods. Eventually, a brief summary will be given in Sec. 5.

2. CONTENT FRAMEWORK

To carry out the empirical analysis, the questionnaire is designed for finding out the if there are connections between purchasing behavior and knowledge of carbon market. Whereas other variables also have obvious impact on it according to the analysis. Although carbon trading has no direct impact on consumers (data supported quantitative model), it has an impact on government policies and company policies (specific analysis) (theoretical support). Finally, it comes to the conclusion that carbon trading indirectly affects consumers' purchasing behavior

3. METHOD

The participants were all urban residents of China. Of the 136 people who took part in the survey, 10 were invalid, resulting in a sample of 126 valid participants. The participants were all under the age of 50, with the majority (48.53%) being between the ages of 40 and 50 and the smallest (2.94%) group being juniors. Over 37.5 of the participants live in Tier 1 cities and above. The majority of the participants have some purchasing power. They described their likelihood of buying a new energy motor vehicle in the next three years as not buying (27.94), 20% likely to buy (16.91%), 40% likely to buy (17.65%), 60% likely to buy (14.71%), 80% likely to buy (5.15%) and would buy (17.65%). Ninety participants (66.18% of the sample) said they had no knowledge of carbon trading. The environmental friendliness of the goods purchased was high, with 43.88% of the participants wanting to be relatively environmentally friendly and 26.47% wanting to be very environmentally friendly. However, 45.59% of the participants considered the safety factor first when purchasing a motor vehicle, and only 9.56% of the group made the use of clean energy in motor vehicles a priority. The majority of the sample (57.35%) were female, 39.71% were male and 2.94% chose not to reveal their gender.

The materials included: (i) an online questionnaire, made available to participants via social media; (ii) relevant literature. The measures collected in the survey reflect the environmental and psychological factors associated with consumers' decisions to purchase new energy motor vehicles in the context of carbon trading. The variables used in this particular study and their measurement levels are listed in Table 1.

Table 1. Frequency analysis for questionnaire.

Items	Categories	N	Percent (%)
Gender	Female	79	57.66
	not to reveal	4	2.92
	female	54	39.42

Items	Categories	N	Percent (%)
Age	18-23	21	15.33
	23-30	26	18.98
	30-40	20	14.60
	40-50	66	48.18
	Under 18	4	2.92
Areas of permanent residence	First-tier	40	29.20
	third-tier	19	13.87
	countryside	9	6.57
	Second-tier	38	27.74
	County-level	20	14.60
	Super first-tier	11	8.03
average annual income	10-30	31	22.63
	30-50	9	6.57
	50-80	4	2.92
	5-10	43	31.39
	under5	45	32.85
	over80	5	3.65
How many new energy vehicles	one	11	8.03
	three	2	1.46
	two	4	2.92
	five	1	0.73
	zero	119	86.86
the likely to buy a new energy vehicle in future	20%	23	16.79
	40%	25	18.25
	60%	20	14.60
	80%	7	5.11
	yes	24	17.52
	no	38	27.74
Anticipation for purchasing preferential policies	Just so so	32	23.36
	zero	24	17.52
	60%	39	28.47
	30%	14	10.22
	100%	28	20.44
Additional requirements for supporting facilities	50%	28	20.44
	0%	26	18.98
	60%	29	21.17
	30%	18	13.14
	100%	36	26.28
Satisfaction with preferential policies	50%	54	39.42
	0	20	14.60
	60%	22	16.06

Items	Categories	N	Percent (%)
	30%	36	26.28
	100%	5	3.65
primary consideration	brand	15	10.95
	service	24	17.52
	safety	62	45.26
	use clean energy	13	9.49
	budget	23	16.79
Budget	10-20	41	29.93
	Over 20	26	18.98
	5-10	32	23.36
	under5	16	11.68
	0	22	16.06
Understanding carbon trading	50%	19	13.87
	0%	91	66.42
	60%	1	0.73
	30%	25	18.25
	100%	1	0.73
Requirements for the environmental friendliness	50%	22	16.06
	0%	8	5.84
	60%	60	43.80
	30%	11	8.03
	100%	36	26.28
The price of new energy vehicles?	10-15	46	33.58
	15-20	32	23.36
	Over 20	14	10.22
	5-10	29	21.17
	Under 5	16	11.68

The research team administered an online questionnaire and participants completed the survey at a location of their choice with a secure internet connection. The questionnaire took approximately 5 minutes to complete. All data was identified prior to analysis. Data was collected for academic purposes only.

To address the hypotheses, we focused our analysis on the impact of carbon trading policies on consumers' new energy motor vehicle purchase decisions. Chi-square analysis is utilized to examine the relationship between the two variables.

4. RESULT

As shown in Correlation analysis (the Table. 2), understanding the carbon trading market is not significantly correlated with the likelihood of purchase ($r=0.128$, Sig>0.05). The chi-square test results (seen in Table. 3) showed that there was no significant correlation between the degree of urban development and the likelihood of purchase (P>0.05). The chi-square test results in Table. 4 exhibit that there is a significant correlation between urban development and environmental awareness (P<0.05).

Table 2. Correlation analysis 1.

		Purchase possibilities
Learn about the carbon trading market	Pearson correlation coefficient	.128
	Sig. (Two-tailed)	.137

Table 3. Chi-square test for urban development and the likelihood of purchase

Possibility	0%	20%	40%	60%	80%	100%
village	2	2	0	3	0	2
County-level city	6	1	4	2	2	5
Third-tier cities	3	4	4	2	1	5
Second-tier cities	13	10	6	2	2	5
First-tier cities	10	5	8	10	2	5
Super first-tier cities	4	1	3	1	0	2
X^2			22.108			
P			0.629			

Table 4. Chi-square test for urban development and environmental awareness

	It's okay if it's not	Slightly eco	Generally environmentally friendly	More environmentall	Very eco
villa	1	0	0	1	7
Cou	1	4	3	6	6
Thir	1	1	1	7	9
Sec	1	3	9	22	3
First	4	2	7	19	8
Sup	0	1	2	5	3
X^2		35.232			
P		0.019			

According to the Correlation analysis in Table. 5, a significant positive correlation appears between the degree of expectation of the purchase policy and the likelihood of purchase (r=0.382, Sig<0.05).

Table 5. Correlation analysis 2.

		Purchase possibilities
The level of anticipation of the purchase policy	Pearson correlation coefficient	.382**
	Sig. (Two-tailed)	.000

5. CONCLUSIONS

In summary, this study aims to further analyse the impact of carbon emissions trading policies on consumers' decisions to purchase new energy vehicles. According to the correlation analysis, consumers' understanding of the carbon trading market has no significant correlation with the purchase possibility, and the degree of expectation of the purchase policy has a significant positive correlation with the purchase possibility. According to the chi-square test, the degree of urban development has no significant correlation with purchase possibility but has a significant correlation with environmental protection awareness.

On the basis of empirical analysis, the social demographical information of consumers filled in the questionnaire can be obtained first, including annual income, from which the consumption level of consumers can be inferred. In addition, the questionnaire question is to investigate the consumer's understanding of the background of new energy vehicles. Not only just let consumers assess their own knowledge of carbon trading, but also verify it. In questions 11 to 13, the questionnaire asked about the number of carbon emissions exchanges. At the same time, the survey questions are also designed step-by-step, from basic background to understanding of carbon trading, and finally to environmental and personal needs. In general, the questions of this questionnaire are relatively novel and comprehensive. However, the problem that still need to be solved is that there are a few areas (locations) involved, since the personal IP address are accumulated in Shaanxi and Hebei, with a small amount in Shandong and Fujian. To make the experiment more accurate, it is necessary to expand the area involved and increase the total quantities of questionnaires.

The energy transition is the direction of China's future development, which will have a bright future as a new energy vehicle that saves emissions and energy. New energy vehicles under the "carbon neutrality" policy is bound to make different adjustments in the face of different consumers. However, after this study, the consumer purchase level has a positive relationship with the subsidy policy, and the purchase level has no obvious relationship with carbon trading. On this basis, the current consumers have very high requirements for new energy vehicles, and the price will be more inclined to subsidies.

The future of new energy vehicles represents the prospect of energy transformation. The era of the future development of mankind relying on mineral energy has come to an end. Studying the purchase prospects of new energy vehicles has far-reaching significance in China's development, which both promotes the upgrading of the industry and protect the environment. These results offer a guideline for optimizing new energy vehicles, improving the confidence of human beings in the development of new energy vehicles, and accelerating changes in the energy structure of the country.

AUTHORS' CONTRIBUTIONS

These authors contributed equally.

REFERENCES

[1] S. Li, G. Zhu, Analysis on the path of energy transformation under the vision of "dual carbon", 2021. DOI: 10.15937/j.cnki.issn 1001-8263.2021.12.006.

[2] T. Li, W. Li, J. He, The development status of the international carbon trading market and the prospect of my country's carbon trading market, Economic aspect, 2010(07). DOI: 1007-7685(2010)07-0076-05.

[3] K. Jing, Mechanism design and international comparative study of China's carbon trading market [D], Nankai University, 2014. DOI: https://cdmd.cnki.com.cn/Article/CDMD-10055-1015531349.htm

[4] D.n LI, Research on countermeasures for the development of my country's new energy vehicle industry under the background of low carbon economy, Economic aspect, 2011. DOI: http://25798422.s21d-25.faiusrd.com/61/ABUIABA9GAAg_puY-gUo7L6cVA.pdf

[5] Y. Cheng, Research on optimization of automobile supply chain operation decision under low-carbon policy, Beijing Jiaotong University, 2018. DOI: https://cdmd.cnki.com.cn/Article/CDMD-10004-1018316236.htm

[6] X. Li, Car companies show new energy "transcripts" in 2021: Tesla's global deliveries exceed 930,000 vehicles, and "Wei Xiaoli" is approaching the 100,000-vehicle mark, 2021. DOI:

http://finance.eastmoney.com/a/202201062237940532.html

[7] G. Xu, F. Xu, Research on Influencing Factors of New Energy Vehicle Purchase Decision, China's population resources and environment, 2010. DOI: http://www.cqvip.com/qk/97796x/201011/358592 51.html

[8] G. Cao, J. Yang, Evolutionary game research on consumers' purchase behavior of new energy vehicles under the incentive of government subsidies, Chongqing University, 2016. DOI: http://manu37.magtech.com.cn/Jwk_jjwtts/CN/abstract/abstract67.shtml.

[9] Y. Wang, Y. Li, An empirical study on consumers' willingness to purchase new energy vehicles based on perceived risk and involvement, East China University of Science and Technology School of Business, 2013. DOI: http://www.cqvip.com/qk/90703x/201305/47076181.html

[10] W. Wang, S. Zhu, International Climate Change Negotiations: Path Trends and China's Strategic Choices, China's population, resources and environment, 2013(09) DOI: https://www.efchina.org/Attachments/Report/report-lceg-20210207-2-zh/