The Impact of Environmental Policy Tools on Public Low-Carbon Travel in Xi'an

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Abstract: The realization of double carbon goal in China is a hot issue by means of promoting the public's low-carbon travel. In order to analyze the impact of environmental policy tools in Xi'an on public low-carbon travel behavior through a questionnaire survey, this paper proposes the hypothesis that environmental policy tools affect public low-carbon behavior, the 362 samples data show that: the high policy response of voluntary tools is conducive to improving the enthusiasm of the public to participate, and the economic incentive tools affect the cost and benefit of the public's travel choices and command-type policy tool mainly constrain the public's traffic travel rules. Environmental policy tools are an important mechanism to guide the public to choose low-carbon travel. Focusing on clear rules and regulations, flexible incentives, and smooth government-civilian interaction, it promotes the coupling of public low-carbon travel and the "dual-carbon" goal, and strengthens the public's green environmental protection.

1. Introduction

As a populous country in the world, China has increasingly prominent environmental problems in the field of living consumption. Promoting green lifestyle and reducing carbon emissions in the field of consumption, especially reducing energy consumption in the field of transportation, are conducive to the realization of carbon neutrality. Transportation is an important part of public life, and choosing a low-carbon and environmentally friendly way of travel is the requirement of the carbon-free era. The effective implementation of low-carbon policies and green travel plans depends on the subject behavior of the public, and the public's recognition and implementation of green travel is an important guarantee to ensure the effect of low-carbon environmental policies. Therefore, exploring the impact of low-carbon environmental policies on public low-carbon travel behaviors can be used as one of the references for policy evaluation. According to the characteristics of public travel behavior, the public can be guided to choose green travel in a targeted way to enhance the sense of identity and happiness of green travel.

2. Literature review

2.1. Low-carbon Travel Behavior

With the continuous expansion of the field of environmental protection, the connotation and dimension of green consumption have been enriched and improved. Traditional green consumption behavior refers to a series of measures taken to avoid resource loss and environmental pollution [1]. Existing studies equate green consumption with the purchase of green products, ignoring the greening of consumption process and consumption concept [2]. With the development of the digital economy era, green consumption behavior should not be confined to the exclusive enjoyment of individuals, and a new type of green consumption should be realized through sharing [3]. Some scholars have emphasized that China's current environmental policies pay less attention to carbon emissions in public consumption, and low-carbon consumption in housing and transportation cannot be ignored [4]. As an important part of the public's green consumption behavior, low-carbon travel plays an important role in guiding consumers to choose green and environmentally friendly travel modes to achieve the goal of "carbon peak and carbon neutrality".

According to the research of Geng Jichao, the public's low-carbon travel behavior involves the choice of travel mode, the purchase of transportation means, the driving behavior and the choice of residence. Travel behavior is affected by subjective factors and objective factors. Subjective factors include psychological variables and group variables, and objective factors generally refer to all conditions outside psychological indicators [5]. Domestic scholars have a wealth of research on factors affecting public travel behavior, using theoretical bases including planned behavior theory, value-belief-norm theory [6], social role theory [7], consumer choice theory [8], etc. Qualitative and quantitative research methods were mainly used in the research, and the qualitative research used literature review. The analysis tools of quantitative research included multi-index and multi-cause MIMIC model analysis [9], latent variable structural equation model [10], multiple linear regression model, etc. Model tools were widely used.

2.2. Policy Tools

Policy tools are the means to achieve policy goals, and the design and use of policy tools is a common concern of government agencies and academia. Policy tools are not only an effective means to achieve policy goals, but also a bridge between policy goals and policy results. Lu Zhikui pointed out that the key to policy implementation lies in choosing reasonable policy tools. Ding Huang and Yang Daifu believe that when choosing to use a certain policy tool, it should be targeted based on the operating environment of the policy tool and the characteristics of the policy tool [11]. Chen Zhenming proposed three evaluation criteria for policy instruments, namely effectiveness, efficiency and fairness, which run through the realization of policy objectives. Some scholars pointed out that the combination and utilization of policy tools should consider the sequence. Therefore, each type of policy tool has its own advantages and disadvantages, and its selection depends on the time and situation.

Policy tools into three categories: command-and-control, economic incentive and voluntary. According to this classification, there are three kinds of intervention mechanisms of policy tools. First, mandatory intervention strategies. The public should be included in the public policy agenda to ensure the public's right to participate, know and choose in government decision-making, and to clarify the path of citizen participation. The binding effect of laws will change the original behavioral trajectory of actors to conform to the mandatory rules of the government. Laws and regulations, prohibitions, permission to enter and other means are the specific forms of mandatory policy tools adopted by the government. Second, economic incentive intervention strategy. The

intervention mechanism of economic incentives is mainly realized by changing the benefits and costs of the actors, rewarding and subsidizing the behaviors conducive to environmental protection, reducing the costs of environmental protection behaviors, and encouraging the active practices of the actors. To increase the cost of behaviors that damage the environment by imposing fines, increasing taxes and other charges, the actors may take decisions to avoid losses under economic measurement. Third, the policy feedback of the actors. Perfect infrastructure, effective information services, and interaction channels between the government and the people are all carriers for the use of voluntary policy tools. By improving the policy perception and satisfaction of actors, actors may improve their consciousness and voluntarily cooperate with the implementation of policies.

3. Theoretical Basis and Research Hypothesis

According to the research of Li Shenglan and other scholars, combined with the existing low-carbon travel environmental policies in Xi 'an, this paper divides the environmental policy tools into three categories: command and control, economic incentive and voluntary. Command-and-control tools restrict behavior through laws and regulations, and the subject needs to bear legal responsibility; Economic incentive tools stimulate individual behavior by means of economic means at material level. Voluntary tools improve the enthusiasm of the public to participate in green activities through the channels of influencing hard and soft services, publicity and guidance, and interaction between the government and the people.

Low-carbon life not only affects individual citizens, but also plays a role in protecting social ecology and shaping economic form. To promote low-carbon life, it is necessary to guide the public to change their consumption concepts, identify low-carbon products, and learn more low-carbon actions that individuals can take, so as to promote the transformation of the public from cognition to behavior. According to Geng Jichao's research, this paper defines low-carbon travel behavior as the behavior of the public buying low-carbon transportation, choosing public transportation, and actively participating in the promotion of green culture. The purchase of low-carbon transportation means includes the purchase of new energy vehicles and bicycles; Choosing public transportation includes using buses, subways, shared bikes, walking, etc. Active participation in the promotion of green culture includes participation in thematic publicity activities such as green travel and bus travel, volunteer activities, participation in government public opinion consultation and other interactions.

Existing studies mainly focus on the impact of policy tools on consumers' low-carbon behavior, classify policy tools as the dimension of external objective factors, or analyze the mechanism of action of a specific policy on public travel. For example, the public's perception and attitude towards the traffic restriction policy, and the traffic restriction policy, as an intermediary variable, is an important factor affecting the public's intention to low-carbon travel. They believe that the implementation of low-carbon transportation for consumers should pay attention to hard regulation and soft policy guidance, and the policy will play a role through psychological factors. Some scholars pointed out that the stronger the government subsidy, the more likely consumers are to choose low-carbon consumption, and the choice income is the result of consumer game. To sum up, policy tools can enhance the low-carbon behavior of consumers, but few studies have been conducted on the impact of policy tools on a specific consumption behavior. Low-carbon behavior includes not only selection, purchase, use, disposal, etc., but also various specific consumption fields. Therefore, this paper will study the impact of policy tools on the specific consumption field of the public, that is, low-carbon travel behavior. This paper focuses on the interaction between transportation choice and policy, analyzes the influence of policy tools combined with the action mechanism of policy tools, and provides suggestions for promoting consumers' green travel.

Based on the existing research, this paper proposes the following research hypotheses:

Hypothesis 1: Command-and-control tools constrain low-carbon travel rules for the public.

Hypothesis 2: Economic incentive tools affect the public's choice of transportation for low-carbon travel.

Hypothesis3: Voluntary tools to increase public initiative to promote low-carbon mobility.

Iii. Research design and results.

(1) Questionnaire design

The questionnaire includes three dimensions: sociodemographic characteristics, low-carbon travel behavior and policy tools, and forms a total of 28 questions. Among them, the dimension of policy tools is subdivided into command, economic incentive and voluntary policy tools. Combined with the content of policy tools, it reflects the correlation between public low-carbon travel and relevant policies. A total of 418 questionnaires were collected, of which 56 were invalid and 362 were valid. The statistical recovery rate of valid questionnaires was 86.6%.

(2) Analysis of research results

1). Descriptive statistics

As shown in Table 1, the models purchased by consumers are mainly fuel vehicles, and new energy vehicles account for 13.5% of the total consumption. Travel to work is mainly private cars, followed by public transport. 38.1% of the public are more willing to choose low-carbon travel, believing that low-carbon travel has the role of "reducing air pollution" and "contributing to sustainable development", but 36.2% of the public are not willing to choose public transport instead of private car travel.

Table 1: Description of public low-carbon travel sample 1

		frequency	percent			frequency	percent
Vehicle type	No car	186	51.4	Transportation options	Private car	176	48.6
	Fuel vehicle	127	35.1		taxi	12	3.3
	Oil-electric hybrid	34	9.4		Public transport (subway, bus)	97	26.8
	Pure electric	15	4.1		Company shuttle bus	18	5.0
					Shared car	25	Shared car
					Bicycle/electric car/motorcycle	21	Bicycle/electric car/motorcycle
					On foot	13	On foot

2). Validity and reliability analysis

As shown in Table 2, the KMO index statistic of the combined reliability of variables is greater than 0.7, and there are common factors among the variables, indicating that the selected variables are suitable for factor analysis, and the significance probability value is statistically significant, and the load factor is greater than 0.6, indicating high internal consistency and stability of the scale.

Through the reliability test, the kmo coefficients of the three main components of the policy instrument variables are 0.723, 0.730 and 0.811, respectively, and the reliability coefficient value is greater than 0.70, indicating good reliability of the subscale.

Table 2: Validity test results of measurement items

Variable item	Load factor	KMO	Sig.
A1The government has clear traffic policies and regulations	0.750		
A2 I know about the transportation policy of Xi 'an City	0.695	0.714	0.000
A3 I will abide by Xi 'an motor vehicle restriction policy	0.768		
B1 The purchase subsidy policy of new energy vehicles promotes me to choose new energy vehicles	0.736		
B2 Fluctuations in gas prices affect how often I use my car	0.688	0.701	0.000
B3 Low cost is an important reason why I use public transport	0.730		
C1 Perfect public transportation makes me willing to choose public transportation instead of private car	0.703		
C2 Walking and cycling are good for your health	0.730		
With good traffic conditions in C3 city, I prefer to use a private car	0.727		
The advertising and publicity of C4 new energy vehicles is very comprehensive	0.723	0.745	0.000
C5 I will take the initiative to understand the publicity and policies of green travel	0.779		
C6 I am concerned about the emissions and energy consumption of petrol cars	0.715		
C7 I am willing to join a public welfare group or organization related to green travel	0.787		
C8 I will use the citizen hotline or "Mayor message" and other interactive channels to express travel demands	0.699		
C9 Public and political interaction in the transport sector received responses	0.754		

4. Analysis on the Impact of Policy Tools and Public Low-Carbon Travel Behavior

Table 3: Summary of multiple regression analysis of policy tools on public low-carbon travel behavior

Coefficient [a]										
mold	Nonnormalized coefficient		Standard coefficient	t	Sig.	correlation			Collinear statistics	
	B	Standard error	Beta			Rank 0	partial	section	allowance	VIF
Command-based policy tools	0.38	0.31	0.15	1.14	0.01	0.43	1.16	0.51	0.32	0.27
R= 0.39 R2= 0.31 F=44.57 DW=0.71										
Economic incentive policy tools	2.76	0.32	0.19	8.56	0.00	0.29	1.02	1.31	0.25	0.31
R= 0.361 R2= 0.24 F=58.18 DW=0.69										
Voluntary policy instruments	0.67	0.45	0.24	8.08	0.00	0.48	1.15	0.68	0.21	0.19
R= 0.52 R2= 0.32 F=65.26 DW=0.80										
a. Dependent variable: low-carbon travel behavior										

As shown in Table 3, the significance probability value of the regression coefficient among the three variables shows that the regression coefficient is significant. The tolerance ranges from 0.21 to 0.32, and there is no 0 value, indicating that there is no linear coincidence problem between

variables. VIF value less than 3 indicates that the multivariate collinearity of the independent variable is not obvious. The command-based policy instrument variables could explain 31% of the variation of low-carbon travel behavior variables. Economic policy instrument variables could explain 24% of the variation of low-carbon travel behavior variables. Voluntary policy instrument variables could explain 32% of the variation of low-carbon travel behavior variables. The value of the Dubbin-Watson (DW) statistic is between 0.6 and 0.8, and there is no self-correlation between the error terms.

The standardized regression model can be obtained from the summary table of coefficients:

$$BE_1 = 0.15X_1 + 0.19X_2 + 0.24X_3 \tag{1}$$

Respectively corresponding to command policy tools, economic incentive policy tools and voluntary policy tools. The influence of three types of policy tools on public low-carbon travel behavior is ranked from largest to smallest: voluntary policy tools, economic incentive policy tools, and command policy tools. The three types of policy tools are positively correlated with public low-carbon travel behavior, indicating that the more vigorous the implementation of policy tools, the more positive the public low-carbon travel behavior. The three research hypotheses that command tools restrict the public's low-carbon travel rules, economic incentive tools affect the public's choice of transportation means for low-carbon travel, and voluntary tools improve the public's initiative to promote low-carbon travel have been verified.

Voluntary policy instruments emphasize the subjective consciousness of the public and government service. Low-carbon travel is based on public awareness of the environment, and when the public recognizes the importance of low-carbon and learns more about the low-carbon actions that individuals can take, the public is likely to implement low-carbon actions. With the support of government services, whether the government provides perfect travel selection services, establishes clear signs and guidance, and proactively perceiving and responding to the public's transportation demands will affect the public's low-carbon behavior. Xi 'an government actively absorbs public policy suggestions and responds to public demands. At the same time, the public can adopt various flexible ways to participate in the interaction between the government and the people and respond to travel demands, so voluntary tools have the most obvious effect on the public's low-carbon travel behavior. The command tool is mainly reflected in the choice of public transportation by the traffic restriction policy, which reduces the private car travel on the day of the traffic restriction, and increases the opportunity for the public to use other means of transportation. Most of the public support the traffic restriction policy. Consumers mainly consider the purchase and use cost when buying cars and choosing transportation modes. In terms of self-interest, the higher the subsidy for the purchase of new energy vehicles, the more consumers can be attracted to choose; The consumability and low cost of public transportation are the first choice of most consumers. The price of gasoline also affects how often consumers use their cars. Mandatory control will restrict the travel rules of the public, and a sound traffic laws and regulations system is an effective guarantee to promote low-carbon travel for the public.

5. Conclusion

Public low-carbon behavior will be affected by subjective and objective factors, showing individual differences. The results of questionnaire survey show that the public's perception of low-carbon travel behavior is affected by factors such as individual cognition depth, sense of responsibility and values. Policy tools can provide effective participation channels to guide the public to actively choose low-carbon travel behavior. From the perspective of egoism and altruism, the public can measure the costs and benefits of low-carbon travel behavior. Therefore, the government can provide behavioral guidance tools based on the public's wishes, preferences,

benefits, perceptions, etc., to help the public strengthen environmental awareness and promote green actions.

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