

Research on Low-carbon Household Consumption from the Perspective of Behavioral Economics

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Abstract:

Under the current global background of climate change and the proposal of the “dual carbon” (carbon peaking and carbon neutrality) goals, achieving tangible quantification of green consumption behavior through carbon inclusiveness platforms is the inevitable path for China to build a low-carbon society. Taking Beijing’s carbon inclusiveness platform as an example, this study aims to explore the low-carbon consumption guidance mechanism under the dual carbon goals, and clarify the relationship and mechanism between the perceivability of low-carbon and low-carbon travel consumption behavior. By sorting out the framework system of the case platform and based on the attitude-behavior-situation theory and interpersonal behavior theory, this study further constructs a research model for low-carbon perceivability and low-carbon travel consumption behavior. Specifically, it takes low-carbon perceivability under the carbon inclusiveness platform as the independent variable, low-carbon travel behavior of consumers as the dependent variable, low-carbon cognition as the mediating variable, and economic incentives as the moderating variable, and proposes theoretical hypotheses for three sets of pathway relationships.

Keywords: Low carbon consumption, Low carbon pal-pability, Low-carbon recognition, Economic incentives

1. Introduction

1.1 Research background

Since the Industrial Revolution, human production and lifestyle have undergone significant changes. However, the massive consumption of fossil fuels such as coal, oil, and natural gas has led to a sharp

increase in carbon dioxide emissions, thereby exacerbating the phenomenon of global climate warming. Since the reform and opening-up policy, China’s economy has maintained rapid development and achieved remarkable achievements in a short period of time. Nevertheless, at the same time, the trend of heavy industrialization and the extensive economic growth model have also caused serious climate

warming issues, and the sustainable development of resources and the environment has become increasingly challenging. According to the report titled “Climate Crisis and Response: Physical Risks and Socio-economic Impacts” released by McKinsey, global temperatures have risen by about 1.1 degrees Celsius since the 1880s, and it is predicted that by 2050, the average temperature in most regions of the world will rise by another 1.5 to 5 degrees Celsius compared to the present. The International Energy Agency’s “World Energy Outlook 2021” report points out that as the world economy rebounds strongly from the pandemic, global carbon emissions have reached a new high of 36.3 billion tons, with China’s contribution being as high as one-third, i.e., carbon emissions of approximately 12 billion tons.

Currently, global warming is affecting every corner of the planet, sounding another alarm for addressing climate change. On the one hand, changes in the ecological environment such as rising temperatures, glacier melting, and sea level rise pose a significant threat to human survival. On the other hand, the impacts on economic and social aspects such as food security, energy supply, and infrastructure bring severe challenges to human development. In the new era, the basic characteristic of the development strategies of economic countries is to achieve high-quality economic development. This requires that while achieving industrial transformation and upgrading, climate and environmental issues must be effectively addressed. In other words, pursuing net-zero greenhouse gas emissions is an inevitable choice for addressing the climate crisis and an urgent need for coordinated economic, social, and environmental development.

1.2 Research significance

This study takes Beijing’s Carbon Inclusiveness Platform as an example to explore the low-carbon consumption guidance mechanism under the dual carbon goals. The main research objectives include the following five points. (1) To reveal the current status of Beijing’s Carbon Inclusiveness Platform and low-carbon consumption behavior under the dual carbon goals. By reviewing recent research by domestic and foreign experts and scholars, a literature database related to carbon inclusiveness and low-carbon consumption behavior will be formed. Primary data and information will be obtained through questionnaires, and a systematic exploration of the operational design of Beijing’s Carbon Inclusiveness Platform under the dual carbon goals will be conducted based on case analyses and comparative discussions with other domestic and foreign carbon inclusiveness platforms. An in-depth analysis of the current practice of low-carbon consumption behavior in China will also be conducted.

(2) To evaluate the relationship between low-carbon perceivability under the carbon inclusiveness platform and low-carbon travel behavior of consumers. Based on primary data from questionnaires and using theories such as the attitude-behavior-situation theory and interpersonal behavior theory, a multiple linear regression model will be constructed between low-carbon perceivability under the carbon inclusiveness platform and low-carbon travel behavior of consumers. Starting from the consumer’s perspective, this model will test whether the level of low-carbon perceivability under the carbon inclusiveness platform has an impact on consumers’ travel behavior. Furthermore, based on this, grouped regression will be conducted for people with different income levels to explain the heterogeneity in the relationship between the two.

1.3 Research content and key issues

This article takes Beijing’s Carbon Inclusiveness Platform as an example, approaching it from the perspectives of both the government and residents. By reviewing previous literature and based on first-hand data obtained through questionnaires, it constructs a theoretical model of the Carbon Inclusiveness Platform and conducts empirical research. The article systematically explores the relationship and mechanism between low-carbon perceivability under the Carbon Inclusiveness Platform and the low-carbon travel behavior of consumers.

The key points and difficulties of this research are as follows:

(1) Assessment of the Current Status of Beijing’s Carbon Inclusiveness Platform and Low-Carbon Consumption Behavior in China: Taking Beijing’s Carbon Inclusiveness Platform as an example, this section employs qualitative case analysis to obtain information related to the design framework of the Carbon Inclusiveness Platform from relevant domestic and international literature and materials. Through discussion and comparison, it reveals the current status of Beijing’s Carbon Inclusiveness Platform and low-carbon consumption behavior. Based on this, indicators and variables, as well as a theoretical model, for low-carbon perceivability and travel consumption behavior are established.

(2) Questionnaire Survey on Consumers’ Personal Experiences with the Carbon Inclusiveness Platform and Their Low-Carbon Travel Behavior: With reference to existing literature in domestic and international academic circles, this section seeks out mature measurement scales for the public’s personal experiences and low-carbon travel behavior. Using quantitative questionnaire surveys, it conducts large-scale formal research on users of Beijing’s Carbon Inclusiveness Platform. Reliability and validity tests are performed on the collected questionnaire data

to gather and organize first-hand data related to Beijing's Carbon Inclusiveness and low-carbon consumption behavior.

1.4 Research methods and ideas

(1) Questionnaire survey method

By distributing unified and standardized questionnaires, data collection and current situation investigation are completed, with large-sample surveys and big data collection conducted. Reliability and validity tests are performed on the collected and organized questionnaire data to provide a foundation and guarantee for subsequent empirical research. Taking Beijing's Carbon Inclusiveness Platform as an example, this study distributes questionnaires to consumers through an online platform (it seems there's a mention of "Juanxing Platform" in the original text, which may be a specific online survey platform, but I've translated it generally as "an online platform" here), collecting first-hand data related to the consumers of Beijing's Carbon Inclusiveness Platform. As many effective sample data as possible are collected to ensure the subsequent model testing of the relationship between low-carbon perceivability and travel and consumption behavior.

(2) Empirical research method

Utilize statistical analysis software such as SPSS and STATA to conduct empirical analysis on questionnaire data. Primarily use SPSS to analyze the reliability and validity of the scales, and employ STATA to conduct correlation analysis and regression analysis. The empirical research in this study is based on the results of literature reviews and questionnaire surveys to construct corresponding economic models.

1.5 Innovation and feasibility analysis

Based on a review and analysis of existing literature, it can be found that current research by scholars at home and abroad primarily focuses on the influencing factors of low-carbon consumption behavior and the basic connotations of carbon inclusiveness. Under the "dual carbon" goals, research on the relationship and mechanism between low-carbon perceivability under carbon inclusiveness platforms and low-carbon travel behavior of consumers has started relatively late, with significant differences in research methods and a lack of relatively unified conclusions. Therefore, this study builds on existing academic research results to conduct in-depth exploration and expansion of the relationship and mechanism between low-carbon perceivability and travel consumption behavior, striving to supplement the existing deficiencies or unaddressed areas in current research.

2. Literature review

2.1 Low-carbon consumption behavior

Low-carbon economy is a combination of "three lows" - low energy consumption, low emissions, and low pollution - with "three highs" - high efficiency, high productivity, and high benefit. Through institutional innovation, technological development, industrial upgrading, and other means, it aims to minimize the consumption of energy resources such as coal and oil, thereby significantly reducing carbon emissions. It represents a socio-economic development model that achieves greater economic output with lesser environmental costs. Therefore, the low-carbon economy is considered a concept derived from the concept of sustainable development. By promoting low-carbon production and consumption patterns, it aims to achieve a win-win situation for economic and social development and ecological environmental protection. It is an inevitable choice for human society in response to global climate change.

2.2 The theoretical basis of low-carbon consumption behavior

(1) Theory of Reasoned Action (TRA)

In 1975, American scholars Ajzen and Fishbein first proposed the Theory of Reasoned Action (TRA). They explored the relationship among attitude variables, behavioral intention, and behavior, believing that the behavioral attitude and subjective norm of the behavioral agent jointly influence behavioral intention, which in turn can predict an individual's actual behavior with relative accuracy.

Specifically, behavioral attitude refers to the behavioral agent's main beliefs about a specific behavior, combined with an evaluation and assessment of the behavior's outcomes, leading to positive or negative attitude variables toward that specific behavior. Subjective norm is the perceived pressure on the behavioral agent to perform a specific behavior, which may originate from influential individuals or groups, social values, or social ethics. Behavioral intention is the mental inclination or behavioral intent that the behavioral agent possesses before engaging in a specific action.

(2) Theory of Interpersonal Behavior

In 1977, social psychologist Triandis proposed the Theory of Interpersonal Behavior, which is a comprehensive behavior model integrated on the basis of existing research. The Theory of Interpersonal Behavior comprehensively considers the influencing factors of behavior from both internal and external perspectives, including behavioral intention, behavioral habits, and facilitating conditions. Specifically, in terms of behavioral intention, behavioral

attitude, social factors, and emotional factors have a direct impact on it. Behavioral attitude refers to the specific perception held towards the outcome of a behavior, which is influenced by the assessment and judgment of that outcome. Social factors have three antecedents: norms, roles, and self-concept. They refer to the behavior subject constraining their behavior in accordance with a certain role and social norms to realize their own ideas. Emotional factors refer to the positive or negative emotions of the behavior subject, encompassing different degrees of emotional response.

2.3 Influencing factors of low-carbon consumption behavior

The Theory of Interpersonal Behavior provides a framework for understanding the influencing factors of low-carbon consumption behavior. By considering behavioral intention, behavioral habits, and facilitating conditions, as well as the role of internal and external factors, this theory can help explain why individuals choose to engage in low-carbon consumption behaviors or not.

3. Research and design

3.1 Hypothesis put forward

From the case studies and comparative discussions of the carbon inclusiveness platform, we can observe that, against the backdrop of achieving the dual carbon goals and implementing the carbon inclusiveness system, consumers' low-carbon travel and consumption behaviors (Green) can be converted into certain carbon credits through the specific methodology of the Beijing Carbon Inclusiveness Platform, enabling consumers to personally perceive the tangibility of low-carbon behaviors and green lifestyles. Based on this, the following hypotheses are constructed in this study.

Hypothesis 1a (H1a): There is a positive correlation between the tangibility of low-carbon on the Beijing Carbon Inclusiveness Platform and consumers' low-carbon travel behaviors. That is, an increase in the level of tangibility of low-carbon on the Beijing Carbon Inclusiveness Platform can significantly enhance consumers' low-carbon travel behaviors.

Hypothesis 1b (H1b): The impact of the level of tangibility of low-carbon on low-carbon travel and consumption behaviors will show heterogeneous results when grouped by different income levels of consumer groups. That is, compared to low-income consumers, an increase in the level of tangibility of low-carbon perceived by users of the Beijing Carbon Inclusiveness Platform will have a stronger positive effect on promoting low-carbon travel

behaviors among high-income consumers.

Hypothesis 2 (H2): In the influence of low-carbon tangibility on low-carbon travel and consumption behaviors, low-carbon cognition plays an intermediary role. That is, the low-carbon tangibility under the Beijing Carbon Inclusiveness Platform can affect consumers' low-carbon travel and consumption behaviors by influencing their internal mechanism of low-carbon cognition.

Hypothesis 3 (H3): In the correlation between low-carbon tangibility and low-carbon travel and consumption behaviors, economic incentives play an interactive moderating role. That is, under different levels of economic incentives, the low-carbon tangibility under the Beijing Carbon Inclusiveness Platform will be converted into low-carbon travel behaviors by consumers to varying degrees of significance.

3.2 Questionnaire design

The questionnaire used in this study is composed of three parts.

First of all, in order to avoid the sense of difficulty and emptiness brought to the subjects by the set questions, this study defines the concept of Beijing Tanpuzai platform during the research. The carbon HP platform in Beijing includes Beijing MaaS platform, 2022 Beijing Green Life Season, low-carbon leader plan, etc. For example, the MaaS platform promoted by Beijing Municipal Transportation Commission and Gaode Map, after the public registered and participated through Gaode Map App, when choosing green outbound navigation such as public transportation, subway, cycling and walking, That is, it can accumulate individual carbon emission reduction, get carbon points, and can be exchanged for commercial rights such as public transport vouchers, N-station M coupons, or it can be used to support public interests such as planting trees and afforestation, and protecting endangered animals and plants.

Furthermore, the main body of the questionnaire consists of 4 subscales. The first part measures consumers' perceived tangibility of low-carbon behaviors on Beijing's Carbon Inclusiveness Platform, specifically the timely "cash-out" of low-carbon behaviors and the "visible and tangible" benefits of green living, encompassing a total of 3 items. The second part investigates consumers' low-carbon travel behaviors to obtain information on their commuting methods, travel methods during holidays, and travel methods over the past month, with a total of 3 items. The third part measures consumers' low-carbon cognition variables, exploring their low-carbon knowledge, perception, emotions, attention, evaluation, and sense of responsibility, comprising a total of 6 items. The fourth part measures the economic incentive variables of the Carbon

Inclusiveness Platform, discussing the platform’s economic incentive measures from the perspectives of monetary benefits and psychological benefits, with a total of 2 items.

Finally, the fifth part measures control variables, namely sociodemographic factors, with a total of 8 items.

Table 1 The Structure of the Scale

Variable category	Research variables	Variable dimension	Questions
Explanatory variable	Low carbon touchability	Low carbon touchability	Q1.1-Q1.3
Explained variable	Low carbon travel consumption behavior	Low carbon travel consumption behavior	Q2.1-Q2.3
Intermediary variable	Low carbon awareness	Low carbon knowledge Low carbon perception Low carbon emotions Low carbon concern Low carbon evaluation price Sense of Low Carbon Responsibility	Q3.1-Q3.6
Adjusting variables	Economic incentives	Economic incentives	Q4.1-Q4.2
Control variable	Social population Statistical factors	Gender Age Occupation Marital Status Education Level Monthly Average Income per Capita of Household Vehicle Ownership Usage of Beijing’s Carbon Inclusiveness Platform	Q5.1-Q5.8

3.3 Model building

To investigate the direct impact of the level of low-carbon tangibility on low-carbon travel and consumption behaviors, based on the construction of indicators for low-carbon tangibility and low-carbon travel and consumption behaviors, this study establishes a basic econometric model, specifically as follows:

$$\text{Green} = \alpha_0 + \alpha \text{Tangibility}_i + \beta X_{ij} + E_i \quad (1-1)$$

where Green represents consumer i’s low-carbon travel and consumption behaviors; Tangibility represents the low-carbon tangibility personally perceived by consumer i; X represents various control variables that may affect low-carbon travel and consumption behaviors; E_i is the random disturbance term; α and β represent the impact on Green of changes in the corresponding explanatory variables when other conditions remain unchanged, i.e., a one-unit change in this factor will result in a change of α or β units in low-carbon travel and consumption behaviors.

In traditional research exploring the mechanism between explanatory variables and explained variables, the methods of mediation effect and moderation effect have always been commonly used. Existing theories and research have also found that low-carbon cognition may affect the effect of low-carbon tangibility on low-carbon travel behavior. Therefore, this study analyzes this influence channel.

In other words, the impact of the explanatory variable, low-carbon tangibility, on the explained variable, low-carbon travel behavior, can not only occur directly but also indirectly through the mediator of low-carbon cognition. In other words, we can consider that the influence of low-carbon tangibility on low-carbon travel behavior arises through two channels: one is the direct influence of low-carbon tangibility on low-carbon travel behavior, and the other is through the mediation channel, where low-carbon tangibility affects low-carbon cognition and subsequently influences low-carbon travel behavior.

$$\text{Green} = \alpha_0 + \alpha * \text{Tangibility}_i + \sum \beta_j * X_{ij} + E, \quad (2-1)$$

$$\text{Awareness} = a * \text{Tangibility}_i + \sum \beta_j * X_{ij} + E_i, \quad (2-2)$$

4. Data analysis and hypothesis verification

4.1 Questionnaire distribution and collection

This study officially distributed questionnaires in February 2023. Over the course of about a week, a total of 509 questionnaires were collected, and the collected questionnaires were screened and checked to improve the quality of the sample data. Firstly, all invalid samples from non-Beijing residents were excluded, such as

questionnaires where the respondent selected “no” on the identification item or had an IP address not within Beijing. Secondly, unqualified samples with obvious answering issues were excluded, such as questionnaires with obviously contradictory answers to previous and subsequent items, excessively short answering time, or completely identical answers to all items. After the above processing, 459 sample data were finally obtained, with an effective recovery rate of 90.17% for the questionnaires. The sample size is relatively adequate for statistical analysis.

4.2 Reliability and validity test of the scale

Reliability testing, also known as data reliability testing, refers to the consistency and stability of the results ob-

tained when the same method is used to measure the same respondent repeatedly. Currently, the academic community commonly adopts the Cronbach’s Alpha reliability coefficient, also known as CronbachsAlpha reliability coefficient, to measure the internal consistency of a particular variable. This coefficient ranges from 0 to 1, and when it is closer to 1, it indicates that the internal consistency of the items in the scale is higher, and the questionnaire is more stable.

If the Cronbach’s Alpha reliability coefficient is above 0.7, it indicates that the reliability and internal consistency of the scale are relatively good. If the Cronbach’s Alpha reliability coefficient is below 0.5, the reliability of the scale is poor, and significant revisions are needed.

Table 2. Reliability Test Results of the Low-Carbon Tangibility Scale

Variable	Questionnaire Item	Cronbach’s Alpha (After Item Deletion)	Cronbach’s Alpha (Based on Standardized Items)	Alpha
Q1.1	(Item related to “Low-Carbon”)	0.782	0.844	0.844
Q1.2	(Item related to “Tangibility”)	0.754	0.844	0.844
Q1.3	(Next item in sequence)	0.811	0.844	0.844

The reliability test results for the low-carbon tangibility scale are shown in the table above. In general, the Cronbach’s Alpha reliability coefficient of the subscale is 0.844, which is higher than 0.8. At the same time, the Cronbach’s Alpha reliability coefficient of the subscale after deleting each item is less than that of the original subscale, indicating that it is not necessary to delete any items. This sug-

gests that the results measured by the low-carbon tangibility subscale have good internal consistency and stability, and can pass the reliability test.

Validity refers to the consistency and degree of agreement between the results obtained through a tool or method and the research topic it is intended to reflect.

Table 3. KMO Test and Bartlett’s Test of Sphericity for the Low-Carbon Tangibility Scale

KMO Measure of Sampling Adequacy		0.723
Bartlett’s Test of Sphericity	Approximate Chi-Square	570.183
	Degrees of Freedom	3
	Significance	0.000

4.3 Descriptive statistical analysis

Table 4. Descriptive Statistical Analysis Table of Sociodemographic Variables

Variable	Category	Frequent (N)	Percentage (100%)
gender	male	249	54.25
	female	210	45.75
age	under 18	31	6.75
	19-30	161	35.08
	31-44	143	31.15
	45-59	94	20.48
	over 60	30	6.54

occupation	public institutions, and state-owned enterprise staff	81	17.65
	personnel in the fields of education, scientific research, and healthcare	50	10.89
	professional and technical personnel	60	13.07
	personnel in commerce, services, and sales	56	12.20
	operators of production and transportation equipment and related personnel	49	10.68
	freelancers	31	6.75
	students currently enrolled in school	43	9.37
	homemakers	33	7.19
	retired personnel	23	5.01
	others	33	7.19

In summary, based on the overall response situation of the sample, the survey participants cover a wide range and have a reasonable distribution in terms of gender, age, occupation. This can provide a universal sample basis for the subsequent empirical analysis. Meanwhile, the survey participants are basically consistent with the actual demographic characteristics of Beijing residents, making the case study of the Beijing Carbon Inclusive Platform in this study have a certain degree of representativeness.

4.4 Empirical results

To test the Hypotheses, which examines the correlation between low-carbon accessibility under Beijing's Carbon Inclusive Platform and the low-carbon travel behavior of consumers, this study employs a multiple linear regression model to perform regression on model (1-1). After conducting a Variance Inflation Factor (VIF) test, the VIF values of all variables in the model are less than 2, with an average VIF of 1.08, indicating that there are no issues of multicollinearity among the variables.

Table 5. The regression results of low-carbon touchable intelligence and low-carbon travel consumption behavior

	(1) green	(2) green	(3) green
tangibility	0.5015***	0.5095***	0.5095***
	(12.2933)	(12.4464)	(13.1323)
gender		0.1136	0.1136
		(1.2831)	(1.2706)
age		0.0146	0.0146
		(0.3303)	(0.3325)
job		0.0225	0.0225
		(1.3232)	(1.4000)
marriage		-0.2403***	-0.2403***
		(-3.1194)	(-2.8901)
education		-0.0109	-0.0109
		(-0.2779)	(-0.3062)
income		0.0318	0.0318
		(0.8173)	(0.9082)
car		-0.0087	-0.0087
		(-0.1732)	(-0.1736)
use		0.0180	0.0180
		(0.1975)	(0.1974)
_cons	1.7206***	1.6585***	1.6585***
	(11.4793)	(4.3025)	(4.3031)
N	459	459	459

The benchmark regression results fully demonstrate Hypothesis 1a, which states that an increase in the level of low-carbon tangibility under Beijing's Carbon Inclusive Platform can significantly enhance consumers' low-carbon travel behavior. From the regression coefficients of "Tangibility", it has been consistently significant and positive at the 1% level, indicating that an increase in low-carbon tangibility has a positive promotional effect on consumers' low-carbon travel behavior. Column (1) shows that for every one-unit increase in low-carbon tangibility, low-carbon travel consumption behavior increases by 0.5015 units. Columns (2) and (3) indicate that for every one-unit increase in low-carbon tangibility, low-carbon travel consumption behavior increases by 0.5095 units.

5. Conclusion

The descriptive statistical analysis of the sample shows that the survey participants cover a wide range and have a reasonable distribution in terms of gender, age, occupation, marital status, education level, monthly per capita household income, vehicle ownership, and usage of the Beijing Carbon Inclusive Platform. These characteristics are basically consistent with the actual demographic statistics of Beijing residents, making the subsequent research on the Beijing Carbon Inclusive Platform in this study have a certain degree of authenticity and representativeness.

With the aim of confirming the existence of a moderating effect, this study selects the economic incentive variable as the moderating variable and employs a multiple linear regression model incorporating interaction terms. The

results show that economic incentives have a positive moderating effect, thus validating the Hypotheses. This means that at different levels of economic incentives, the low-carbon tangibility under Beijing's Carbon Inclusive Platform translates into low-carbon travel behavior by consumers to varying degrees of significance. The underlying reason may be that due to the positive guiding role of economic incentives, Beijing residents are better able to personally perceive the low-carbon tangibility of Beijing's Carbon Inclusive Platform and are more willing to engage in low-carbon travel behavior.

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