Trends in Social Sciences and Humanities Research
ISSN: 2959-9938
DOI: 10.61784/tsshr3071

HOW POPULATION MOBILITY SHAPES CLIMATE BEHAVIOR: MECHANISMS AND EVIDENCE FROM CHINA'S FLOATING POPULATION

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Abstract: This paper explores the impact mechanisms of population mobility on climate behavior. Based on survey data derived from telecommunications big data, it employs a path analysis model and a logistic regression model to examine the characteristics of the floating population regarding energy conservation, emission reduction, resource conservation, green travel, and other climate behaviors. Additionally, it investigates the mediating roles of climate cognition and economic rationality in climate behavior decisions. The results show that the floating population is more inclined toward climate-friendly behavior patterns than the local population, and population mobility can promote climate mitigation behavior both directly and indirectly. The floating population exhibits heterogeneity in different climate mitigation behaviors, and climate cognition partially explains the differences in these behaviors. However, even after controlling for climate cognition, the floating population remains more proactive in energy conservation, emission reduction, resource conservation, and green travel. The floating population considers the balance between economic and environmental factors in climate behavior decisions, and the mediating roles of climate cognition and economic rationality constitute the mechanisms through which population mobility impacts climate behavior. This paper has theoretical and practical value for understanding the intrinsic link between population mobility and climate change, as well as for promoting low-carbon emission reduction participation across society.
Keywords: Population mobility; Climate behavior; Impact mechanisms

1 INTRODUCTION

Climate change is currently the most pressing global environmental issue[1]. As one of the largest developing countries in the world, China has submitted its Nationally Determined Contributions document to the Secretariat of the United Nations Framework Convention on Climate Change, pledging to reach peak emissions by around 2030 and striving to achieve carbon neutrality by 2060. China's "dual carbon" goal is a policy-driven climate action plan[2]. This requires policymakers to balance social, economic, and environmental effects while considering public values[3]. To achieve this goal, the Chinese government explicitly stated: "Unite the consensus of the whole society, advocate green low-carbon lifestyles, and accelerate the formation of a good pattern involving everyone's participation."

Currently, the number of China's floating population has reached 376 million, accounting for about one-fifth of the total population and approximately one-quarter of the labor force. The influence mechanism of the floating population on climate behavior is complex, as they are both participants and stakeholders in climate actions. With the continuous growth of the floating population, studying their climate behavior characteristics and revealing the influence mechanisms of population mobility on climate behavior provides a theoretical basis for formulating and implementing effective climate policies. This research aims to deliver accurate policy foundations for advocating public emission reduction and promoting low-carbon green consumption.

Therefore, this paper aims to explore the influence mechanisms of population mobility on climate behavior to provide policy references for China's carbon peaking and carbon neutrality goals. This study will utilize big data analysis and questionnaire surveys, focusing on the living and working environments, values, and consumption habits of the floating population, and exploring their impacts on climate behavior. It is hoped that the results of this study will offer an important theoretical foundation for formulating and implementing climate policies, thereby promoting public emission reduction and low-carbon green consumption.

2 LITERATURE REVIEW

Addressing climate change and implementing "dual carbon" actions represent a nascent field in environmental research, lacking a fully mature theoretical framework. Climate change, as a specific environmental phenomenon, necessitates further exploration and enhancement of existing environmental science theories to improve their applicability in studying the relationship between population dynamics and climate change. This paper focuses its literature analysis on the relationship between population migration, mobility, and environmental/climate change, exploring the intrinsic links and theoretical logic connecting population mobility and climate behavior, while identifying the theoretical gaps and empirical dilemmas that persist in this area.

Research on the relationship between population migration and climate change reveals two distinct value orientations. The first is the population-environment-friendly theoretical perspective, which posits that the consumption patterns and environmental awareness of mobile populations or migrants tend to be more climate-friendly compared to those of local populations in developed areas. Their environmentally friendly behaviors, particularly in energy conservation, waste reduction, and low-carbon travel, are more pronounced[4-6]. Conversely, the second perspective suggests that mobile populations or migrants may be more inclined to tolerate poorer working and living conditions for economic benefits such as higher wages. This leads to their excessive concentration in impoverished communities or environmentally degraded areas, suggesting that the empirical relationship between mobile populations and environmental/climate change should not be interpreted as a straightforward causal link[7,8].

The theoretical interpretation of the relationship between population pressure and environmental degradation remains contentious, with arguments emphasizing that economic, technological, consumption, and urbanization factors are the primary drivers of environmental degradation under population pressure[9]. Existing empirical evidence is insufficient to substantiate the view that population mobility or migration directly leads to environmental degradation[10]. Furthermore, the impact of population mobility on climate behavior is influenced by various factors, including social, economic, cultural, and institutional elements, indicating that no single theory can comprehensively explain this relationship. Necessary empirical research focused on specific regions, time periods, and populations holds both theoretical and practical significance.

In summary, climate change as an environmental event entails theoretical controversies regarding the population-environment relationship within the realm of migration and climate behavior research. The impact of population mobility on climate behavior is shaped not only by diverse factors such as society, economy, culture, and institutions but also requires more empirical studies for support and clarification. In-depth research on the relationship between population mobility and climate change will facilitate a better understanding of climate change impacts and promote sustainable development in the population-environment nexus.

3 RESEARCH HYPOTHESIS

The socio-economic environment and characteristics of population migration in China differ significantly from those in Western countries and historical contexts. Migrant populations adapt their lifestyles to the changing socio-economic landscape to better integrate into society. These selective and adaptive traits lead migrants to exhibit environmentally friendly tendencies, which, in turn, encourage them to adopt climate-friendly behaviors.

Based on existing theoretical perspectives and empirical research, the selective and adaptive characteristics of migrant populations result in their inclination toward environmentally friendly cultural concepts, psychological identification, and behavioral patterns. Consequently, they are more likely to choose low-carbon lifestyles[5]. The consumption patterns of migrant populations are influenced by environmental factors and economic conditions, leading them to select more environmentally friendly modes of transportation[11] and exhibit lower carbon emissions[6]. Furthermore, migrants' awareness and attitudes toward climate-friendly behaviors significantly impact their willingness to accept and support relevant policy measures[12,13].

In summary, this study hypothesizes that migrant populations demonstrate a preference for climate-friendly behaviors, and their selective and adaptive characteristics make them more inclined to adopt environmentally friendly lifestyles and transportation modes. This research hypothesis is crucial for understanding the intrinsic mechanisms underlying the relationship between population migration and climate change, and it provides both theoretical and practical support for achieving China's carbon peaking and carbon neutrality goals.

4 DATA AND METHODS

4.1 Data Description

This paper utilizes online survey data derived from the telecommunications big data of the Shenzhen Social Science Key Research Base's project titled "Research on the Socio-economic Impact and Implementation Path of Carbon Peaking and Carbon Neutrality in Megacities." The micro-level individual information related to climate change concepts, attitudes, and behaviors originates from this data source.

The survey plan is as follows: First, Beijing, Shanghai, Guangzhou, and Shenzhen are selected as survey cities to adequately represent climate change-related issues in megacities. Second, the representative sample consists of permanent residents aged 18 or older, with a target sample size of 2,000 individuals (approximately 500 per city) to ensure broad coverage. Third, random sampling is conducted using telecommunications big data, focusing on mobile phone users who experienced signal roaming locally at least once a week during the six months preceding the survey, defining those active locally every week in that timeframe as permanent residents. Fourth, to enhance the response rate of the online survey, a telecommunications service provider is commissioned to send survey invitations on behalf of the researchers, including information about the survey's purpose, significance, the questionnaire app, and confidentiality clauses. Fifth, the online survey commenced in June 2021, with text messages dispatched to potential respondents until the target sample size was reached. Lastly, 200 respondents were randomly selected from the collected samples for telephone callbacks to verify the reliability and validity of the questionnaire.

The survey questionnaire includes dependent variables, independent variables, and control variables necessary for this study. Climate change-related issues are measured using a Likert scale, where respondents indicate their level of agreement with climate change issues. Specifically, the scale ranges from 1 to 5, with 1 representing "strongly disagree" and 5 representing "strongly agree." Additionally, the respondent's household registration location serves as an indicator of migrant status, while demographic, social, and economic factors constitute the control variables.

To mitigate systematic errors, respondents are informed in advance that they are participating in a survey on social issues, without disclosing its focus on climate behavior, thus controlling for selective participation. A summary assessment of the survey results reveals that 8,032 text messages were sent, yielding a response rate of 24.90%. Following a logicality check, 1,992 valid questionnaires were obtained, with a callback accuracy rate of 98.69% when comparing the callback survey results with the retrieved questionnaires.

4.2 Dependent Variables

In this study, voluntary behaviors characterized by environmental and low-carbon attributes in respondents' daily lives are collectively referred to as climate mitigation behaviors. Regarding question design, the survey inquires whether respondents have engaged in specific behaviors in the past, rather than their expectations for future actions, to more accurately reflect actual behavior and reduce self-reporting bias[14].

Respondents self-report their response levels based on question statements, indicating that a higher value corresponds to a higher response level. Table 1 details the content of the climate concepts and behaviors questions, including classifications, question statements, scoring methods, response levels, and the associated concepts for each question.

Table 1 Description of Climate Behavior Question Items

	Questions	Concepts
Climate Concepts (A)	A1. Do you think that climate change is now or will have adverse effects on us in the future?	Climate Concern
	A2. Do you think society can make a positive contribution to addressing climate change?	Social contribution to mitigating climate change
	A3. Do you think individuals can make their own contributions to addressing climate change?	Individual contribution to mitigating climate change
	1. Strongly disagree; 2. Disagree; 3. Don't know; 4. Agree; 5. Strongly agree	Likert scale values
Climate Mitigation Behavior (B)	In the past year, have you taken any of the following daily actions to mitigate climate change:	
	B1. Waste sorting	Waste sorting
	B2. Reduce household energy consumption	Energy saving and emission reduction
	B3. Reuse of water, shopping bags, etc.	Resource conservation
	B4. Change transportation mode due to carbon emission reasons (bus, carpooling, etc.)	Green travel
	B5. Change travel destination due to carbon emission reasons	Long-distance travel
	1. Strongly disagree; 2. Disagree; 3. Don't know; 4. Agree; 5. Strongly agree	Likert scale values

Table 2 is a summary statistical description of climate-related concepts and behavior questions, as well as a consistency test between the migrant population and the local population. The results show that the approval rate for climate-related concept questions is between 70% and 99%, and the approval rate for the migrant population is higher, with similar conclusions in related studies. The approval rate for climate mitigation behaviors varies greatly, with a lower approval rate for long-distance travel and a higher approval rate for energy-saving and emission reduction. Overall, the approval rate of the migrant population for the issues involved is higher than that of the local population, and the difference in the mean approval rate for most questions is statistically significant.

Table 2 Statistical Description of Dependent Variables

	Local population (n=1239)			Floating population (n=753)			Difference [4]
	Approval rate [1]	Mean [3]	standard deviation	Approval rate	average	standard deviation	
	(%)	(X)		(%)	(Y)		YX
A1. Climate concern	92.22	4.51	0.84	98.19	4.82	0.55	0.30
A2. Social contribution to climate change mitigation	74.53	3.83	1.26	89.44	4.37	1.00	0.54 ***
A3. Individual contribution to climate change mitigation	72.12	3.79	1.31	87.10	4.30	0.99	0.51 ***
A composite index (CCP_index) [2]	N/A	12.28	2.99	N/A	13.43	2.15	1.25 ***
B1. Garbage classification	75.08	3.76	1.20	78.07	3.91	1.20	0.16
B2. Energy saving and	87.28	4.29	1.06	94.23	4.60	0.85	0.31 **

emission reduction							
B3. Resource saving	81.58	3.95	1.11	88.48	4.27	1.00	0.31 **
B4. Green travel	57.32	3.29	1.40	63.27	3.52	1.47	0.23 *
B5. Long-distance travel	41.42	2.78	1.34	53.35	3.19	1.51	0.41 ***
B composite index (CMB_index)	N/A	15.88	5.27	N/A	17.99	5.12	2.12 ***

Note: 1. The approval rate refers to the proportion of Likert scale scores 4 and 5 in Table 1. 2. The composite index is the sum of Likert scale scores, with A and B ranges of 3-15 and 5-25, respectively. 3. The mean is the average of Likert scale scores. 4. The difference = the average approval rate of the floating population - the average approval rate of the local population, using a two-sided t-test. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

4.3 Independent Variables

Table 3 presents the statistical description of the independent variables, with the core independent variable being the floating population dummy variable (1 = floating population, 0 = local population). Notably, 37.80% of respondents belong to the floating population. This paper aims to examine the relationship between the floating population and climate behavior variables, testing the mechanisms of population mobility on climate mitigation behavior while controlling for socio-economic factors that may influence this relationship.

The remaining variables in Table 3 serve as control variables. Regarding age, the floating population is significantly younger than the local population, with an average age difference of 5.70 years. While some studies have indicated that older respondents are more likely to support climate mitigation policies[15], recent empirical findings suggest that, when controlling for other factors, younger individuals show greater concern for climate change than their older counterparts[16]. Thus, a correlation between age and climate behavior may exist.

In terms of gender, the social role expectations for women differ markedly from those for men, with women generally exhibiting preferences for risk aversion and altruism[17], often translating to more environmentally friendly behaviors in climate change contexts[18]. Therefore, gender may also influence climate behavior.

Public education and information dissemination are recognized as effective tools for addressing climate change[19], with individuals holding higher education levels more likely to accept scientific information and recognize potential climate risks[20]. Hence, education may positively impact climate behavior.

Income, as an indicator of affluence, is frequently employed as an explanatory variable in environmental research. The Environmental Kuznets Curve[21] posits an "∩" relationship between income and environmental degradation; before reaching a peak income level, increased income is associated with higher environmental emissions. Consequently, this paper considers income level as a factor influencing climate behavior.

Daily commuting by car is treated as a binary variable, with 93% of the local population and 75% of the floating population engaging in daily car use. Although perceptions of climate change among daily car drivers may vary, some individuals alter their driving behavior for environmental reasons[22]. Thus, there may be a relationship between the "daily car commuting" variable and climate behavior.

Research indicates that economic shocks negatively affect environmental perceptions, particularly among the labor force[23]. Therefore, employment status (employed) is included to identify the labor participation status of respondents, with 68% of the local population and 76% of the floating population being employed. The labor participation rate among the floating population is significantly higher than that of the local population, aligning with the basic economic characteristics of China's floating population[24].

The "urban-rural" variable is used to assess the urban-rural attributes of respondents. Among the local population, 87% are urban residents, while only 45% of the floating population hail from urban areas. Rural residents typically demonstrate lower political participation awareness compared to their urban counterparts and tend to adopt more conservative climate perceptions[25]. Additionally, some environmentally unfriendly behaviors, such as reliance on biomass energy in rural areas, negatively impact the environment[26].

Table 3 Statistical Description of Independent Variables

variable	variable name	Local population (n=1239) Mean (X)	standard deviation	Floating population (n=753) Mean (Y)	standard deviation	Difference [1] YX
age)	*age*	43.75	13.63	38.06	12.18	-5.70 ***
Gender (male=1; female=0)	*sex*	0.48	0.37	0.52	0.35	0.04
Years of education (years)	*edu*	12.16	8.12	11.33	7.61	-0.83
Personal annual income (10,000 yuan)	*income*	7.89	6.59	5.11	4.05	-2.78 ***
Daily commuting by car (1=yes; 0=no)	*d_car*	0.93	0.36	0.75	0.37	-0.18 **
Employment status (1=active; 0=not active)	*job*	0.68	0.53	0.76	0.71	0.08 **
Student (1=yes; 0=no)	*stu*	0.15	0.21	0.18	0.28	0.03 *
retired (1=yes; 0=no)	*ret*	0.14	0.27	0.04	0.13	-0.10 *

Unemployed (1=yes; 0=no)	*une*	0.03	0.14	0.02	0.16	-0.01
Urban and rural (urban=1; rural=0)	*u_r*	0.87	0.38	0.45	0.49	-0.43 **

Note: 1. The difference - the mean value of the floating population - the mean value of the local population, using a two-sided t test. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

4.4 Research Methods

(1) Analysis of the population mobility effect on the climate behavior composite index. A common method for analyzing Likert scales with interconnected questions is to calculate the composite index of the scores of each question[27]and use Cronbach's alpha to assess the reliability of the composite index. The calculation formula for the climate behavior composite index in this study is as follows:

$$C\_index = \sum_{i=1}^{n} X_i \quad (1)$$

In the formula, C_index is the composite index; Xi is the score of the ith question, with a range of 1~5; n is the number of questions.

Climate perceptions are crucial to the climate adaptation process and potential mitigation behaviors[23], which may influence people's daily climate mitigation actions. The differences in climate perceptions themselves can explain part of the differences in climate mitigation behaviors[20]. The statistical description in Table 2 shows that the floating population has strong climate perceptions, and the climate perception composite index as a mediating variable may partially explain the reason for the higher climate behavior composite index scores of the floating population (indirect effect). To statistically test this possibility, this study adopts a path analysis model for causal analysis of the climate behavior composite index. The mathematical expression is as follows:

$$\begin{bmatrix} Y_1 \\ Y_2 \end{bmatrix} = \begin{bmatrix} 0 \\ \beta_{12} \end{bmatrix} \times Y_1 + \begin{bmatrix} \gamma_{11} & \cdots & \gamma_{18} \\ \gamma_{21} & \cdots & \gamma_{28} \end{bmatrix} \times \begin{bmatrix} X_1 \\ \vdots \\ X_8 \end{bmatrix} + \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \end{bmatrix} \quad (2)$$

.In the formula, Y is the endogenous variable vector (composite indices of climate perceptions and climate behaviors, dependent variables); X is the exogenous variable vector (independent variables); β is the path coefficient of the endogenous variables; γ is the path coefficient matrix of the exogenous variables; ε is the residual vector.

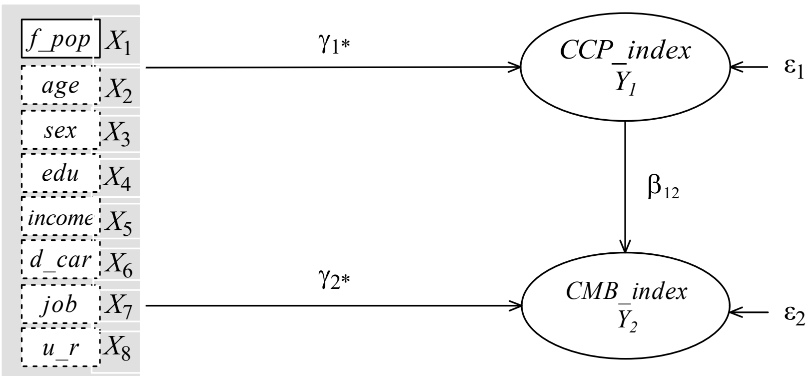

Figure 1 Path Analysis Model for the Climate Behavior Composite Index

(2) Analysis of the population mobility effect on climate mitigation behaviors. This study adopts a logistic regression model by recoding the dependent variable into a binary variable (1=agree, 0=disagree) and performing logistic regression on each specific question of climate behavior one by one, which also makes it easier to interpret the relationship between statistical results and research hypotheses. The mathematical expression is as follows:

$$\text{logit}(p_i) = a_i + b_i \times f_{pop} + \sum_{j=2}^{8} c_{ij} x_{ij} + d_i x_{ccb} + \varepsilon_i \quad (3)$$

In the formula, pi is the probability of "agreeing" with the ith question; bi is the regression coefficient of the "floating population" dummy variable (f_pop); cij is the coefficient of the ith question and the jth control variable; xij is the control variable in Table 3; x_ccp is the climate perception composite index; di is the coefficient of the ith question climate perception composite index; εi is the residual term.

5 RESULTS ANALYSIS

5.1 Population Mobility Effect on Climate Behavior Composite Index

Table 4 presents the analysis results of the standardized direct, indirect, and total effects of the floating population dummy variable and other control variables on the climate behavior composite index. The path analysis model demonstrates a good fit with the survey data, as indicated by acceptable overall test parameters (R^2) and goodness-of-fit indices (GFI, AGFI, IFI, CFI, RMSEA). Additionally, Cronbach's alpha coefficient confirms the reliability of the survey data. The impacts of other control variables align with findings from previous related studies, affirming the appropriateness of their selection as controls. The following discussion focuses primarily on the relationship between the floating population and climate behavior.

Empirical results indicate that the floating population dummy variable significantly positively influences both climate perception and the climate behavior composite index, with total effects ranging from 0.10 to 0.23. Specifically, the effect of the floating population dummy variable on the climate perception composite index is 0.23, suggesting that the floating population's climate perception score is 0.23 standard units higher than that of the local population. Given the composite index coding method, a higher score corresponds to more positive climate perceptions, indicating a systematic association between population mobility and climate perception; thus, the floating population demonstrates more favorable climate perceptions. The selectivity and adaptability of floating populations/migrants contribute to their shift towards environmentally friendly cultural perceptions and behavioral patterns[12]. The environmentally friendly behaviors of the floating population may reflect changes in their perceptions[28].

The total effect of the floating population dummy variable on the climate behavior composite index is 0.10, with a direct effect of 0.08 and an indirect effect of 0.02. This signifies that population mobility not only directly promotes climate mitigation behaviors but also indirectly encourages them by altering climate perceptions. Notably, the direct effect of climate perception on climate mitigation behavior is 0.31, while the indirect effect of other factors on climate mitigation behavior through climate perception is 0.11, highlighting the significant mediating role of climate perception in influencing the climate mitigation behavior of the floating population[29].

Overall, population mobility exerts a direct influence on climate behavior, with the floating population displaying climate-friendly characteristics in areas such as energy conservation, emissions reduction, resource conservation, and green travel. However, there is no evidence of climate-friendly preferences among the floating population concerning waste sorting and long-distance travel. Moreover, changes in climate perceptions during the process of population mobility also indirectly affect climate behavior patterns, with the floating population exhibiting climate-friendly behaviors under the combined influence of various socio-economic factors.

Table 4 Analysis Results of Population Flow Effect of Climate Behavior Composite Index

	CCP_index	*CMB_index*		
		direct effect	indirect effect	total effect
f_pop	0.23 ***	0.08 **	0.02 ***	0.10 *
age	-0.12 *	-0.04	0.01 *	-0.03 *
sex	-0.06 *	-0.04	0.01 *	-0.03 *
edu	0.08*	-0.01	0.00	-0.01
income	0.01	0.05*	0.02***	0.07*
d_car	-0.04	-0.03	0.01	-0.02
job[1]	0.07*	0.07*	0.02*	0.09*
u_r	0.05***	0.08*	0.02***	0.10*
mediating effect				
CCP_index		0.31	0.11	0.42
Cronbach' alpha	0.71		0.82	
R^2	0.62		0.63	
Goodness-of-Fit Index (GFI)				0.95
Adjusted Goodness-of-Fit Index (AGFI)				0.93
Incremental Fit Index (IFI)				0.97
Comparative Fit Index (CFI)				0.92
Root Mean Squared Error of Approximation (RMSEA)				0.04
N				1992

Note: 1. Active=1; Not active=0; 2. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

5.2 Population Mobility Effect on Climate Mitigation Behaviors

To further examine whether the impact of population mobility on different climate mitigation behaviors varies, we constructed and tested baseline models (including only independent variables), standard models (including independent and control variables), and extended models (including independent variables, control variables, and the climate perception composite index).

1.Impact on Climate Mitigation Behaviors: The results in Table 5 indicate that, with the exception of long-distance travel (B5), the regression coefficients for the floating population dummy variable in the baseline and standard models are statistically significant for the corresponding dependent variables (B1–B4). In the standard and extended models, the floating population demonstrates a significant positive impact on climate behaviors related to waste sorting, energy conservation and emissions reduction, resource conservation, and green travel, while the effect on long-distance travel remains insignificant. This suggests that the floating population is more inclined towards climate-friendly behaviors in waste sorting, energy conservation, emissions reduction, resource conservation, and green travel compared to the local population.

2.Proactivity in Climate Behaviors: In both the standard and extended models, the regression coefficients for the floating population dummy variable related to energy conservation and emissions reduction, resource conservation, and green travel are all positive, with incidence ratios exceeding 1.00. This indicates that the floating population is more proactive in these areas than the local population. Interestingly, individual annual income negatively impacts behaviors associated with energy conservation, emissions reduction, resource conservation, and green travel. Given that the average income of the floating population is lower than that of the local population, this negative impact suggests that individuals with lower incomes may be more inclined to adopt daily climate mitigation behaviors. Overall, the climate mitigation behaviors of the floating population align with economic interests and exhibit economically rational motivations.

3.Heterogeneity of Climate Behaviors: Daily car commuters display distinct behaviors regarding energy conservation and emissions reduction compared to green travel. In the baseline and standard models, the incidence rate ratios for the "daily car commuting" variable concerning energy conservation and emissions reduction (B2) are 2.38 and 2.22, respectively, whereas the ratios for green travel (B4) are 0.65 and 0.63. Even with similar climate perceptions, daily car commuters are more accepting of energy conservation and emissions reduction behaviors; however, the likelihood of adopting green travel methods is lower due to conflicts with daily commuting. This heterogeneity emphasizes the importance of considering the feasibility of climate-friendly behaviors across different groups when promoting low-carbon initiatives.

4.Insignificance of Certain Climate Behaviors: Regarding waste sorting (B1), the regression coefficients for the floating population dummy variable are significant in the baseline and standard models but become insignificant in the extended model when controlling for the climate perception composite index. This indicates that, when accounting for climate perception, there is no significant difference in waste sorting behavior between the floating population and the local population. Waste sorting in China entered the legalization stage in 2019, with major cities like Beijing, Shanghai, Guangzhou, and Shenzhen being early adopters of mandatory sorting policies. However, the effectiveness of these policies has been limited[30], often due to inadequate methods and conflicts between policy objectives and public behaviors[31]. As a result, the preference for waste sorting demonstrated by the floating population in the earlier models is overshadowed by the mediating effect of climate perception in the extended model.

Additionally, in the long-distance travel (B5) model, the regression coefficient for the floating population dummy variable is not significant, indicating no meaningful difference in long-distance travel behaviors between the floating and local populations with regard to carbon emissions. It is essential to note that long-distance travel in this context refers to "changing travel destinations due to carbon emission reasons," thus excluding tourism-related long-distance travel. This clarification may explain the lack of significant difference between the two groups regarding long-distance travel.

5.3 Summary

The analysis reveals that both the direct positive effect of the floating population dummy variable on the climate behavior composite index and its indirect effect through climate perception indicate a preference for climate-friendly behaviors among the floating population. This supports the theoretical hypothesis that "there is a systematic relationship between population mobility and climate mitigation behavior."

The floating population exhibits different preferences for various climate mitigation actions. While climate perception partially accounts for differences in behavior, the risk ratios for energy conservation, emissions reduction, resource conservation, and green travel remain higher for the floating population even when controlling for climate perception. This finding reinforces the hypothesis that the floating population possesses climate-friendly behavior preferences. Conversely, waste sorting behavior becomes insignificant after controlling for climate perception, and no significant difference is found in long-distance travel behaviors affected by carbon emissions between the two groups.

The change in climate perception during migration has a positive mediating effect on climate behaviors. The floating population balances economic considerations with environmental impacts in their decision-making regarding climate behaviors. The interplay of climate perception and the economic rationale underlying climate behavior forms the mechanism through which population mobility influences climate action.

6 CONCLUSION AND DISCUSSION

Currently, we are in the initial stages of implementing the "dual carbon" goals, which require not only emission control measures in the production sector but also the exploration and practice of emission reductions in daily life. According to statistics from the United Nations Environment Programme, carbon emissions from residents' daily consumption account for approximately two-thirds of total emissions[32], while China's daily carbon emissions represent about 50% of the total emissions[33]. This proportion is expected to rise with improving living standards. Guiding the public towards a climate-friendly lifestyle has thus become an essential strategy for mitigating climate change. This paper employs survey data based on communication big data to empirically analyze the climate behavior traits of the floating population, offering insights into the mechanisms through which population mobility impacts climate behavior.

1.Overall Findings: The empirical results indicate that the floating population exhibits more climate-friendly behavior patterns compared to the local population. Whether through changes in ideas and concepts during migration or restrictive consumption patterns, population mobility can positively influence climate behavior in the current socio-economic environment. Megacities, as primary destinations for population inflows in China, benefit from the climate-friendly characteristics of the floating population, which hold significant social value for promoting green lifestyles and fostering societal participation in low-carbon emission reduction.

2.Specific Climate Behaviors: The floating population demonstrates significant climate-friendly tendencies in energy conservation, emissions reduction, resource conservation, and green travel. However, no such preferences are observed in waste sorting and long-distance travel. The mediating roles of climate perception and the economic rationality behind climate behavior decisions serve as mechanisms through which population mobility impacts climate behavior.

3.Policy Implications: The "dual carbon" target policy should account for both macroeconomic feasibility and the rational responses of the public. Policies lacking public support may face challenges, leading to minimal results[2]. For instance, climate tax policies could lead to higher energy prices and increased living costs, often provoking a conservative public response. Therefore, policy formulation and implementation must consider the economic interests of the public[34], seeking a balance between policy objectives and individual concerns. The daily climate mitigation behaviors of the floating population are influenced by economic factors[35], with behaviors that lower living costs being more readily accepted. Thus, targeted social campaigns can be more effective. Changes in travel patterns may have a greater impact on daily life than energy conservation and emissions reduction, which are often easier to adopt. Consequently, when promoting low-carbon and environmentally friendly behaviors, it is crucial to consider the potential effects of such changes on daily living.

4.Future Research Directions: Under the context of China's "dual carbon" goals, climate behavior represents a new research frontier in environmental social science and climate change response. Given the long-term nature of population migration and mobility, it is essential to track and study the intergenerational transmission patterns of the floating population's climate behavior as they become more urbanized and improve their economic status, leading to localized consumption patterns[36,37].

FUNDING

This research was supported by the Guangdong Provincial Carbon Peak Action Strategy and Regional Joint Peak Mode Research Project (Grant No. GD23XYJ45).

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

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Table 5 Logistic Regression Results of Climate Mitigation Behavior

	1 Garbage classification			B 2 Energy saving and consumption reduction			B3 Resource Conservation			B4 Green travel			B5 long-distance travel		
	benchmark model	standard model	extended model	benchmark model	standard model	extended model	benchmark model	standard model	extended model	benchmark model	standard model	extended model	benchmark model	standard model	extended model
f_pop	1.11 *	1.08*	1.07	2.15**	2.04**	1.78*	1.56*	1.32*	1.29*	1.90*	1.89*	1.49*	1.23	1.21	1.07
	(0.34)	(0.29)	(0.27)	(0.54)	(0.51)	(0.45)	(0.67)	(0.51)	(0.41)	(0.76)	(0.62)	(0.51)	(0.44)	(0.32)	(0.41)
age		1.01	1.00		1.00	0.98		1.02	1.01		1.01	1.00		1.00	1.01
		(0.0131)	(0.0122)		(0.0071)	(0.0081)		(0.0088)	(0.0074)		(0.0061)	(0.0058)		(0.0073)	(0.0083)
sex		1.17*	1.11*		1.43*	1.22*		1.32**	1.20**		1.63**	1.54**		1.21	1.16
		(0.33)	(0.31)		(0.34)	(0.44)		(0.35)	(0.43)		(0.59)	(0.48)		(0.30)	(0.41)
edu		0.95*	0.91*		1.06**	1.05*		1.07***	1.03***		1.09*	1.06*		1.12	1.11
		(0.17)	(0.16)		(0.22)	(0.19)		(0.14)	(0.24)		(0.31)	(0.24)		(0.23)	(0.25)
income		1.09	1.07		0.71**	0.81**		0.79**	0.82**		0.82***	0.79**		1.34*	1.27*
		(0.32)	(0.22)		(0.11)	(0.16)		(0.13)	(0.23)		(0.24)	(0.27)		(0.57)	(0.66)
d_car		0.81	0.80		2.38***	2.22***		0.99	0.96		0.65**	0.63**		0.79	0.69
		(0.26)	(0.23)		(0.42)	(0.45)		(0.32)	(0.26)		(0.11)	(0.12)		(0.16)	(0.13)
job	The reference group is "employed"														
stu		0.77	0.73		0.71 *	0.77 *		0.59 *	0.65 *		1.78 **	1.57 **		1.21 *	1.19 *
		(0.31)	(0.35)		(0.31)	(0.33)		(0.21)	(0.24)		(0.62)	(0.58)		(0.44)	(0.37)
back		1.01	1.00		1.73 **	1.63 **		1.85 *	1.71 *		0.98 **	0.95 **		1.23 *	1.20 *
		(0.59)	(0.51)		(0.99)	(0.75)		(1.18)	(1.03)		(0.38)	(0.32)		(0.81)	(0.90)
a		0.93	0.94		1.11*	1.06*		1.13*	1.10*		1.23***	1.19***		1.25**	1.17**
		(0.45)	(0.42)		(0.39)	(0.43)		(0.35)	(0.23)		(0.31)	(0.76)		(0.56)	(0.66)
u_r		1.53***	1.45***		0.83	0.81		1.21	1.20		1.32**	1.27**		0.83*	0.80
		(0.98)	(0.81)		(0.32)	(0.42)		(0.29)	(0.33)		(0.54)	(0.48)		(0.43)	(0.23)
CCP_index			1.33***			1.27**			1.23**			1.12*			1. 1 5 **
			(0.78)			(079)			(0.82)			(0.72)			(0.59)
N		1992			1992			1992			1992			1992	

Note: 1. The values in brackets are standard deviations. 2. The parameters in the table are odds ratios 3. * p < 0.05; ** p < 0.01; *** p < 0.001.