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Can nudging affect tourists' low-carbon-footprint travel choices?

Abstract

Purpose – This study investigated low-carbon-footprint travel choices, considering both destination attributes and climate change perceptions, and examined the impacts of nudging (a communication tool to alter individuals' choices in a predictable way) on tourists' preferences for carbon mitigation in destinations.

Design/methodology/approach – A discrete choice experiment questionnaire was administered to a sample of 958 Hong Kong respondents. Hybrid choice modeling was used to examine the respondents' preferences for destination attributes and to explain preference heterogeneity using tourists' climate change perceptions. The respondents' willingness to pay for the destination attributes was also calculated to measure the monetary value of the attributes.

Findings – Destination type, carbon emissions, and travel cost had significant effects on tourists' choices of destination. Nudging increased tourists' preference for low-carbon-footprint choices. Tourists with higher climate change perceptions were more likely than others to select low-carbon destinations with carbon offset projects.

Originality – This study addressed a gap in the literature on tourist travel choice by considering carbon emission-related attributes and climate change perceptions and by confirming the role of nudging in increasing the choice of low-carbon destinations.

Practical implications – The findings of this study provide an impetus for destination management organizations to support local carbon offset projects, implement policies that mitigate carbon emissions, and develop sustainable tourism to fulfill tourists' demand for low-carbon-footprint travel choices. Based on the findings, policymakers could promote sustainable tourism by publishing relevant climate change information on social media.

Keywords: Nudge effect, Low carbon footprint, Climate change, Discrete choice experiment, Hybrid choice model

1. Introduction

The Intergovernmental Panel on Climate Change (IPCC, 2019) has indicated that continued carbon emissions substantially drive global warming, which has resulted in and will continue to cause severe, pervasive, and irreversible impacts on global ecosystems. A joint worldwide commitment was thus proposed by the United Nations Framework Convention on Climate Change (UNFCCC) to limit global warming to no more than 1.5 degrees Celsius higher than the pre-industrial level (UNFCCC, 2022). The contribution of tourism sectors to global climate change deserves particular attention, as carbon emissions from tourism are already substantial and continue to grow. According to the latest research by the World Tourism Organization (UNWTO), carbon emissions from tourism grew by at least 60% from 2005 to 2016 and are predicted to rise by 25% or more by 2030 if decarbonization actions are not implemented (UNWTO & ITF, 2019). Therefore, the development of sustainable tourism has become increasingly important for both economies and individuals.

Fortunately, there is considerable potential to reduce carbon emissions in the tourism sector. For example, tourists can reduce their emissions and minimize the negative impact of the

carbon footprint of tourism by making more sustainable choices, such as choosing lower-emission flights, supporting local carbon offset projects, and purchasing carbon credits. Nonetheless, tourism remains one of the main drivers of carbon dioxide emissions due to fossil fuel consumption for transportation and electricity generation in tourist accommodation. Previous studies have focused on topics related to travel route choices and methods to reduce carbon emissions and improve energy efficiency in transportation sectors such as the aviation industry (Brouwer et al., 2008; Choi & Ritchie, 2014; Denstadli & Veisten, 2020; Lu & Shon, 2012). However, relatively few studies have investigated how carbon-emitting aspects of travel influence tourists' destination choice.

Information related to carbon emissions may influence tourists to make more environmentally conscious choices (Carroll et al., 2022; Kaivanto & Zhang, 2017). However, the effect of different information types and the manner in which information is provided to tourists deserve more research attention. Nudging approaches, which aim to improve individuals' desirable decisions, have been widely used in energy, public health, and agriculture because of their low cost of implementation and effectiveness in changing behavior, which has been confirmed in various fields (Alemanno, 2012; Burgess, 2012; Filimonau et al., 2017; Kuhfuss et al., 2016; Ouvrard et al., 2020). However, few studies have investigated how carbon-related factors influence tourist destination choice and which nudging techniques effectively encourage tourists to make environmentally friendly choices (Cozzio et al., 2020; Kallbekken & Sælen, 2013), particularly regarding destination selection (Souza-Neto et al., 2022).

To bridge these gaps in the literature, this study examined tourist destination choice with consideration of carbon emission-related factors and the impacts of nudging messages on tourist preference change using the hybrid choice model (HCM). This study makes four contributions to the literature. First, it proposes a new destination choice mechanism underpinned by random utility theory and nudge theory in the context of sustainable tourism. It also contributes to the literature on tourists' pro-environmental behavior by expanding the understanding of how tourists value carbon emissions during travel decision-making. Second, it includes the design of a stated discrete choice experiment (DCE) integrated with carbon mitigation-related attributes to investigate tourists' low-carbon-footprint choices. Third, we explore how nudging information influences sustainable destination choice and use climate change perceptions to explain tourist preference heterogeneity. Fourth, willingness to pay (WTP) given the destination attributes is calculated to provide policymakers and businesses with references for carbon pricing in tourism. Overall, the findings of this study also provide these groups with useful ways to promote low-carbon travel.

The remainder of the paper is organized as follows. Section 2 reviews prior research on the factors affecting destination choice, particularly with respect to carbon emission attributes and climate change perception, as well as the impacts of nudging on travel choice. Section 3 presents the research design, data collection, and model specifications of the study, and Section 4 presents the estimation results and discussions. Lastly, Section 5 provides the conclusions and implications of the study.

2. Literature review

2.1 Carbon emission-related factors and destination choice

Following Lancaster's characteristics of consumer goods framework (Lancaster, 1966), destinations can be regarded as bundles of external attributes in which each attribute brings tourists utilities (Papatheodorou, 2001). Studies have shown that travel costs, destination attractions, and service quality are the most critical factors that affect destination choices (Eymann & Ronning, 1997; Moscardo et al., 1996; Tian-Cole & Crompton, 2003). Weather and climate conditions have also been shown to exert considerable effects on destination choices (Stemerding et al., 1999). More recently, as climate change and trends in decarbonization have gained prominence, an increasing number of researchers have included these challenges as attributes of destination (Bujosa & Rosselló, 2012; Landauer et al., 2012; Pröbstl-Haider et al., 2015; Pröbstl-Haider & Haider, 2013; Seekamp et al., 2019; Steiger et al., 2020; Unbehaun et al., 2008).

Climate change has critically affected both tourism and tourists. Tourists are increasingly expected to travel to destinations with better environmental quality (Lam-Gonzalez et al., 2022), and tourist decisions regarding travel activities are commonly determined by the negative effects of climate change, such as extreme weather events and environmental risks, including wildfires and infectious diseases (Cavallaro et al., 2017; Lam-Gonzalez et al., 2022; Matthews, 2021; Rutty et al., 2020). Other research has explored the direct and indirect effects of climate change on visits to beaches or winter sports destinations (Landauer et al., 2012, 2014; Pröbstl-Haider & Haider, 2013; Steiger et al., 2020).

Studies from various fields have indicated that consumers' carbon footprints play a significant role in their decision-making. Vanclay et al. (2011) investigated the sales of several groceries with high, median, and low carbon emissions in Australia and found higher sales of low-carbon groceries. Achtnicht (2012) conducted a choice experiment and found that carbon emissions performance was a substantial factor in German consumers' car choices. Sovacool et al. (2021) reported that around half of Swedish participants and one third of Italian, German, and Spanish participants were willing to pay more for low-carbon heat. Individuals' preference for low-carbon products means that better carbon performance brings extra utility to consumers in the form of positive emotional experience and social and environmental values (Cheng et al., 2020, 2021).

Studies on tourism have also identified tourists' preferences for products with low-carbon attributes (Brouwer et al., 2008; Choi & Ritchie, 2014; Denstadli & Veisten, 2020; Lu & Shon, 2012). For example, Choi and Ritchie (2014) found a significant negative relationship between airlines' carbon emissions and their probability of being chosen by tourists, with tourists supporting airlines' carbon price policies. Tol (2007) used a simulation model to investigate the impact of kerosene taxes on international travel choice and found that a carbon tax on aviation fuel would shift tourist choices from long-haul to medium-haul flights and from medium-haul flights to short-distance trips by car and train. Babakhani et al. (2017) and Raux et al. (2021) both found that when tourists were provided with sufficient carbon emissions information about transportation alternatives, they preferred lower-emission alternatives. However, most of these studies on low-carbon choice have exclusively focused on the transportation section of tourism; few studies have explored the role of carbon-related attributes in destination choice. In addition to the common factors, carbon emission-related

factors also affect individuals' decision-making process. To explore the impacts of carbon-related attributes on destination choice, we propose the following hypothesis:

Hypothesis 1: Carbon emission-related attributes significantly influence tourists' destination choices.

Willingness to pay (WTP), the amount of money that an individual is willing to pay for a given non-monetary attribute, reveals the relative importance of that attribute (Chuah et al., 2022; Sadik-Rozsnyai & Bertrandias, 2019). Studies have shown that travelers are willing to pay for programs that aim to reduce carbon emissions. Brouwer et al. (2008) investigated the WTP of travelers in Asia, North America, and Europe and found that 75% were willing to pay about €25 per ton offset of carbon emissions. Choi and Ritche (2014) found that Australian travelers had a mean WTP of AU\$21.38 for reducing per ton of carbon emissions from flying. Similarly, Denstadli and Veisten (2020) explored the WTP of Norwegian air travelers and found that they were willing to pay for carbon neutrality in addition to carbon taxes. Seetaram et al. (2018) found that outbound travelers from the UK had mean WTPs for carbon taxation of £74, £79.5, and £79.6 for short-, medium-, and long-haul flights, respectively. Ritchie et al. (2021) mentioned that Australian air travelers were willing to pay \$166 to an optimal carbon offset program with their most desired location, credibility, effectiveness, and other attributes. Given the consistency of these findings, we propose the following hypothesis:

Hypothesis 2: Tourists have a significant positive WTP for low-carbon-footprint travel.

2.2 Nudging and low-carbon destination choices

As an external factor, information can influence individuals' responsible choices and behavior. From the perspective of neo-classical economic theory, overcoming information deficits and encouraging utility maximization are central to promoting sustainable consumption. However, the failure of neo-classical economic models to substantially increase sustainable behavior in practice has led to researchers' and practitioners' realization that higher-quality information alone is insufficient to change behavior (Hall, 2013; Lever-Tracy, 2010).

Based on the recognition of individuals' bounded rationality in behavioral economics, nudging is a type of purposeful change in choice architecture that alters the informational structure of the environment and thus influences decision-making (Lehner et al., 2016). Nudging aims to encourage individuals' desirable decision-making (such as reducing emissions) and to provide recommendations for changing consumer behavior. Following libertarian paternalism, Thaler and Sunstein (2008) referred to nudging as "any aspect of the choice architecture that alters people's behavior in a predictable way without forbidding any options or significantly changing their economic incentives" (p. 6). By altering the available options and offering positive reinforcement of beneficial decisions, nudging focuses on enabling desirable behavior and decisions by presenting a behavioral world in which intervening factors influence human behavior at a subconscious level (Thaler & Sunstein, 2008).

Defaults, warnings, and reminders are common types of nudging used in public health, agriculture, energy, and finance (Alemanno, 2012; Burgess, 2012; Filimonau et al., 2017, 2017; Kallbekken & Sælen, 2013; Kuhfuss et al., 2016; Ouvrard et al., 2020). Managers and

policymakers have broadly realized the low costs and high effectiveness of nudging for boosting consumers' desirable behaviors and choices compared with using traditional regulatory tools alone (Chang et al., 2016; Kallbekken & Saelen, 2013, Thaler & Sunstein, 2008). For example, Hummel and Maeche (2019) reviewed 100 papers on nudging between 2009 and 2017 and indicated that two thirds of nudge effects (e.g., default, warning, reminders, and social reference) significantly changed behavior. Although less effort has been made to understand nudging in the context of environmental protection from tourism activities (Souza-Neto et al., 2022), some studies have found that nudging had substantial effects on tourists' sustainable behavior (Cozzio et al., 2020; Gössling et al., 2019). For example, Saulais et al. (2019) exposed restaurant consumers to a recommendation (dish of the day) for a food option and found that vegetarian consumption increased. Cui et al. (2020) provided participants with various cleaning strategies that hotels provided with and without physical cleaning across experiments and found that after nudging treatment, the participants more frequently chose more environmentally friendly options.

Apart from nudging theory, the framing effect is a useful mechanism for influencing consumer choices. Framing is defined as a cognitive bias that affects individuals' decisions because of the way in which information is presented. For example, Araña et al. (2013) utilized different pricing frames to test tourists' preferences and values for environmental policies and found that including an opt-out frame regarding a carbon offsetting fee led more tourists to accept the payment. Framing can also affect tourist choice behavior by highlighting distinctive ways of presenting information by using different wordings, settings, and situations. The main aim of this study is to investigate tourists' sensitivity to climate change-related information and tourists' climate change perceptions regarding carbon emission-related factors. Nudging theory is a more appropriate theoretical foundation to achieve this research aim.

Despite the fact that nudging has been explored in prior studies, no studies were found that considered its role in low-carbon destination choice. This study addresses this gap by introducing nudging into a DCE regarding tourist travel choices and comparing the results of two experiments. We formulate the following hypothesis:

Hypothesis 3: Nudging has a significant positive effect on tourists' selection of low-carbon-footprint travel.

2.3 Climate change perception and low-carbon destination choices

Internal factors (including personal psychology and demographic characteristics) and external factors heavily influence tourists' low-carbon choices (Wang et al., 2021). Understanding personal psychological factors can help decision-makers change external environmental conditions to effectively influence these psychological factors. Current knowledge regarding psychological determinants of climate mitigation behavior is mainly based on climate change knowledge and perceptions (Chuvieco et al., 2021). As a personal psychological factor, perception refers to an individual's perceptions of the causes and impacts of climate change and their beliefs regarding climate change action (van Valkengoed et al., 2021; Yu et al., 2013). Perceptions of causes pertain more to anthropogenic causation such as deforestation, fossil fuel use, industrial pollution, and urbanization; impacts include individual and environmental health and economic and social effects; and individual beliefs refer to confidence in government and oneself to respond to climate change. Increased climate

change perception generally guides individuals to support climate policies and take actions to mitigate carbon emissions (Fan et al., 2016; Mi et al., 2018; van Valkengoed et al., 2021). Based on the literature on the relationship between climate change perceptions and individual mitigation behavior, we propose the following hypothesis:

Hypothesis 4: Tourists with higher (vs. lower) climate change perception are more likely to choose low-carbon-footprint travel.

In addition, some studies have found that climate change perception and willingness to act were associated with age, gender, education, income, and other demographic factors (Juvan & Dolnicar, 2017). Educational level has been shown to be positively related to knowledge about environmental issues and potential solutions, and it thus may affect sustainable tourist behavior. Older people may also be more likely to perceive climate change signals because of their memory of the climate between 1951 and 1980 (Hansen et al., 2012), whereas younger generations (millennials and Gen Z) tend to be more concerned about environmental issues and sustainable values (Deloitte, 2021). In addition, people with higher incomes are more likely to engage in environmentally friendly behavior (Dolnicar, 2010). However, based on prior studies, the relationship between gender and sustainable tourist behavior is inconclusive (Dolnicar, 2010; Dolnicar & Leisch, 2008). Considering the significant impacts of sociodemographic information of individuals on tourist behavior, we formulate the following hypothesis:

Hypothesis 5: Tourists' sociodemographic factors have significant effects on their low-carbon-footprint travel choices.

3. Methodology

3.1: *Experimental design*

The study comprised three stages: experimental design, data collection, and model estimation. In the first stage, we designed a DCE with consideration of the carbon emission-related attributes and nudging message. Based on prior studies, we used the following attributes to differentiate the destinations: destination type (i.e., short- and medium-haul destinations and long-haul destinations; IATA, 2020), destination temperature (°C; Lise & Tol, 2001; Martínez-Ibarra et al., 2019; Scott et al., 2008, 2016), carbon dioxide emissions of the trip per person (kg; UNWTO & ITF, 2019), carbon offset projects, and carbon offset price (Green and Sustainable Finance Cross-Agency Steering Group, 2022). In the next step, we utilized the D-efficient design method to assign attribute levels and create choice sets, which have been widely applied in prior studies (Boto-García et al., 2022; Choi & Ritchie, 2014). Table I presents the attributes and corresponding levels. In the experiments, all of the attributes of the alternative destinations (e.g., tourism attractions and service quality) other than those listed in Table I remained the same.

(Insert Table I about here)

The final questionnaire was composed of four sections. In the first section, travel information was collected regarding the respondents' overseas leisure travel experiences in the past five years. The second section focused on the stated choice experiments, in which the respondents were presented with a hypothetical scenario in which they were planning an overseas leisure trip in light of their responses regarding their past travel information. They were provided with eight choice sets and asked to choose one destination from each set (see Figure 1 for an

example). To investigate the effect of nudging on tourists' low-carbon-footprint travel preferences, we designed two versions of the questionnaire, one of which included the nudging message as a treatment in the experiment in the form of a piece of news about carbon emissions given before the respondents made their destination choice (Figure 2). In line with Ouvrard et al. (2020), we considered nudging as a communication tool to promote individuals' preferences for choices with low carbon emissions (Kuhfuss et al., 2016). This study conducted a between-sample experiment in which 472 and 486 respondents were respectively assigned to the control and treatment groups.

(Insert Figures 1 & 2 about here)

The next section comprised items about respondents' climate change perceptions, which were measured on a 5-point scale and addressed perceptions of climate change impacts (Cheval et al., 2022), causes (Cheval et al., 2022; Lee et al., 2020; Silvestri et al., 2012; van Valkengoed et al., 2021; Yu et al., 2013), actions in response to climate change (van Valkengoed et al., 2021), and the influence of climate change on their destination choice. In the last section, the respondents provided their sociodemographic information, such as gender, age, education level, and annual income.

3.2: Data collection

A professional market research company conducted the survey among a random sample of Hong Kong residents. To confirm its validity and readability, we conducted a pilot study with 150 samples. The main survey was then administered in July 2022 to 1,537 participants, but 444 did not complete the survey because they failed to pass the screening questions; for instance, some had not traveled abroad in the past five years, some had no interest in traveling overseas in the next 12 months, and others did not understand the experiment. After data cleaning, 958 useful responses (62.3%) were used for the data analysis and model estimations.

The respondents were widely spread across gender, age, education level, and income cohorts (see Table II). In our sample, 49.9% were younger (18–39 years old), 7.3% were older (over 60 years old), 51.2% were female, 15.1% had a master's degree or higher, and 19.3% had an annual household income of HK\$800,000 or above.

(Insert Table II about here)

3.3: Model estimations

In the third stage, we compared the performance of different choice models, with the HCM model used to generate estimates by combining the discrete choice model with the latent variable model (see Figure 3), as done in prior studies (Daly et al., 2012; Dekker et al., 2013; Kim et al., 2014; Ouvrard et al., 2020). This study integrated the nudge effect into the HCM to examine the impacts of a nudging message on tourists' preferences regarding carbon emission-related attributes.

(Insert Figure 3 about here)

The theoretical underpinning of the discrete choice model is random utility theory. The utility $U_{j,n}$ for tourist n choosing the destination (or alternative) j is described by the following equation (Morley, 1992):

$$U_{j,n} = V_{j,n} + \varepsilon_{j,n} \quad (1)$$

$$V_{j,n} = \sum_{m=1}^M [D_a \beta_{a,m,n} X_{j,m} + (1 - D_a) \beta_{b,m,n} X_{j,m}] \quad (2)$$

$$y_{j,n} = \begin{cases} 1, & \text{if } U_{j,n} \geq U_{k,n} \forall k \in Z_n \\ 0, & \text{otherwise} \end{cases} \quad (3)$$

where $V_{j,n}$ is the deterministic component of the utility function and $\varepsilon_{j,n}$ is an unobserved i.i.d. extreme value error term; D_a is a dummy variable equal to 1 for the nudging treatment group and 0 for the control group; $X_{j,m}$ is a vector of the observed attribute m describing the destinations; $\beta_{a,m,n}$ and $\beta_{b,m,n}$ are random parameters to measure tourist preference heterogeneity assumed as a normal distribution for non-monetary attributes and a negative lognormal distribution for price attributes; and $y_{j,n}$ is the measurement component of the choice model, equal to 1 if respondent n chooses destination j and 0 otherwise (Daly et al., 2012; Dekker et al., 2013; Kim et al., 2014; Walker & Ben-Akiva, 2002).

The value of the parameter $\beta_{m,n}$ indicates the estimate of each destination attribute m , which follows a normal distribution at the inter-individual level, as follows:

$$\beta_{m,n} = \mu_m + \sigma_{m,inter} * \xi_{m,n} + \lambda^L LV_n \quad (4)$$

where μ_m is the estimated mean for β_m ; $\sigma_{m,inter}$ is the standard deviation at the inter-individual level; $\xi_{m,n}$ is the error term following a normal distribution; λ^L denotes an individual's preference heterogeneity in terms of each destination attribute based on their climate change perception; and LV_n represents the latent variable indicated by an individual's climate change perception.

The latent variable (LV), which was continuous and normally distributed (Hensher et al., 2015), indicated the underlying attitudes of the respondents and was introduced into the random parameters of the destination attributes. The respondents' latent values were affected by their sociodemographic characteristics, including age, gender, income, and education, as described by the following:

$$LV_n = \gamma z_n + \eta_n \quad (5)$$

$$I_{pn} = \begin{cases} 1 & \varphi_{p0} \leq \theta_p LV_n < \varphi_{p1} \\ 2 & \varphi_{p1} \leq \theta_p LV_n < \varphi_{p2} \\ \vdots & \vdots \\ S & \varphi_{p(S-1)} \leq \theta_p LV_n < \varphi_{pS} \end{cases} \quad (6)$$

where z_n is a vector representing the sociodemographic variables for individual n ; γ is a vector of estimated parameters capturing the impact of these variables on LV_n ; η_n is a random error term following a standard normal distribution; I_{pn} denotes the observed ratings of the indication question p of the latent variable; $\varphi_{p\#}$ is the parameter associating the latent variable with the ratings; and θ_p represents the scale coefficient regarding the attitudinal questions.

The joint likelihood function was expressed by the product of the conditional choice probability and the conditional density function of the indicators and integrated over the density distribution of the latent variable as follows:

$$LL_n(y_n, I_{pn} | X_{j,m}; \beta_{m,n}, \lambda^L, \gamma, \varphi, \theta) =$$

$$\int_{\eta} \int_{\beta} f_y(y_n | X_{j,m}, LV_n; \beta_{m,n}, \lambda^L) f_{I_{pn}}(I_{pn} | LV_n; \varphi, \theta) f_{\beta}(\beta_{m,n}) f_{\eta}(\eta_n) d\beta d\eta \quad (7)$$

with

$$f_y(y_n | X_{j,m}, LV_n; \beta_{m,n}, \lambda^L) = \frac{\exp(U_{j,n})}{\sum_{k \in Z_n} \exp(U_{k,n})} \quad (8)$$

$$f_{I_{pn}}(I_{pn} | LV_n; \varphi, \theta) = \sum_{s=1}^S (I_{pn} = s) \left[\frac{\exp(\varphi_{ps} - \theta_p LV_n)}{1 + \exp(\varphi_{ps} - \theta_p LV_n)} - \frac{\exp(\varphi_{p,s-1} - \theta_p LV_n)}{1 + \exp(\varphi_{p,s-1} - \theta_p LV_n)} \right] \quad (9)$$

where $f_y(\cdot)$ denotes the choice probability conditional on the destination attributes; $f_{I_{pn}}$ is the likelihood function of observed indicators of climate change perception, described as an ordered specification (Hess & Palma, 2022); and f_{β} and f_{η} indicate the joint density function of individual preference for the specific attribute and the joint density function of the latent variable, respectively.

WTP was calculated as the ratio of the coefficient of a non-monetary attribute and the coefficient of the price-related attribute, which indicated an individual's trade-off between the non-monetary and monetary attributes (Choi, 2020; Masiero et al., 2015; Sriarkarin & Lee, 2018), as follows:

$$\text{WTP} = \frac{MU_q}{MU_r} = -\frac{\beta_q}{\beta_r} \quad (10)$$

where β_q is the mean coefficient of the target attribute q ($q = 4$) and β_r is the mean coefficient of the monetary attribute.

4. Results

4.1 Model performance

The HCM was estimated using the Apollo package in R (Hess & Palma, 2022). We compared the performance of the HCM benchmarked with the multinomial logit model (MNL) and that of the mixed multinomial logit model (MMNL). According to the log-likelihood and AIC results, the HCM performed the best, with higher log-likelihood values than other models (Table III). In addition, the HCM incorporating the individual psychological factors could better explain respondents' preference heterogeneity in terms of destination attributes.

(Insert Table III about here)

4.2 Sustainable travel choice

Because of the superior performance of the HCM, we utilized its results for further analysis (Table IV). The coefficients of all of the attributes were significant with the expected signs. According to the results for the control group, the respondents were more likely to select short- and medium-haul destinations (0.457, $p < 0.01$) with a low temperature (-0.03, $p < 0.01$). During the COVID-19 pandemic, the respondents were likely to travel to local destinations or those close to their origin countries because of complicated cross-border policies related to quarantine and safety concerns, which aligned with the conclusions of prior studies (Li et al., 2021). Furthermore, the lower temperature preference corroborated the findings of Bujosa and Rosselló (2013) and Haegeli et al. (2010). The respondents also preferred to avoid destinations that released high levels of carbon emissions (-0.622, $p < 0.01$) and to select destinations that supported and promoted carbon offset projects (0.371, p

< 0.01). Nevertheless, they were less willing to pay the additional carbon offset expenditure, as expected by demand theory (Guthrie, 1961) (-1.542, $p < 0.01$). In addition, the standard errors related to all of the attributes were significant ($p < 0.01$), which implied that the respondents exhibited heterogeneous preferences for destination attributes. Given that the respondents generally preferred sustainable travel choices, Hypothesis 1 was supported.

(Insert Table IV about here)

To investigate the effect of nudging on travel choice, we provided the respondents with information regarding the impacts of climate change before they made the destination choice in the stated choice experiment. According to the estimation results, the coefficients of all of the attributes in the nudging scenario were significant with the expected signs, such that the respondents in the treatment group had similar preferences for the destination attributes as those in the control group, but the former had greater concern for carbon neutrality-related factors, as displayed by the lower coefficients for the amount of carbon emissions (-0.776) and higher coefficients for carbon offset projects (0.522). This reflected the fact that the nudging message increased the respondents' choice of the low-carbon-emission trip and improved individuals' awareness of environmental protection. More importantly, an increase in the parameter of the carbon offset projects from 0.317 (control group) to 0.522 (treatment group) indicated that carbon offset projects had a higher value when the respondents made decisions under the influence of nudging. We further calculated the differences in the coefficients of the attributes between the control and treatment groups using the delta method. The results in Table V show significant differences in the parameters of carbon emissions and offset projects between the control and treatment groups, supporting Hypothesis 3.

(Insert Table V about here)

Figure 4 shows the respondents' climate change perceptions. The majority of respondents (75%–90%) agreed or strongly agreed with the following statements: 1) climate change results in negative human health effects, species loss, economic costs, and environmental deterioration; 2) climate change is caused by deforestation, fossil fuel use, industrial pollution, and urbanization; and 3) climate policies are essential and individuals must take responsibility and change their behavior to manage climate change. About half of the respondents agreed or strongly agreed that carbon emissions would affect their destination choice. As shown in Table IV, the respondents with higher climate change perceptions were more likely to select trips with low carbon footprints and to destinations that were taking action to mitigate carbon emissions, but they were more sensitive to the carbon offset price. These findings supported Hypothesis 4. In addition, according to the estimates of the structural component of the latent variable model, respondents older than 60 years possessed more knowledge of climate change impacts and causes and thus were more likely to take actions in response to climate change than the younger respondents. These findings partly supported Hypothesis 5.

(Insert Figure 4 about here)

4.3 Willingness to pay

We calculated WTP using the mean parameter estimates of the five attributes from the hybrid model according to Equation (10) (see Table VI), which produced universally significant values at the 1% level. On average, the respondents in the control group were willing to pay HK\$296 for short- and medium-haul travel and HK\$206 for carbon dioxide emission offset

projects. The respondents in the control group would demand compensation if the temperature became higher and carbon dioxide emission increased. The respondents in the treatment group would pay HK\$328 for short- and medium-haul travel, HK\$534 for carbon reductions, and HK\$359 for carbon offset projects in the destination. By comparison, first, respondents in both groups were willing to pay relatively more for the destination closer to their home. In the post-pandemic era, due to quarantine policies and safety concerns, most of the respondents preferred destinations with short distances from their origin markets. Second, the respondents in the treatment group were willing to pay for a destination with a higher temperature, but the amount was much lower than those for the other attributes. Third, carbon offset projects were important for the respondents in both the control and treatment groups, but the respondents in the nudging scenario with the impacts of climate change were willing to pay more to support the carbon mitigation projects in the destination. Finally, the respondents in the treatment group were inclined to compensate for the environmental pollution caused by carbon emissions, while those in the control group were reluctant to pay extra during their trip. In the nudging scenario, this value was HK\$131 higher than in the control group. This implies that the nudging information played a vital role in respondents' destination choice and their willingness to pay for carbon mitigation-related attributes in the destination.

Additionally, regarding the WTP amount for carbon-related attributes, each respondent was willing to pay an average of HK\$403 per trip per ton of CO₂ mitigation, which was higher than the social cost of carbon (~HK\$350/ton in 2022) proposed by Nordhaus (2016). The findings supported Hypothesis 2. As found in previous studies, travelers' WTP for reducing carbon emissions often exceeded the supplied carbon prices (Brouwer et al., 2008; Denstadli & Veisten, 2020; Lu & Shon, 2012).

(Insert Table VI about here)

5. Discussion and conclusion

5.1 Conclusion

This study investigated tourists' preferences for low-carbon-footprint travel choices with consideration of a nudge effect using the HCM. The study found that (1) tourists cared about destination type, carbon emissions, and travel expenditure when they selected destinations; (2) nudging played a significant role in the tourist decision-making process and increased environmentally friendly choices; and (3) tourists with higher climate change preferences were more willing than others to travel to low-carbon-emission destinations that supported carbon offset projects.

5.2 Theoretical implications

This study makes four major theoretical contributions. First, it extends the destination choice mechanism by incorporating carbon emission-related factors and a tourist psychological factor, climate change perception, in the context of global warming based on random utility theory and nudge theory. Furthermore, this study fills a research gap by showing that factors related to carbon emissions influenced tourist destination choice, thus contributing to the literature on consumers' preferences for low-carbon choices in the aviation industry (Babakhani et al., 2017; Choi and Ritchie, 2014; Raux et al., 2021) and other industries (e.g., the automobile and retail industries; Achtnicht, 2012; Sovacool et al., 2021; Vanclay et al., 2011). In addition, the effects of individuals' climate change perception and demographic characteristics on low-carbon travel choice support the idea that tourists' preferences for

destination attributes vary depending on tourists' potential sociopsychological setting (Um & Crompton's, 1991). The study verifies that tourist destination choice behavior was determined by both destination attributes and individual psychological factors. Third, this study utilizes nudging theory to indicate that a slight push, such as a piece of information, can change tourists' decisions in terms of destination choice. This finding enriches those of prior studies on tourists' pro-environmental behavior by exploring whether nudging information influences low-carbon destination choice and supports the effectiveness of nudging in promoting desirable behavior (Thaler & Sunstein, 2008) from the tourism perspective. The study provides a useful nudging technique to encourage tourists to make environmentally friendly travel choices. Fourth, the study extends prior studies by estimating tourists' WTP for carbon-related attributes in a general destination setting (destination choice) rather than in a specific tourism section (e.g., aviation). Each respondent in the current study was willing to pay an average of HK\$534 per trip per ton of CO₂ mitigation, which was higher than the social price of carbon (~HK\$350/ton in 2022) proposed by Nordhaus (2016). As found in previous studies, travelers' WTP for reducing carbon emissions often exceeded the supplied carbon prices (Brouwer et al., 2008; Denstadli & Veisten, 2020; Lu & Shon, 2012). Based on economic demand theory, the findings regarding WTP affect the supply of and demand for carbon mitigation products as well as consumer surplus in the free carbon market.

5.3 Practical implications

The practical implications of the study are summarized as follows. First, the respondents exhibited a high preference for destinations with low carbon emissions and decarbonization actions. Therefore, destination businesses should make more effort to reduce carbon emissions, such as improving the accessibility, affordability, and acceptability of low-carbon-footprint travel products. Travel agencies could design and promote lower emission travel packages for tourists to improve awareness of environmental protection during their trips. Based on the significant positive estimates of willingness to pay for carbon mitigation attributes, business practitioners should be encouraged to incorporate environmental protection costs into their pricing strategies.

Second, destination management organizations (DMOs) should consider supporting and investing in carbon neutral projects, including policies such as carbon subsidies or carbon reduction taxes for restaurants, hotels, and scenic attractions. The design and implementation of adaptation and prevention policies is also important to mitigate the expected damage caused by climate change at the destination. Climate change and carbon emissions influence tourists' selections of specific destination types as well as the seasonality of tourism demand in the destinations. Therefore, to sustain the volume of repeat visitors, DMOs should undertake adaptation policies according to the destination's specific situation to ameliorate the damage caused by carbon emissions. To do so, DMOs must regularly evaluate the impacts of climate change and carbon emissions and take corresponding measures to rapidly address the issues in ways that enhance the attractiveness of the destination (Lam-Gonzalez et al., 2022).

Third, to mitigate the carbon emissions of tourism transportation, the UNWTO, UNEP, and WMO (2008) proposed two major carbon offsetting strategies: first, encouraging tourists to select short-haul destinations and public transportation and to reduce aviation use, and second, providing market-based incentives for tourism practitioners to reduce carbon emissions and improve energy efficiency (Debbage & Debbage, 2019). DMOs could consider

promoting tourists' use of public transport services and providing travel routes by public transport tailored for tourist uses. The preferential tax regime applied to the aviation industry should also be abolished, as it distorts prices compared with other modes of transport. Rather, governments should levy taxes on long-haul air travel routes with a variety of alternative transportation modes (Nawijn & Peeters, 2010). This might affect tourist preferences and replace such flights with other more environmentally friendly transportation modes. Lastly, destinations should add a proxy for the environmental costs to ticket prices and extend lengths of stay through promotions on accommodation (Laroche et al., 2023).

In this study, influenced by the nudging message, the tourists in the treatment group gave more attention to carbon emission-related factors, which suggests that releasing information on social media in relation to climate change might be a useful avenue for policymakers to encourage tourists to make sustainable travel choices. Furthermore, as people with higher climate change perception ascribed higher value to destinations supporting decarbonization projects, the regular dissemination of information associated with climate change causes, impacts, and possible actions on various social media platforms could increase tourists' environmentally beneficial behavior and consumption. More importantly, tourism will continue to be a major driver of climate change if national policymakers do nothing to manage global carbon emissions (Gossling et al., 2023). International cooperation is a necessary component of coping with climate change, and every country must therefore actively undertake carbon mitigation commitments and be devoted to the development of a low-carbon economy (Wei et al., 2020).

5.4 Limitation and future research

The study has some limitations that provide opportunities for further research. First, we analyzed preferences for destination choices among tourists in Hong Kong, so the findings might not be generalizable to other countries or regions. Future studies could therefore investigate the impacts of carbon-related attributes on destination choice in other origin markets or destinations. Second, studies could explore the effects of different types of nudging (e.g., default nudging) on low-carbon travel choices. Additionally, tourists' low-carbon-footprint travel choices can be influenced by many latent factors other than climate change perception. Therefore, future studies could incorporate psychological factors such as personal norms and habits into the model to explain tourist decision-making behavior and further explore the mechanism behind tourists' low-carbon travel choices. Finally, future experimental designs would benefit from adding other attributes, such as governmental environmental protection policies, to the choice set to examine whether tourist behavior can be changed by these additional destination-specific factors.

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Table I. Attributes and attribute levels

Attribute	Description	Levels
Types of destination	Short- and medium-haul: flight duration < 6 hours from Hong Kong to the destination; long-haul: flight duration > 6 hours	Short- and medium-haul destination Long-haul destination
Destination temperature (°C)	Average temperature between October and November	11-16°C 17-22°C 23-28°C 29-34°C
Carbon dioxide emission of the trip per person (kg)	Amount of carbon dioxide emitted by a flight per person	0-320 (lowest carbon dioxide emission) 321-640 (low carbon dioxide emission) 641-960 (high carbon dioxide emission) 961-1280 (highest carbon dioxide emission)
Tourism-related carbon offset projects	Tourism-related sectors in the destination conduct measures to reduce local carbon emissions (e.g., hotels equipped with energy-saving lights or other facilities using renewable energy; restaurants using less disposable tableware; scenic spots providing shuttle buses using solar energy, natural gas, high-energy batteries, or other renewable energy or lower-polluting energy)	Yes No
Carbon offset payment	Voluntary payment for carbon offsets in addition to the original tourism price of the trip per person	2.5% of the tourism price 5% of the tourism price 7.5% of the tourism price 10% of the tourism price

Table II. Profile of the sample

		Full sample (n = 958)	Control group (n = 472)	Nudging group (n = 486)
	Variable	%	%	%
Gender	Female	50.2	50.2	50.2
	Male	49.8	49.8	49.8
Age	18-29	23.5	23.3	23.7
	30-39	26.4	26.7	26.1
	40-49	23.7	23.5	23.9
	50-59	19.1	19.1	19.1
	60 and above	7.3	7.4	7.2
		No formal education	0.1	0
Educational attainment	Primary school	0.3	0.4	0.2
	Secondary education	22.5	24.4	20.8
	Further education	15.9	16.1	15.6
	Bachelor's degree	46.1	43.2	49.0
	Master's degree	13.2	14.0	12.3
	Doctoral degree	1.9	1.9	1.9
Annual household income	below HK\$300,001	13.6	14.0	13.2
	HK\$300,001-400,000	17.2	17.6	16.9
	HK\$400,001-500,000	16.3	17.8	14.8
	HK\$500,001-600,000	11.8	12.9	10.7
	HK\$600,001-700,000	11.8	10.6	13.0
	HK\$700,001-800,000	9.7	9.3	10.1
	HK\$800,001-900,000	7.2	4.9	9.5
	HK\$900,001-1,000,000	4.0	5.3	2.7
	HK\$1,000,001 or more	8.5	7.6	9.3

Table III. Performance of MNL, MMNL and hybrid choice model

	MNL	MMNL	Hybrid Choice Model
Log-likelihood (choice)	-5069.69	-4636.85	-4621.04
AIC (choice)	10159.37	9313.7	9282.08

Note: AIC = Akaike information criteria; MNL = multinomial logit; MMNL = mixed multinomial logit; HCM = hybrid choice model.

Table IV. Estimation results of the hybrid choice model for destination choice

	Coeff.	(Std. err)	Std. dev	(Std. err)
Individual preference for destination attribute				
<i>Control group</i>				
Destination type	0.457***	(0.066)	0.888***	(0.079)
Temperature	-0.030***	(0.005)	0.047***	(0.009)
Carbon emissions	-0.622***	(0.075)	0.502***	(0.163)
Carbon offset	0.317***	(0.072)	1.232***	(0.097)
project				
Payment	-1.542***	(0.558)	2.929***	(0.431)
(including carbon offset payment)				
<i>Treatment group</i>				
Destination type	0.476***	(0.066)	0.982***	(0.077)
Temperature	-0.032***	(0.004)	0.013***	(0.012)
Carbon emissions	-0.776***	(0.078)	0.849***	(0.122)
Carbon offset	0.522***	(0.065)	0.960***	(0.082)
project				
Payment	-1.453***	(0.507)	3.141***	(0.467)
(including carbon offset payment)				
Effects of latent variable on individual preference for destination attribute				
<i>Control group</i>				
Destination type	0.035	(0.067)		
Temperature	-0.001	(0.005)		
Carbon emissions	0.310***	(0.077)		
Carbon offset	-0.152**	(0.072)		
project				
Payment	0.880***	(0.190)		
(including carbon offset payment)				
<i>Treatment group</i>				
Destination type	0.099	(0.067)		
Temperature	0.005	(0.004)		
Carbon emissions	0.237***	(0.082)		
Carbon offset	-0.263***	(0.068)		
project				
Payment	0.208	(0.178)		
(including carbon offset payment)				
Effects of socio-demographic information on latent variable				
Age (old people)	0.383***	(0.124)		
Age (younger generation)	-0.005	(0.058)		
Gender (female)	0.046	(0.058)		
Income (higher)	-0.102	(0.073)		
Education (high)	0.049	(0.081)		

Estimates of the parameters of the measurement equations of climate change perception (CCP)

Indicator 1	-2.107***	(0.136)
Indicator 2	-2.184***	(0.139)
Indicator 3	-1.617***	(0.107)
Indicator 4	-2.104***	(0.137)
Indicator 5	-1.610***	(0.106)
Indicator 6	-1.745***	(0.112)
Indicator 7	-1.803***	(0.115)
Indicator 8	-1.911***	(0.119)
Indicator 9	-1.684***	(0.112)
Indicator 10	-1.416***	(0.097)
Indicator 11	-1.587***	(0.104)
Indicator 12	-0.785***	(0.079)

Notes: ***, **, and * represent 1%, 5%, and 10% significance levels, respectively.

Table V. Delta method results of coefficient differences between control and treatment groups

	Differences in coefficients	Std. err.	t-ratio	p-value (one-tailed)
Destination type	-0.020	0.093	-0.210	0.417
Temperature	0.002	0.006	0.280	0.390
Carbon emissions	0.154*	0.107	1.450	0.074
Carbon offset projects	-0.205**	0.096	-2.140	0.016
Payment (including carbon offset payment)	-0.088	0.754	-0.120	0.452

Note:***, **, and * represent 1%, 5%, and 10% significance levels, respectively.

Table VI. WTP mean values for non-monetary attributes

	Control		Treatment	
	WTP	Std. err.	WTP	Std. err.
Destination type	296***	(0.145)	328***	(0.151)
Temperature	-20***	(0.010)	-22***	(0.010)
Carbon emissions	-403***	(0.194)	-534***	(0.239)
Offset projects	206***	(0.107)	359***	(0.155)

Note: Values of WTP are in HK\$; ***, **, and * represent 1%, 5%, and 10% significance levels, respectively.

	Destination A	Destination B
Type of destination	Long-haul destination	Short- or medium-haul destination
Destination temperature (°C)	11-16°C	23-28°C
Carbon dioxide emission of the trip per person (kg)	961-1280 (highest carbon emission)	321-640 (low carbon emission)
Carbon offset projects	Yes	No
Carbon offset payment (HK\$)	188	94
Which destination would you choose?	<input type="checkbox"/> A	<input type="checkbox"/> B

Figure 1. Sample choice set in the experiment

Imagine you are planning a *[response to question 1.3]* days leisure trip with *[response to question 1.5]* persons. You will select a destination that you prefer and go there by plane during October and November. The average temperature in Hong Kong at that time is 23~26°C. When you are making the travel plan, you see a piece of news about carbon emissions on social media: Carbon dioxide emissions have had severe impacts on the entire world. According to the Intergovernmental Panel on Climate Change (IPCC), continued carbon emissions largely determine global warming and increase the likelihood of severe, pervasive and irreversible impacts on ecosystems, including more frequent wildfires and extreme weather, accelerated sea-level rise and mass extinction of species etc. Travel activities are also affected by global climate change which is caused by excessive carbon dioxide emissions. Everyone has the responsibility to take action to reduce carbon emissions for environmental protection and sustainable tourism development.



Figure 2. Nudging message in the questionnaire.

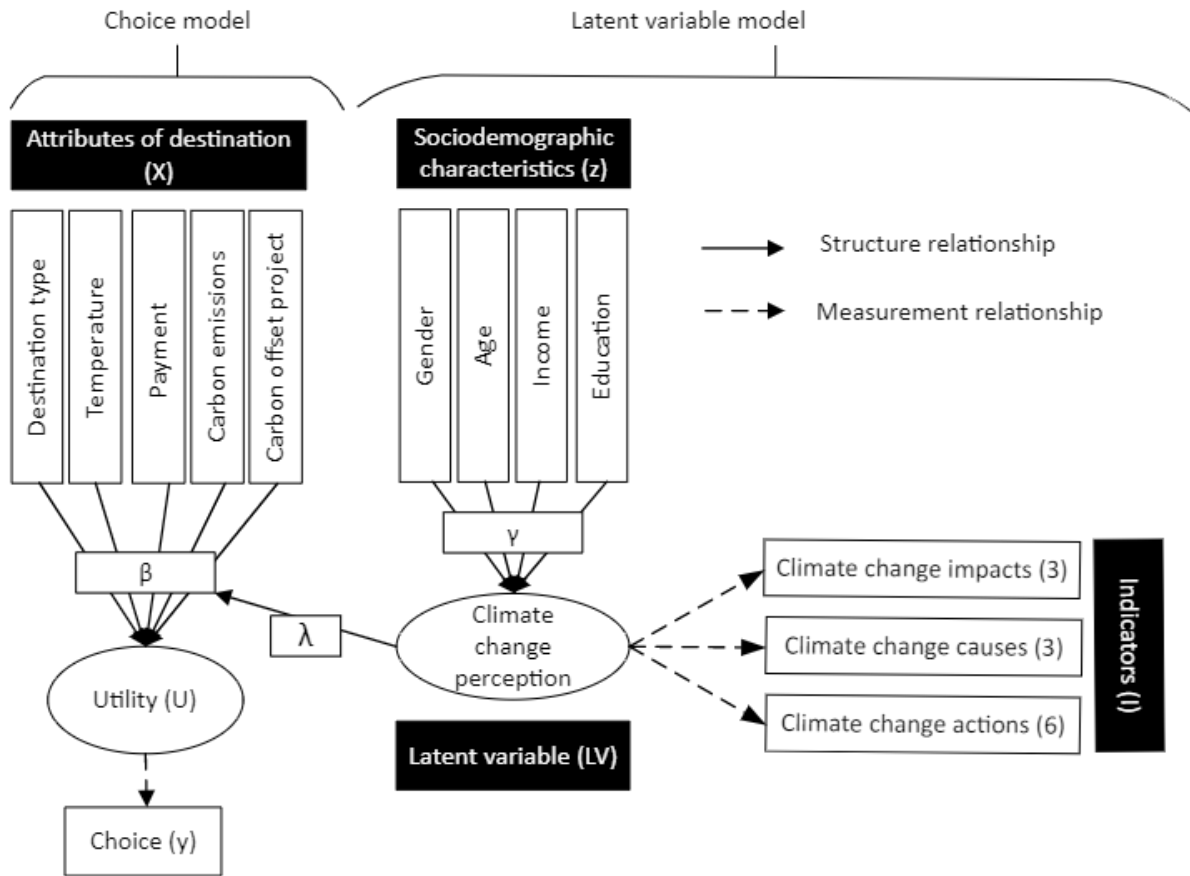


Figure 3. Framework of hybrid choice model

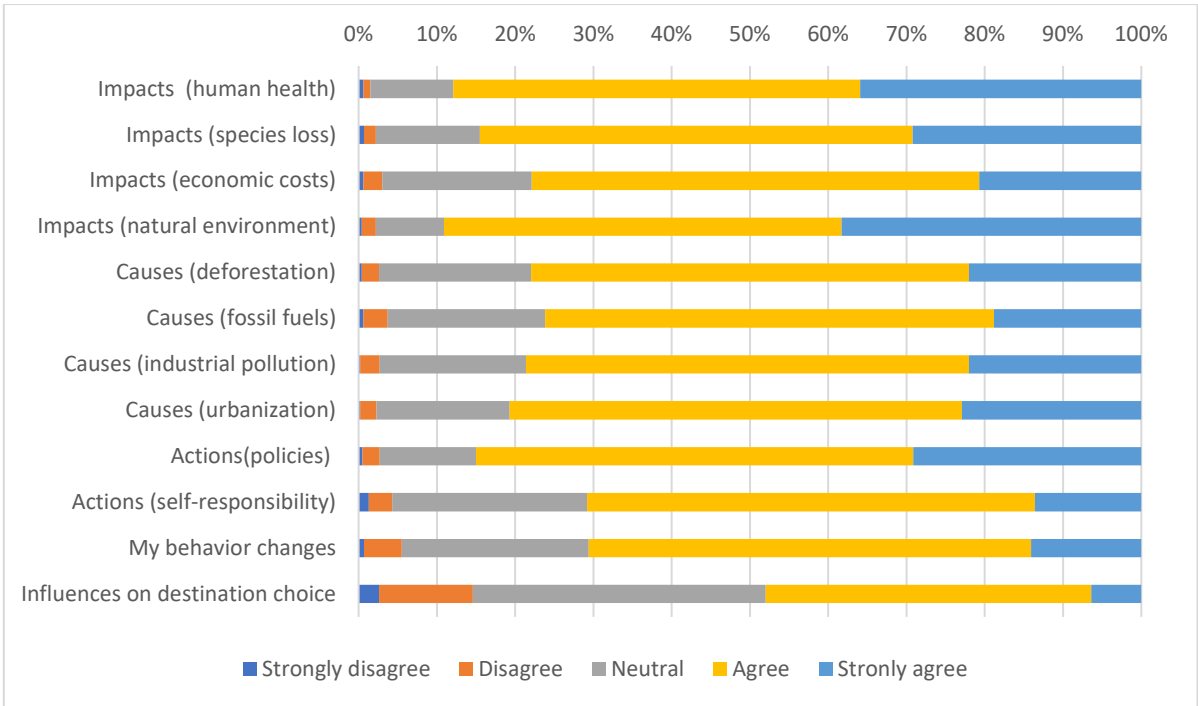


Figure 4. Perception of climate change