The Willingness to Carbon Offsets and Its Influencing Factors of the Catering Owners in Forest Tourism Based on Boosted Regression Tree—A Survey on 159 Samples in 10 National Forest Parks in Jiangxi

Liguo Wang, Xiaowen Xie, Ya Liu and Danhua Xiong

ABSTRACT

Climate and environment issues mainly caused by global carbon emissions are becoming more and more prominent. As a major implementer of carbon emissions, the catering operators’ willingness to use energy and carbon offset plays an important role in the low carbon development of forest tourism. Based on the effective questionnaire survey of 159 catering operators in 10 national forest parks in Jiangxi Province, this study analyzed the willingness of catering operators to carbon offsets and its influencing factors by the Boosted Regression Tree model. The results show that 20 factors such as means of carbon offset affect the catering operators’ willingness of carbon offset, and the contribution rate of each variable factor was calculated, among which 12 factors affect more than 85%; the operators’ perception of tourism ecological environment, the means of carbon offset, the convenience of carbon offset, the operator's carbon offset motive, the operating income, and the degree of education are positively correlated with the carbon offset willingness, in line with the null hypothesis. The carbon emissions are adverse to climate change. The perception of influence is negatively correlated with the willingness to carbon offset. This study provides a decision-making reference for the establishment of a carbon offset mechanism for forest tourism.¹

¹Liguo Wang, Xiaowen Xie, (1. College of Land and Resources, Jiangxi Agricultural University; 2. Key Laboratory of Agricultural Resources and Ecology of Poyang Lake Basin, Jiangxi Province; 3. Rural Tourism Development Research Center of Jiangxi Agricultural University; 4. Nanchang Rural Tourism Development Research Center, Nanchang, China 330045)
Ya Liu. Jiangxi College of Foreign Studies, Nanchang, China, 330009
Danhua Xiong. Jiangxi Wuyuan Tea Vocational College, Wuyuan, China, 333299
KEYWORDS

Willingness to Carbon Offset; Catering Operators; Influencing Factors; BRT Model.

INTRODUCTION

In global climate change times, “low carbon” has become a hot topic. Carbon offset [1] is an effective and viable way to achieve low carbon development. In practice, of the national, enterprise and individual levels, some carbon offset cases have shown good experience, which made ecological services from free to be paid [2-4]. In academics, scholars have also carried out researches on carbon offset from different perspectives, mainly focusing on carbon offset willingness, carbon offset mechanism, carbon offset market, and carbon offset operation mode. For example, Choi A.S and BW Ritchie (2014) studied the Australian airplane travellers’ willingness and behaviors of carbon offset [5]. Miller KA, SA Snyder et al. (2012) assessed forest carbon credits of US forest landowners under carbon market transactions [6]. Kollmuss A (2008) discussed the role of the resource carbon offset market [7]. Eijgelaar (2010) proposed solutions of voluntary carbon offset to reduce tourism emissions, and considered offsetting as the best solution to reduce emissions by assessing the carbon emissions of airlines and travel companies [8]. Soto JR, DC Adams, et al. (2016) studied the attitudes and willingness of landlords in Florida accepting forest carbon offsets with the procedures model of pros and cons [9]. Habesland DE, MA Kilgore et al. (2016) studied the willingness of Norwegian family forest owners to participate in carbon offset projects [10]. Christopher. S (2009) used virtual “field testing” to calculate the impact of forest management carbon offset agreements on accounting [11]. Wittman Hannah K. and Caron Cynthia studied the phenomenon of carbon offsets and inequalities in Guatemala and Sri Lanka, and analyzed the social costs and common interests of local carbon offsets [12]. Liguo Wang (2012) study the core stakeholders’ carbon offset decision-making behavior in forest tourism with the case of the Sanzhualun national forest park [13]. The focus of academic circles is on the key problems of global carbon market, carbon market design, forest carbon offset and carbon leakage [14].

The researches on carbon offset have a good theoretical and case reference for our study, and the results of carbon offset stakeholders are relatively few, and mainly concentrated on tourists, government, residents, farmers, but seldom for tourism operations. As a participant in tourism activities, forest catering operators also generate carbon emissions in their business activities. Therefore, it is necessary to study the catering operators’ willingness of carbon offset and its influencing factors. This paper conducts a survey on the carbon offsetting willingness of 159 catering operators in ten national forest parks, and uses R software to analyze the factors affecting the willingness to participate in carbon
offset using the Enhanced Regression Tree (BRT) model. This not only provides theoretical support for the establishment of tourism carbon offset mechanism, but also provides countermeasures for the development of low carbonization of forest tourism.

MATERIALS & METHODS

Data Source

The data were mainly obtained through questionnaires. The main target of the survey was the catering operators around the selected forest park. The survey conducted two periods during April-October 2016 and the summer of 2017. According to the geographical location of the parks and the local forest park tourism conditions, this paper selects 10 typical national forest parks, namely Yangling, Sanbaishan, Doushihu, Meiling, Yulinhu, Sanwan, Shangqing, Guifeng, Mingyueshan and Wugongshan, including 3 in the south, 2 in the north, 1 in the middle, 2 in the east, and 2 in the west of the province (shown in Figure 1). According to the different developments in different regions, the number of samples in the forest parks varies, and the number of questionnaires issued by 10 forest parks is also different. A total of 180 questionnaires were delivered out, 168 questionnaires were returned, and 159 questionnaires were completed and valid. The effective rate of the questionnaire was 88.3%. In this paper, the reliability analysis of 40 judgment questions of 159 valid questionnaires is carried out. The cloned Bach coefficient Cronbach alpha of the questionnaire is 0.737, which is in the high confidence interval, indicating that the questionnaire has high reliability and the data is consistent.

Methods

In the study, we’re exploring whether the catering operators in the forest park are willing to participate in carbon offsets. Whether they are willing or not is a qualitative dichotomous variable. This paper adopted the boosted regression trees (BRT) model for binary regression analysis. BRT is a self-learning method based on classification and regression tree (CART), which generates multiple regression trees through random selection and self-learning methods. During the operation process, a certain amount of data is randomly selected to analyze the influence of independent variables on the dependent variables. The rest of the data is used to test the fitted data. The model finally takes the mean of the generated multiple regression trees and outputs it [15-17]. The model continuously subdivides the sample by recursive or continuous layering method, so that the sample homogeneity in the node is maximized until the number of samples in the node is too small to end the layering. The model determines the number of decision trees by 1/10 cross-validation and the user determines the important
parameters ranging from learning rate, tree complexity to bag fraction, etc. according to actual needs. The BRT method improves the stability and accuracy of the calculation results, and obtains the influence of the independent variable on the dependent variable as well as the relationship between the independent variable and the dependent variable when other independent variables take the mean or remain invariable[18-19]. The BRT not only can detect the degree of correlation between the independent variables and the dependent variables, but also accurately calculate the contribution rate of each variable to the dependent variable.

**Variable Selection and Description**

According to the regression analysis of the willingness of operators to carbon offset, the dependent variable of this paper is whether the operator are willing for carbon offsets or not. According to the research hypothesis, combined with the corresponding references and related research on BRT methods, under the premise of not considering individual variables, BRT analysis is carried out on a total of 38 factors in four parts, which are respectively 9 factors of environmental perception and 11 participation attitude factors, 8 participation motivation factors, 10 participation behavior factors; In the analysis of block variables, according to the principle of major component analysis, the principal component variables are screened from high to low according to the standard of cumulative contribution rate of 60%[19], and then the BRT analysis of the influencing factors of the operator's carbon offset willingness after integration is carried out, so as to obtain the influence degree and influence direction of the main influencing factors of the operator's carbon offset willingness, the control variable, the individual variables of the operator, added.

**BRT ANALYSIS OF CARBON OFFSET WILLINGNESS OF CATERING OPERATORS**

**Research Hypothesis**

With the references to relevant results [13] and the actual status of the forest parks in Jiangxi Province, the factors that may affect the operators’ willingness of carbon offsets are divided into five parts: environmental perceptions, attitudes, motivations, behaviors and personal factors. There mainly includes the following hypothesis.

**Hypothesis 1:** There is a positive correlation between the catering operators’ cognition of tourism ecological environment and their willingness of carbon offsets. Forest park catering operators rely on the natural and social environment around them, and are theoretically more sensitive to the tourism ecological environment. If the surrounding environment does not change much and affects
its production and operation, the willingness to carbon offsets may not be obvious; If it has already been affected and the impact is obvious, they will make efforts to improve the current environment, and their willingness to carbon offsets will greatly increase.

Hypothesis 2: The operators’ cognition of carbon offset is positively correlated with the willingness to carbon offset. The perception of the behavior of carbon offset will make the operator choose the emotional attitude of carbon offset. If the cognition is more comprehensive and realizes that carbon offset is conducive to the environment and beneficial to oneself, then the emotional attitude towards carbon offset tends to be supporting and thus willing to carbon offset; While with little or even negative understanding, the operator is not willing to participate in carbon offsets.

Hypothesis 3: The operator's carbon offset motivation is positively correlated with the willingness of carbon offset. Motivation factors include intrinsic motivation and extrinsic motivation. The intrinsic motivation is why the operator is willing for carbon offset or what he wants. While the external motivation is what the society can give to the operators who participate in carbon offset. Operators may participate in carbon offsets for a variety of intrinsic motivations such as their own special purposes, preferences, responsibilities, etc., which is relatively continuous. Operators may also participate in carbon offsets due to external motivations such as social reputation and governmental awards, but such extrinsic motivations are conditional.

Hypothesis 4: The condition for carbon offset is positively correlated with the operator's willingness to carbon offset. The less time it takes in carbon offsets, the more convenient the carbon offset methods are, and the more reasonable the use of carbon offset funds is, the stronger the willingness of operators to carbon offset is. At the same time, the energy consumption required for operation, the acceptance and selection of clean energy, and its own carbon emissions will also affect the operators’ willingness of carbon offset. With use of clean energy, there will be less carbon emissions and less willingness to compensate for carbon.

Hypothesis 5: The individual factors of the operator are related to the willingness to carbon offset. The difference in gender causes different in subjective cognition and discrimination of carbon offset. The perceptions and attitudes of carbon offset are different at different ages, so willingness to carbon offset may be different. At the same time, in theory, the higher education the operator gets, the stronger the willingness for carbon offset is, and the higher income he obtains, the stronger willingness for carbon offset he/she has.

Research Results and Analysis

RESEARCH PROCEDURE

In this paper, the enhanced regression tree analysis is carried out by using the BRT3.0 equation package written by Elith. The parameters are as follows:
decision tree complexity $tc=5$, learning probability $lr=0.0001$, and division ratio (bag fraction)$=0.5$. Each calculation calculates 50% for data analysis, that’s model construction; 50% for training, that’s detection model.

The number of trees is determined by 1/10 cross-validation method. Finally, various models are constructed as follows—environment perception model consisting of 4200 decision trees, a participation attitude model consisting of 6300 decision trees, a participation motivation model consisting of 7500 decision trees, and a participation behavior model consisting of 6000 decision trees as well as the analysis model of comprehensive factors consisting of 8000 decision trees after adding the operator's personal variables. The percentage indicates the contribution rate of the factor. The overall trend of the curve indicates the positive and negative correlation with the dependent variable. The overall trend of the curve is rise, which means positively correlation, and the decrease is negative correlation; The curve of some variable showing different trend at different stages indicates that the factor has different influences on the dependent variable at different stages; The rising trend of the curve and the high contribution rate indicate that the factor has a high positive correlation with the dependent variable, and vice versa.

Figure 1. The influence of main factors affecting carbon offset willingness and its marginal effect.
With the BRT analysis of environmental perception, participation attitude, participation motivation, and participation behavior, the results show that (Table I): (1) Among environmental perception factors, co2e is important factors for climate change (A08), the surrounding tourism ecological environment is deteriorating (A01), and carbon emissions will have adverse effects on climate change (A05). The cumulative contribution rate of the three factors is 62.7%, greater than 60%, and these three factors are selected as the main component variables; (2) In the analysis of 11 factors involved in attitudes, the cumulative contribution rate of the four factors, carbon offset contributes to the scientific management of forests (B02), the time spent on carbon offsets (B08), and the correct use of tourism carbon offset funds (B04), carbon offset can improve my social status (B06), confidence in tourism carbon offset prospects (B05), is 66.1%, greater than 60%, and they are selected as the main component variable; (3)
Among the 8 factors involved in motivation, the cumulative contribution rate of the four factors, which are, no specific purpose to participate in carbon offset (C01), participation in carbon offset for ones preferences (C02), carbon offset will enhance personal reputation (C05), and undertake social responsibility (C06), is 69.9%, more than 60%, so they are selected as the main component variable; (4)In 10 factors selected for participation behavior, the contribution rate of positive correlation factors, carbon offset means (D07), Co2e that is willing to be eliminated each year (D06), annual energy expenditure of the business(D01), and carbon emissions estimated annually (D05), is 24.7%, 18.1%, 17%, and 14.4%, and the cumulative contribution rate of the four factors is 82.4%, greater than 60%, which are selected as the main component variable.

The 20 principal component factors screened are subjected to BRT analysis again, and the results are shown in Figure1 and Table 1.

RESEARCH RESULTS AND ANALYSIS

The results of BRT operation show that among the 20 selected factors, the degree of influence on factors in the operators’ willingness of carbon offset is: the contribution rate of C01 carbon offset with certain specific purposes is 12.4%; the contribution rate of D07 carbon offset means is 10.1%.; the contribution rate of A08 CO2e is an important factor contributing to climate change is 9.9%; the contribution rate of C02 participation in carbon offset for ones preferences is 9.8%; the contribution of gender is 7.1%;D06 Co2e that is willing to be eliminated each year is 6.4%; D05 Estimated annual co2e is 5.3%; the contribution of D01 annual energy expenditure is 4.8%; the contribution of individual carbon emissions to adverse effects of climate change is 4%; The contribution rate of carbon offsets contributing to forests scientific management is 3.8%; The contribution rate of participation in carbon offset to take the social responsibility in protecting environment is 3.7%; carbon offset time contributes 2.7%; education contributes 2.5%; The contribution rate of participation in carbon offset improving social reputation is 2.3%; the participation in carbon offset increasing the social status contributes 2.2%; tourism carbon offset funds to be used properly contributes 1.6%; the confidence to the prospect of tourism carbon offset contributes 1.3%; annual revenue contributes 1.3%; Age contributes 0.6%

From the statistical principle of principal components [53], the cumulative contribution rate of the first 12 factors reaches 85.4%, which are the main factors affecting the willingness of operators to carbon offset; the cumulative contribution rate of the last 8 factors is 14.6%, of small impact. The analysis of the factors affecting the willingness of operators to carbon offset is as follows:

(1) The cognition of tourism ecological environment is positively correlated with the willingness for carbon offsets. Among the factors of environmental cognition, operators believe that CO2e is an important factor in climate change, and they also realize that the surrounding tourism ecological environment is
deteriorating. This shows that the more they agree that carbon dioxide is an important factor in climate change, and the higher their recognition of the surrounding tourism ecological environment deteriorating is, the higher their willingness to carbon offset is. As the catering operators of forest tourism destinations, their business activities depend on the surrounding tourism ecological environment. The bad trend of the climate change cause damage to the natural environment, and the tourism ecological environment is also affected resulting in the decrease in the tourist arrival, which means that the business activities of the operators are affected, so when carbon offsets can alleviate this problem, their willingness to carbon offsets will rise.

(2) The operator’s means of carbon offset is positively correlated with the willingness of carbon offset. Among the 20 factors selected, the contribution rate of carbon offset means indicates that in the behaviors of carbon offset, operators pay more attention to how to reduce carbon emissions in business activities, and the more reasonable and scientific the carbon offset means, the stronger willingness to carbon offsets the operator has. Obviously, in the case that the operators are not very clear about their own carbon emissions and they are not very familiar with carbon offset, the carbon offset means largely determines their willingness to offset. Combined with the carbon offset options given in the questionnaire, the reason may be as follows: firstly, scientific and reasonable carbon offset means can make operators believe that carbon offset can make the environment better, and benefit their own business activities. Secondly, if the carbon offset means can be carried out possibly by themselves, for example planting trees to offset carbon emissions, the willingness of operators to participate in carbon offsets will increase. The carbon emissions that are willing to be eliminated each year are also positively correlated with the willingness for carbon offset, with a contribution rate of 6.4%. The annual carbon emissions that are willing to be eliminated are related to annual carbon emissions, which means that the higher the annual carbon emissions, the greater the willingness for carbon offset. The large amount of carbon emissions indirectly shows that its operating income is definitely relatively high, and the ability of carbon offset is higher, then its willingness will become stronger.

(3) The convenience of carbon offset is positively correlated with the willingness to carbon offset. The convenience to carbon offset affects obviously the operator's choice of carbon offset attitude. Under the condition that carbon offset does not take too much time, the carbon offset funds can be used correctly and promote the management of the surrounding forests. And the willingness of the operators to participate is correspondingly increased. Too much time will affect the operators’ normal business, which is not what they expect. If the carbon offset fund is not used for carbon offset, which is contrary to the original intention of the paying, this may be the key reason for the positive correlation between the convenience of carbon offset and the willingness to carbon offset.

(4) The operator's motivation of carbon offset is positively correlated with the
willingness to carbon offset. The motivation of the operator's carbon offset is a engine for he/her to participate in carbon offset. The contribution rate of the four motivation factors in the overall factors is 28.2%. Operators will decide whether to participate in carbon offset according to their own preferences, or with some specific purposes; Participation in carbon offset is also to protect the environment and assume their own social responsibilities and expect to improve the personal social reputation. Now people's living standards have greatly improved, and the lifestyles they are expecting are changing. Compared with the past, utilitarianism is no longer so serious. Operators understand the connotation of carbon offset, and hope that in this way, they will do their utmost to protect the environment everyone depends on. That’s what they are willing to do.

(5) The perception of the adverse effects of carbon emissions on climate change is negatively correlated with the willingness to carbon offset. The negative impact of the operator's carbon emissions on climate change is negatively correlated with the willingness of carbon offset, which contributes 4%. That is to say, the more the perception of the operators’ adverse effects on their own carbon emissions on climate change, the lower the willingness for carbon offset. This abnormal special situation doesn’t match with the null hypothesis.

(6) The operator's operating income is positively correlated with the willingness of carbon offset. The contribution rate of the operator's annual operating income to the carbon offset willingness is only 1.3%. Although it is not the main affecting factor, it can be seen from the curve in the figure that the increase in annual operating income is positively related to the carbon offset willingness. That means the higher the operating income is, the stronger the willingness to carbon offset is.

After the operators understanding the carbon offset and considering that the carbon offset can form a virtuous circle, the carbon offset method is optional, and the carbon offset fee is not high relatively to their income, they will be willing to make carbon offsets.

(7) The educational level of operators is positively correlated with the willingness to carbon offset. The educational level can determine people's perceptions and attitudes toward things. The higher his/her education is, the faster the acceptance of new things and concepts is, and the deeper the understanding is. Although the contribution rate of the cultural factor is only 2.5%, the curve in the figure shows that the higher the level of education, the higher the willingness to carbon offset. The education level of the operators will affect their understanding and acceptance of carbon offset. The higher the education level is, the more the cognition of carbon offset the operator has, and the higher his/her enthusiasm for participation in carbon offset is. But due to the lower level of education, misunderstanding of carbon offset and consideration that it is only a disguised way to increase taxes, the operator often reduce his/her willingness to carbon offset.

(8) The gender and age of the operators have a certain impact on the willingness to carbon offset. In the results, the contribution rates of gender and
age to the willingness for carbon offset were 7.1% and 0.6%. The segmentation curve in the figure shows that the male operator’s willingness to carbon offset is higher than that of the female, and the operator’s under 50 years old has higher willingness than the older operators. This may be because men have more social activities than women, they are more concerned about current events than women, and they are willing to take social responsibility, while women are mainly family-oriented, and are reluctant to spend time and money outside the family;

Operators older than 50 may think that they are about to retire, and no longer engaged in this business, so the willingness for carbon offset is low, and those under 50 years old hope that more carbon offsets can bring benefits and increase income, so the willingness is relatively high.

CONCLUSION AND DISCUSSION

Through the BRT analysis of the data from survey samples, the following conclusions can be drawn:

(1) There are 20 factors affecting the carbon offset willingness of catering operators in forest parks, such as carbon offset with specific purposes, carbon offset means, carbon dioxide emission as an important factor of climate change; participation by one’s own preferences, gender, and carbon emissions they are willing to eliminate each year, expected carbon emissions, annual energy expenditures of the business, personal carbon emissions having adverse effects on climate change, carbon offsets contributing to forest management, social responsibility awareness, time for carbon offset, education, social reputation from carbon offset, social status from carbon offset, the correct use of tourism carbon offset funds, confidence for tourism carbon offset, annual operating income, age and others, among which the impact of the first 12 factors is over 85%.

(2) Among the main factors affecting the willingness to participate in carbon offset, the perception of tourism ecological environment, the carbon offset means, the convenience of carbon offset, the motivation of operators’ carbon offset, the operating income, and the education is positively correlated with the willingness for carbon offset, in line with the null hypotheses. However, the perception of the adverse effects of carbon emissions on climate change is negatively correlated with the willingness for carbon offset. With analysis of all factors, there may be several reasons: Firstly, compared to other heavy pollution such as manufacturing industry, catering industry would be regarded that its carbon emission is far from reaching the level that can affect climate change. Secondly, because the relevant national policies and regulations do not enforce for the participation in carbon offset, operators often make decision according to their own preferences; thirdly, operators often believe that the main governance force of climate change should be the government, and their individual role can be minimal. Therefore, it is necessary to improve the ecological awareness, low carbon awareness and carbon offset awareness of the operators in a planned and targeted manner.
(3) The BRT model can resolve the issues on the carbon offset willingness of the catering owners in forest tourism areas and its influencing factors. In this paper, the model reasonably screened the influencing factors and accurately calculated the contribution rate of each variable factor. According to our former research on carbon offset decision-making behavior and its influencing factors of the forest tourism operators, the results of Logistic regression model analysis show that among tourism operators’ carbon offset behavior and habitat anxiety, stress fear, system worry, cost attitude, the future confidence, usefulness, self-involvement, and social responsibility, and there is a significant and positive correlation. The willingness for the carbon offset of catering operators meets basically the analysis scope in terms of the decision-making behavior by the general tourism operators and its influencing factors.

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