The role of eco-tourism in ecological conservation in giant panda nature reserve

Wei Zhou [a], Bin Zheng [a], Zi-qiang Zhang [b], Zhen-jiang Song [a], Wei Duan [a,*]

[a] *College of Economics & Management, South China Agricultural University, Guangzhou, Guangdong, 510642, China*
[b] *College of Tourism and Culture Industry, Guizhou University, Guiyang, Guizhou, 550025, China*

A R T I C L E I N F O	A B S T R A C T
	Eco-tourism is rapidly developing in giant panda nature reserves in China, and is considered a popular tool for biodiversity conservation and the welfare of local communities. However, there is lack of empirical evidence on whether eco-tourism promotes the conservation behavior of local communities members, who live around nature reserves. To this end, this study constructed a framework to measure households' forest conservation activities, and conducted a questionnaire survey in 12 giant panda nature reserves in Sichuan Province, China. A total of 686 valid samples were obtained. A logit model was used to confirm whether income from community-based ecotourism (CBET) could enhance households' conservation behavior. The results show that households prefer three types of conservation practices, and CBET could significantly improve the income of households engaged in it. Income from CBET has motivated local households to participate in conservation activities; however, but the effects are different. In all three conservation activities, income from CBET has shown significant effects on promoting forest maintenance and protection activities, but not on reforestation ones. The results of this research could help us better understand the relationship between CBET and local households' conservation behavior. It also provides information for policymakers seeking for the best way to balance conservation and development.

1. Introduction

According to the International Ecotourism Society, ecotourism is defined as "responsible travel to natural areas that conserve the environment, sustain the well-being of the local people, and involve interpretation and education".[1] Based on the principle that biodiversity must pay for itself by generating economic benefits, community-based ecotourism (CBET) has become a popular tool for biodiversity conservation (Kiss, 2004). The economic benefits it generates could alleviate conflicts between conservation and the demand for development of the local community.

Particularly in China, ecotourism is highly valued because of its significant role in economic, environmental, and social benefits (Zhong and Liu, 2017). A study conducted in 2011 revealed that ecotourism was prevalent in 1033 of the 1110 protected areas surveyed; 43% of these had more than 100,000 ecotourists visiting the area annually (Zhong and Wang, 2011).

Eco-tourism has also developed rapidly in giant panda nature reserves. As of 2015, 67 of these reserves covered 3.36 million hectares (Duan and Wen, 2017). Numerous communities are distributed around the giant panda habitats. The regulation policies of nature reserves limit their development, thus impacting their income and well-being. Concurrently, agricultural management activities and living habits of the local communities are the main threats to nature reserves. CBET is an important manner in which for poverty alleviation and biodiversity conservation in giant panda nature reserves can be achieved (Ma et al., 2019a). According to the fourth Sichuan panda survey, at the end of 2013, there were 14 large-scale tourist scenic spots, with an area of 300, 000 km^2, in the giant panda habitat of Sichuan Province[2]. The main tourist season was from May to November, and a total of 8.19 million tourists visited during the year.

Although eco-tourism has drawn the government's attention and has developed rapidly, our question is: Can it really promote the conservation behavior of people from local communities around nature reserves? This study aims to determine whether income from CBET could encourage households to engage in conservation behavior.

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* Corresponding author.
E-mail addresses: zhouw@scau.edu.cn (W. Zhou), yuki@stu.scau.edu.cn (B. Zheng), 532959728@qq.com (Z.-q. Zhang), tgsongzhenjiang@126.com (Z.-j. Song), duanwei@scau.edu.cn (W. Duan).
[1] See https://ecotourism.org/what-is-ecotourism/.

Many researchers have focused on the effects of CBET on household income and biodiversity separately, and have derived different answers. The positive economic impact of CBET on local communities has been found in many studies. Income from CBET could reduce poverty in local communities and promote the development of rural areas (Ferraro and Hanauer, 2014; Job and Paesler, 2013). This is also the case in China's giant panda nature reserves. Ma and Wen (2016) found that increased non-farm income from CBET could significantly raise the net per capita income for local communities. More specifically, income and well-being have significantly increased for those who live at higher altitudes (Ma et al., 2019b). However, some studies have also found negative outcomes of CBET (Niu and Cheng, 2019). He et al. (2008) found that significant inequality existed between local communities and other stakeholders. There may be a disproportional distribution of economic benefits among stakeholders, thus leading to the failure of ecotourism and consequently, conservation. Coria and Calfucura (2012) discovered that resource and skill constraints were the main reasons the locals suffered. Lonn et al. (2018) found no significant household income and livelihood differences for CBET and non-CBET members in Cambodia. They argued that it is challenging to employ CBET to reduce poverty and improve livelihoods. Ma et al. (2019a, 2019b) found that CBET could increase income inequality for households living inside nature reserves and at high altitudes.

Many researchers argue that ecological conservation activities could increase with rising income from CBET (Nyaupane and Poudel, 2011; Salvador et al., 2011). The income generated from it could enhance local pride in their natural resources and reduce their extraction-based land use behavior, thus achieving the goal of conservation (Kirkby et al., 2011). However, some studies found that CBET could lead to deforestation and other ecologically destructive activities. The demand for forest products led by CBET has resulted in deforestation (Liu et al., 2001; Wang and Liu, 2013). Some even argue that tourism is responsible for 3.5%–5.5% of species losses (Hall, 2010). Ma et al. (2019a) found that CBET increased natural resource extraction behavior among those living at high altitudes in giant panda nature reserves.

Previous studies on the impact of CBET have focused separately on local household income and conservation behavior. Many researchers have found that CBET could enhance the local community's income; however, there is a lack of empirical evidence on whether increased income and welfare can promote their conservation behavior. Although a few studies have evaluated the ecological and economic impacts of CBET simultaneously (Liu et al., 2018; Ma et al., 2019a), a more comprehensive framework for evaluating conservation behavior is required. Therefore, the aim of this study is to empirically analyze whether CBET could promote conservation behavior of locals around the giant panda nature reserves. More specifically, we want to examine: (1) Would CBET enhance the income of people who lived around the giant panda nature reserves? (2) Would additional income from CBET help promote local conservation behavior? and (3) What kinds of conservation behaviors could CBET promote? To answer these questions, we conducted a questionnaire survey during 2018–2019 in the giant panda nature reserves in Sichuan Province. Although previous studies have qualitatively analyzed CBET's contribution to the conservation of natural resources in the area, as these could be attractive for travelers, the results of this research could provide empirical evidence for the same, thus helping better understand the relationship between CBET and local households' conservation behavior. Identifying specific conservation behavior that households engaged in CBET perform, can provide beneficial information for policymakers to find effective ways to balance conservation and development.

2. Methods

2.1. Theoretical framework

The key hypothesis connecting CBET with locals' conservation behavior is the incentive of increasing income, that would encourage their participation in conservation activities. This work is based on the agricultural household model. Households in this study are engaged in agricultural and CBET activities. They are assumed to maximize their expected utility of consumption of leisure, on-farm produced staples and other consumption goods that must be purchased with cash in the marketplace. Based on existing works, such as Singh et al. (1986), for any production cycle, a household is supposed to maximize the following utility function:

$$U = U(X_a, X_m, X_l) \qquad (1)$$

where X_a, X_m, and X_l are agricultural staples, market-purchased goods, and leisure, respectively. The utility is maximized, subject to the cash income constraint:

$$p_m X_m = p_a(Q_a - X_a) + p_E N_E - p_l(L - F_a - F_E) - p_v V + E \qquad (2)$$

where p_m and p_a are the prices of the market-purchased good and agricultural staple, respectively. Q_a is the household's production of the agricultural staple, p_e is the consumption of a single ecotourist, N_e is the total number of ecotourists the household served, p_l is the market wage, L is total input, F_a is the family labor input on agriculture and CBET management activities, and F_E is the family labor input on forest conservation behavior. Thus, if $L\text{-}F_a\text{-}F_E$ is positive, it implies that there is hired labor in the household. When $L\text{-}F_a\text{-}F_E$ is negative, it means off-farm labor. V are all kinds of other inputs that occur when carrying out agricultural and CBET activities, and p_v is the market price of the other inputs. E is any other non-farm, non-labor, and non-CBET income.

For households, time is also a constraint. The total time of the household is equal to leisure, on-farm production, and CBET management activities or off-farm employment and conservation behavior. This is shown as:

$$X_L + F_a + F_E = T \qquad (3)$$

where T is the total stock of the household time. In this research, we mainly focus on the relationship between CBET management and forest conservation behavior. As per CBET's definition, the quality of the eco-environment is important to attract ecotourists. Thus, we suppose that N_E, namely the number of ecotourists, is mainly decided by Q_E, the quality of the ecosystem. Households can enhance Q_E from two aspects. They could put family labor on forest conservation behavior, namely, F_E. Additionally, they can invest cash income in forest conservation behavior, with a constraint of $p_m \times X_m$.

$$N_E = N(Q_E) \qquad (4)$$

$$Q_E = Q(F_E, p_m X_m) \qquad (5)$$

Based on these assumptions and equations, we may arrive at two inferences. Income from CBET could enhance households' ability to purchase more market goods, thus improving their utility. The quality of the ecosystem is associated with CBET, and therefore, households are motivated to participate in forest conservation behavior. However, increasing income from CBET could make households care more about leisure. Additionally, following forest conservation behavior requires time and income, which may discourage households from doing following the same.

Furthermore, conservation activities have not been well defined, thus making it difficult to ascertain the direct effects of CBET on conservation (Chou, 2018). Since poaching behavior is strictly forbidden by the government in the giant panda nature reserve, and the main ecological threats are forest and habitat degradation, conservation activities can be assessed by forest conservation practices. Following Chou's (2018) research, forest conservation activities are incorporated into three categories: forest maintenance, forest protection, and reforestation (see Table 1). Forest maintenance activities include: "Do not collect plants for business," "Do not collect fuelwood," and "Do not

Table 1
Locals' participation in conservation activities.

Categories	Variables	Activity definition
Forest maintenance activities	*ncol*	Do not collect plants for business
	nfir	Do not collect fuelwood
	nlog	Do not harvest trees
Forest protection activities	*npes*	Do not use pesticide during your agricultural production
	resc	Do you have participated in wildlife rescue
	mana	Do you have participated in the management of the nature reserve
Reforestation activities	*refo*	Do you have contributed household labor to reforestation

harvest trees." Forest protection activities include: "Do not use pesticide during agricultural production," "Participate in wildlife rescue," and "Participate in the management of the nature reserve." Reforestation includes, "Contribute household labor to reforestation."

2.2. Empirical model

To examine whether CBET increases local residents' income, we utilize a *t*-test to identify differences in the means of each kind of income. Generally, the income of locals around nature reserves consists of agricultural and non-agricultural income. According to the survey, the agricultural income of locals around giant panda nature reserves is usually derived from crop cultivation, animal rearing (chicken, duck, pig, cow, and sheep), logging, and non-wood forest product collection. In this paper, we refer to the first two sources as agricultural income and the latter two as forestry income. Additionally, because we focus on the impact of ecotourism income on locals' conservation behaviors, we distinguish between ecotourism revenue and non-agricultural income. Therefore, non-agricultural income is divided into ecotourism income and other sources. Income from ecotourism includes fees from homestays or restaurants, as the survey results show that the vast majority of residents around these nature reserves earn their income by operating them. Other income includes salaries from government and private or non-governmental organizations, wages from labor, and income from small businesses that are not involved in agricultural and forestry activities or CBET.

Further, we test whether CBET income could motivate local residents' conservation behaviors. A binary logit regression model, whose dependent variable must be input as 1 or 0, is established to test the hypothesis: the income that local residents receive from ecotourism will encourage them to participate in conservation activities in nature reserves. Due to data limitations, this study focuses only on symbols of significant levels without concerning the coefficient level. Equation (6) describes the specific model formulas:

$$P_i = F(y_i) = \left(\beta_0 + \sum_{j=1}^{n}\beta_j X_{ij}\right) = \frac{\exp\left(\beta_0 + \sum_{j=1}^{n}\beta_j X_{ij}\right)}{1 + \exp\left(\beta_0 + \sum_{j=1}^{n}\beta_j X_{ij}\right)} \tag{6}$$

where P_i is the probability that residents around nature reserves will participate in conservation activities. Thus, $F(y_i)$ denotes the probability distribution function. y_i is a dummy variable representing the seven conservation activities in which local residents participated. When y_i equals 1, it implies that residents have participated in the conservation activities; when it equals 0, it implies they have not participated. To facilitate parameter estimation, the simplified equation can be obtained by taking the logarithm of both sides of equation (6):

$$y_i = \ln\left(\frac{p_i}{1 - p_i}\right) = \beta_0 + \sum_{j=1}^{n}\beta_j X_{ij} \tag{7}$$

In this study, CBET income (*cbin*) is the core independent variable, and the regression model can be expressed as

$$y_i = \beta_0 + \beta_1 cbin_i + Z\varGamma + \mu_i \tag{8}$$

where Z represents a series of factors that affect the participation of locals around nature reserves in conservation activities, except for ecotourism income, and μ_i is the random disturbance term.

In addition to CBET income, other sources are also expected to impact conservation behaviors and are considered as independent variables.

The degree of participation in conservation activities may vary depending on the household characteristics. For instance, education (*educ*) may have a positive impact on the conservation behaviors of local people (Stone et al., 2008). Government officials (*offi*) are more likely to participate in conservation activities because they are familiar with the rules of nature reserves, as are residents who have received technical training in nature reserves (*tech*) (Ma et al., 2019b). Households with more members (*size*) are less likely to participate in forest conservation activities as they have more labor and a greater reliance on natural resources (Stone et al., 2008).

The influence of agricultural (*fala*) and forestland (*fola*) can be positive or negative. To increase output, households with a large agricultural or forest land are more likely to have ecologically destructive behaviors (Dolisca et al., 2006; Kauneckis and York, 2009). Moreover, the minimum distance from the residence to the forest land (*dist*) may affect the intensity of their use of resources through cost of travel, thereby affecting conservation behaviors (Chou, 2018).

2.3. Data collection

This study was conducted in the Sichuan Province, which is located in southwest China and is home to the majority of wild giant pandas. According to the Fourth Survey Report on Giant Panda in Sichuan Province, at the end of 2013, there were 1387 wild giant pandas, accounting for 74.4% of the country's total population. The province has 46 giant panda nature reserves, with 15 national-level nature reserves, 20 provincial-level ones, and 11 county-level nature reserves. These are important in terms of social, economic, and cultural aspects. They are distributed in 870 panda towns of 41 panda counties and contain almost eight million villagers. The natural resources of these nature reserves are an important source of livelihood for the local people. Traditionally, most households have earned their living through farming, logging, or picking activities. However, according to China's regulation policy, logging and picking are forbidden inside nature reserves. Therefore, CBET has developed rapidly, relying on superior natural conditions and diverse traditional cultures. Additionally, 6.1% of the sample households in the Fourth Survey Report on Giant Pandas participated in this activity.

Based on their geographic distributions and administrative levels, we chose 12 typical nature reserves as our study area. Detailed distribution information is shown in Fig. 1. Among the selected nature reserves, five are national level ones, six are provincial ones and one is county level. National and provincial nature reserves are usually larger, with better ecological environment quality and infrastructure, thus attracting more ecotourists. Therefore, we mainly selected national and provincial nature reserves. Moreover, the selected ones are located in 11 different counties, thus better representing the total household's social and economic situation (see Table 2). An on-site questionnaire was administered from June 2018 to May 2019 with the assistance of the local community. We selected four villages around these nature reserves based on their location and households' per capita income. In each village, at least 15 households were randomly chosen as our interviewees using a stratified random sampling procedure. Household heads were the main objects of our survey. The questionnaires were designed to collect data at both the village and household levels. At the village level, the local leaders were interviewed to acquire basic social and economic information. At the household level, detailed information
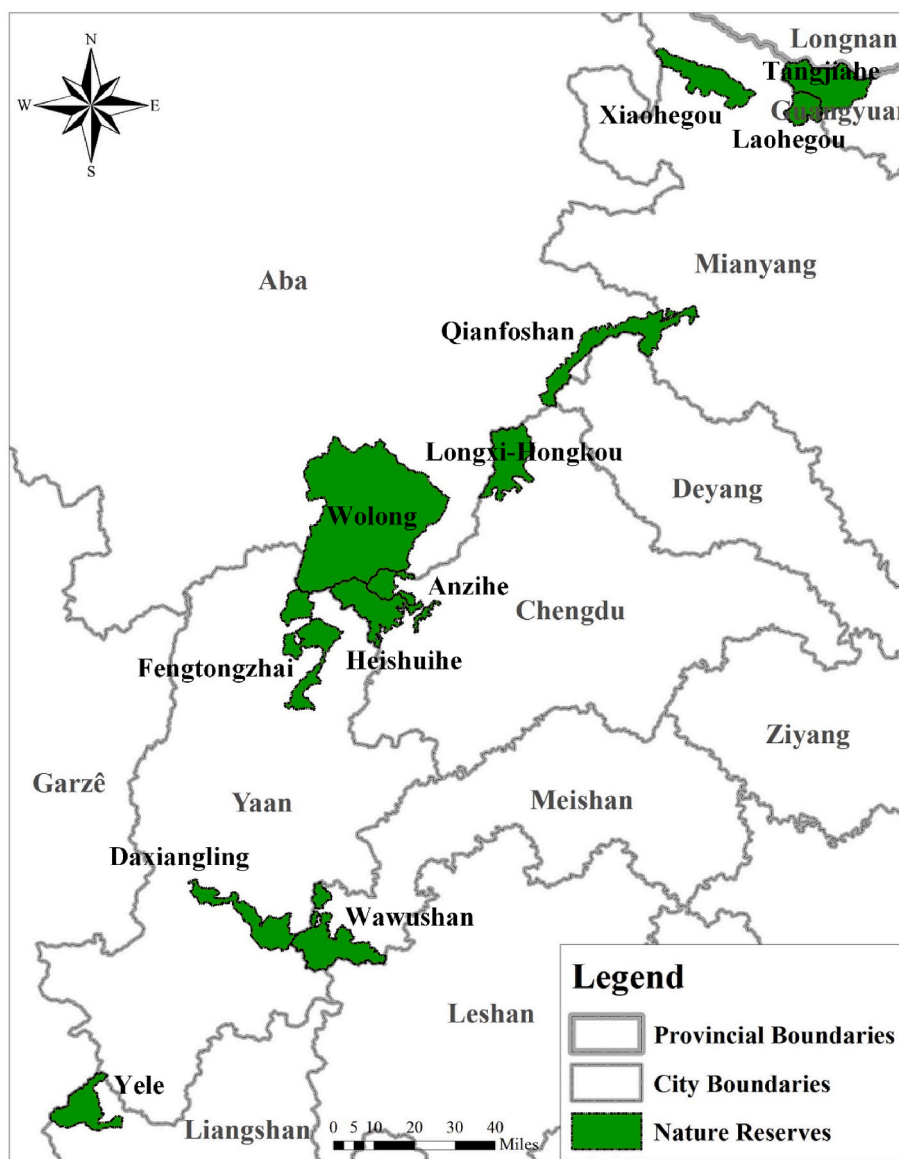
Fig. 1. The detailed geographic information of the investigated nature reserves.

Table 2
The detailed information of investigated nature reserves and sample size.

Names	NR level	Area(ha)	Year of Establishment	Sample size	Location
Qianfoshan	National	11,083	1993	38	Anxian County, Beichuan County
Wolong	National	200,000	1963	63	Wenchuan County
Tangjiahe	National	40,000	1978	61	Qingchuan County
Wawushan	Provincial	36,490	1993	65	Hongya County
Fengtongzhai	National	39,039	1975	62	Baoxing County
Anzihe	Provincial	10,141	1993	64	Chongzhou City
Longxi-Hongkou	National	31,000	1997	60	Dujiangyan City
Yele	Provincial	24,293	1993	30	Mianning County
Daxiangling	Provincial	28,450	2003	62	Yingjing County
Xiaohegou	Provincial	28,227	1993	60	Pingwu County
Laohegou	County	11,000	2011	60	Pingwu County
Heishuihe	Provincial	31,790	1993	38	Dayi County

Note: The data are cited from the Report of the Fourth National Giant Panda Census (State Forestry Administration, 2015). 1 ha is equal to 10,000 square meters.

Table 3

Investigated households' demographic and family assets variables.

Variables	Definition	Mean	Std.Dev.	Min	Max
size	Number of household members	4.271	1.708	1	11
educ	Education of household head (years)	6.973	3.485	0	18
offi	Village cadres in the household (=1 if yes, = 0 if not)	0.265	0.441	0	1
tech	Received technical training of nature reserves (=1 if yes, = 0 if not)	0.431	0.496	0	1
fala	Area of agricultural land (mu)	5.076	11.94	0	704
fola	Area of forest land (mu)	106.295	456.855	0	833
dist	Minimum distance from the residence to the forest land (meters)	1896.245	3829.734	0	70,000
cbet	Engaged in CBET (if yes = 1; no = 0)	0.223	0.417	0	1

Note: 1 mu is equal to 666.7 square meters.

on family members, resource endowment, agricultural production behavior, conservation behavior, and income from different aspects, including CBET, were recorded. Finally, among the 720 samples, we collected 686 valid ones with an effective rate of 95.28%.

3. Results

3.1. Respondent profiles and forest conservation practices

Table 3 presents the results of our investigated households around nature reserves. A total of 686 questionnaires were used in our analysis; 22% of the households were engaged in ecotourism. The investigated households had an average of approximately four members; the average educational background of the head was only elementary school, and the level of education was generally low. There were family members who served as village cadres in 26.5% of these households. In terms of improving their ability to make a living, 43.1% of the farmers said they had participated in technical training organized by nature reserves. In terms of land assets, since the terrain of nature reserves is mainly mountainous, the average household owned 5.076 acres of agricultural land and 106.295 acres of forest land. On average, the minimum distance between woodlands and residences was 1896.245 m.

Fig. 2 shows the current forest conservation practices of households around giant panda nature reserves. In forest maintenance activities,

about 88% and 70% of our investigated households showed no logging and firewood collection activities, respectively. However, only 47% had not participated in commercial collection activities. In forest protection activities, only 19% and 24% of investigators engaged in rescuing wild animals and management activities of the nature reserves. Moreover, around 34% households did not use pesticide in their agricultural activities, while approximately 70% had engaged in reforestation activities. These results reveal households have preference for three kinds of conservation practices. Households have the highest participation in reforestation activities and the lowest in forest protection. The degree of participation in various types of conservation practices is also different. In forest maintenance activities, households show the lowest response rate when facing the "no commercial collection" question.

3.2. The impact of CBET on rural households' income

Table 4 shows the income difference for households which engaged and did not engage in the CBET. The average of ecotourism income from CBET for engaged households is 35,540 CNY. And the average total income for households engaged in CBET is 99,440 CNY, which is higher than for the ones who are not engaged (54,070 CNY). The *t*-test also shows a significant difference in the total income between the two groups. There is no significant difference in agricultural income, forestry income and other income between the two groups of sample households
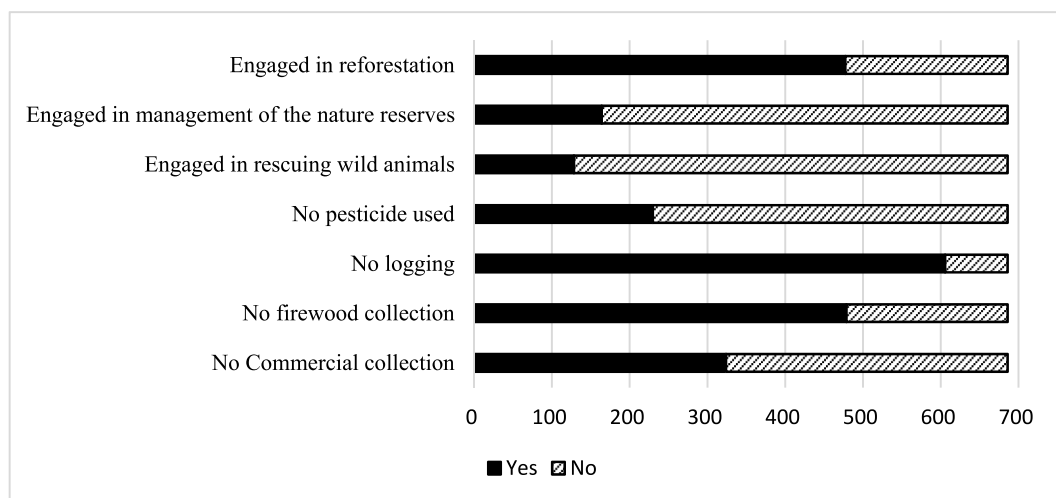

Fig. 2. Investigated households' forest conservation practices.

Table 4
Income difference for households who engaged or not engaged in the CBET.

	Not engaged in CBET (N = 533)			Engaged in CBET (N = 153)			P>|t|
	mean	median	sd	mean	median	sd	
cbin	0	0	0	3.554	2.050	4.098	0.000
cbti	0	0	0	6.778	5	4.377	0.000
fain	0.808	0.16	2.019	0.873	0.215	2.128	0.608
foin	0.583	0	1.696	0.671	0	1.955	0.604
otin	3.181	2.155	3.613	2.883	1.65	3.549	0.305
toin	5.407	3.184	8.184	9.944	5.921	12.502	0.000

Note: *cbti* represents the average annual duration of residents engaging in ecotourism, and the unit of measurement is months.

(p-value> 0.1). Therefore, we can presume that the total income gap between the two groups of households is mainly due to the income from ecotourism operations. These results are consistent with Ma and Wen (2016)'s findings in the giant panda nature reserve.

However, CBET activities around nature reserves exhibit periodic characteristics. According to our investigation, households could only engage in CBET for approximately seven months a year. Our results show that while CBET could increase household income, it is unsteady and unsustainable in a one-year period.

3.3. The effects of income from CBET on conservation activities

To examine whether income from CBET could motivate local households' participation in conservation activities, we ran seven separate analyses. The results are presented in Table 5. It shows that from the perspective of three kinds of conservation activities, the income from CBET has significantly affected households' conservation activities, except for reforestation ones.

Table 4 shows almost 70% of our investigators engaged in reforestation activities. However, the determinants for their reforestation behavior are mainly economic. Moreover, most of the investigators considered the ecological environment of the giant panda nature reserve, including the forest cover, to be improving, and thus, there was no need for them to conserve the habitat by reforestation activities. Therefore, no significant effects of income from CBET on reforestation were found.

Table 5 also shows that income from CBET significantly influences all three types of forest maintenance activities. However, the results differ.

Income from CBET has positive effects on "no firewood collection" and "no logging," and negative effects on "no commercial collection," indicating that when income from CBET increases, the probability of the investigated households collecting fuelwood and harvesting timber will decrease. On the contrary, increasing income from CBET would also increase the likelihood of commercial collection activities. This result is in line with the findings of Ma et al. (2019b). This may be due to the fact that the households engaged in CBET attract tourists by collecting vegetables and fruits in the forest, thus earning a higher income.

As for forest protection activities, income from CBET only shows significant positive effects on two kinds of activities: "Engaged in rescuing wild animals" and "Engaged in management of the nature reserves." This indicates that increasing income from CBET would raise the probability of the investigated households participating in rescuing wild animals and managing nature reserves.

Among the control variables, "farm income," "forest income" and "if there are village cadres in the family" show the most significant impact. In other words, households would decrease the probability of collecting fuelwood and log timber and increase the probability of rescuing wild animals when farm income increases, forest income decreases, or there are village cadres in the family.

4. Conclusions

Although it has been reported that CBET could produce cash benefits for local households and alleviate conflicts between conservation and development, its effects on the detailed conservation activities and the underlying mechanisms are lacking in the giant panda nature reserves. To confirm whether the income from CBET could promote the conservation behavior of local households around the reserves, a face-to-face questionnaire survey was conducted in 12 communities from 2018 to 2019. A total of 686 valid samples were obtained. We used the Logit model to analyze the data. The detailed conclusions are as follows:

Our research has proved that CBET could significantly improve the income for households engaged in it; however, due to the short management duration, the income from it is not sustainable. The average total income for those who are engaged in it is about 99,440 CNY, which is much higher than those who are not engaged in it (54,070 CNY). The direct income from CBET is 35,540 CNY, which accounts for more than 35% of the total income for those who engaged in it. Although households earn much more from CBET, the costs of engaging in it are high, and they need to find alternative non-farm jobs or operate farm

Table 5
Results of the Logit regression model.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	ncol	nfir	nlog	npes	resc	mana	refo
cbin	−0.0600** (0.0298)	0.0578** (0.0289)	0.0882*** (0.0160)	−0.0468 (0.0630)	0.0461* (0.0246)	0.0572** (0.0276)	0.0148 (0.0319)
fain	−0.0422 (0.0740)	0.0416*** (0.0153)	0.2358*** (0.0496)	0.1864*** (0.0557)	0.0590** (0.0235)	0.0173 (0.0186)	−0.1184*** (0.0414)
foin	−0.1759 (0.1244)	−0.1083*** (0.0393)	−0.6110*** (0.0234)	−0.2851*** (0.0565)	0.0769*** (0.0245)	0.0898 (0.0639)	0.3675** (0.1699)
otin	−0.0003 (0.0304)	−0.0078 (0.0326)	0.0870** (0.0383)	−0.0333 (0.0333)	0.0216 (0.0275)	0.0280 (0.0314)	0.0386* (0.0230)
educ	0.1129* (0.0686)	0.0000 (0.0176)	0.0169 (0.0250)	0.0053 (0.0472)	0.0275 (0.0294)	−0.0158 (0.0132)	0.0282 (0.0384)
offi	−0.7367** (0.3097)	−0.1483 (0.2357)	−0.2042 (0.3107)	−0.2612* (0.1570)	0.6584*** (0.1149)	0.3072** (0.1542)	0.1992 (0.3370)
tech	−0.4894* (0.2946)	−0.0235 (0.1406)	0.1516 (0.2445)	−0.0797 (0.3413)	0.1635 (0.1366)	1.4941*** (0.2968)	0.7501*** (0.1666)
size	−0.0773 (0.0606)	0.0026 (0.0217)	−0.2482*** (0.0555)	0.0394 (0.0936)	−0.0910 (0.0706)	0.0083 (0.0442)	−0.0555*** (0.0058)
fala	−0.0341 (0.0311)	0.0166*** (0.0055)	−0.0097*** (0.0022)	−0.0003 (0.0284)	−0.0100 (0.0173)	−0.0136 (0.0163)	−0.0191** (0.0090)
fola	−0.0004 (0.0007)	0.0000 (0.0001)	0.0003 (0.0007)	−0.0003* (0.0002)	−0.0000 (0.0001)	0.0006* (0.0003)	0.0001 (0.0001)
dist	0.0001 (0.0001)	−0.0001*** (0.0000)	0.0000 (0.0001)	0.0001* (0.0000)	0.0000* (0.0000)	−0.0000 (0.0000)	0.0000 (0.0000)
Constant	−0.1748 (0.5115)	0.5709*** (0.2007)	2.8802*** (0.3882)	−1.0148*** (0.3239)	−1.5580*** (0.2581)	−2.1557*** (0.4894)	0.4455* (0.2335)

Note: Robust standard errors in parentheses, ***p < 0.01, **p < 0.05, *p < 0.1.

businesses to earn income when CBET activities are suspended. Therefore, the local government or the nature reserve management office should help local households expand their business activities in ecotourism.

Income from CBET does motivate local households to engage in conservation activities, but the effects are different. In all three conservation activities, income from CBET has shown significant effects on promoting forest maintenance and protection activities, except for reforestation ones. Commercial collection activities in forest maintenance are positively related to income from CBET, which is not good for conservation behavior. However, researchers should focus on the types and quantities of forest vegetables and fruit collected by households around the giant panda nature reserves. Although our research focused on CBET in China, the results of this study suggest that governments in other countries with similar circumstances, should formulate an appropriate incentive policy for promoting CBET development. Meanwhile, policymakers should realize that the contribution of CBET to different forest conservation activities is not the same.

Although this study uses data analysis to obtain positive results on the impact of CBET income on forest conservation activities, the mechanism behind it has not been well tested. In addition, since the increase in CBET income and conservation behavior do not necessarily occur at the same time, future research can use panel data to verify this conclusion.

Credit author statement

Zhou Wei: Conceptualization, Methodology, Writing – original draft, Zheng Bin: Investigation, Data Formal analysis, Writing – original draft, Zhang Zi-qiang: Investigation, Conceptualization, Song Zhen-jiang: Investigation, Visualization, Duan Wei: Methodology, Reviewing and Editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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