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The impact of farm household tourism operations on poverty reduction and conservation under the control policies of China's protected areas

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Against the global trend of increasing multiple participants involvement in protected areas management, the Chinese government has implemented a series of stricter policies since 2015. Tourism is an important alternative livelihood for farmers near protected areas. Based on survey data from 1,028 households in six protected areas, this study uses the propensity score matching (PSM) method to empirically examine the change effects of poverty reduction and conservation of farmers engaged in tourism under the influence of protected areas tourism management policies. The PSM method reduces sample self-selection bias and improves the accuracy of research conclusions. The findings reveal that irrespective of whether the areas are subjected to regulatory policies or not, tourism operations are significantly and inversely correlated with households' multidimensional poverty index, and are notably positively correlated with their comprehensive conservation index. Consequently, tourism operations exhibit substantial poverty alleviation and protective effects. However, the current suite of protected areas control policies has curtailed the sustainable growth of tourism within these areas, resulting in 9.64% decrease in poverty alleviation effects and 10.33% decrease in protective effects derived from tourism operations. Despite their restrictive impacts on tourism, these policies have yielded some positive outcomes, fostering social equity within protected areas and catalyzing the transition from traditional livelihoods. Drawing upon these empirical findings, this study proposes recommendations and directions for fine-tuning China's existing regulatory policies pertaining to tourism in protected areas.

KEYWORDS

poverty reduction effects, conservation effects, control policies, protected areas, propensity score matching (PSM)

1 Introduction

The IUCN (International Union for Conservation of Nature) recognizes and recommends four governance modes: government governance, private governance, community governance, and shared governance. The state still governs 90.00% of the world's protected areas based on the ownership of management (Nyaupane et al., 2022).

National governance is the only model of protected area (PA) governance in China. The purpose and level of protection of Chinese protected areas are similar to those of IUCN protected areas categories I-IV. By the end of 2018, China had established protected areas at both national and provincial levels. The total number of protected areas is 2,750, corresponding to 14.88% of China's total land area. The protected area is divided into three zones: the core, buffer, and transition zones. Protected area control policy refers to the government's regulations that prohibit or restrict activities within protected areas to prevent any adverse impact on their ecological environment (Qi and Ke, 2021). China's protected areas implement a "fencing" management approach that aims to safeguard biodiversity by prohibiting or limiting the production and living activities of local communities within the protected areas.

The Chinese government has transformed its management policies for tourism within the transition zones of protected areas, shifting from lenient to stringent measures. Since 2015, along with the enhancement of China's economic strength, the importance of the quality of development and ecological civilization has become increasingly prominent, and the state has sequentially implemented a series of policies to protect the ecological environment. The "Regulations on Protected Areas of the People's Republic of China" were revised in 2017. The establishment of tourism projects that are inconsistent with the principles of protected areas protection is strictly prohibited. The "Green Shield" supervisory and inspection program has been implemented for national-level protected areas. The central government has directed local governments to promptly address the issue of unauthorized tourism expansion within the protected areas under their jurisdiction within the specified timeframe. To avoid accountability from the central government for any potential issues that may arise during the management of protected areas, which could impact local performance, provincial governments not only rigorously enforce the National Protected Areas Regulations but also demonstrate a phenomenon of enhanced protection in managing protected areas for tourism. This is evident through the quiet expansion of protected areas and the growing stringency in implementing protection regulations (Wu et al., 2022). Except for a group of tourism infrastructure, such as hotels and entertainment facilities, which were illegally built in the core and buffer zones of the protected areas and subsequently closed down and demolished following the law, tourism activities in the transition zone are subject to rigorous monitoring, and even in the absence of a legal basis they have been regarded as illegal tourism development and have been shut down. The management department of the protected areas has successfully implemented measures to discourage the development of new tourism projects within the reserve (Cai and Su, 2022). The surrounding farmers were regarded as potential threats to the ecological environment protection of the protected areas and were excluded from the protected areas, thus affecting the legitimate tourism business activities within the transition zone of the protected areas.

Protected areas control policies may have both positive and negative impacts on tourism. On one hand, protected areas with superior resource conditions are more attractive to tourists than those with poor conditions (Grünewald et al., 2016). The Chinese government has implemented rigorous management policies for protected areas since 2015, enhancing ecosystem services (Xie et al., 2023) and facilitating favourable conditions for tourism development. Simultaneously, after being restricted by regulatory policies, farmers' production methods may be forced to give up some of the traditional production methods highly dependent on natural resources, such as forest logging and grazing, and shift to engaging in environmentally friendly production methods, such as tourism. Regulatory policies can promote the transition of farmers' production methods and enhance their willingness to participate in tourism operations (Wondirad, 2019). Therefore, analysed from these perspectives, the control policy will promote the tourism operation of farm households in protected areas. On the other hand, regulatory policies deprive tourism operators and farmers of their partial rights to utilize natural resources. The expansion of protected areas and the enhancement of regulatory measures by provincial governments during the implementation of national protected areas policies have also affected the operational efficiency of existing tourism businesses for certain farmers, consequently impeding their tourism operations.

This research considers 1,028 households around six protected areas to examine the changes in the conservation effect and poverty reduction effect of tourism operations households near protected areas under control policies. It aims to verify whether the series of tourism control policies implemented by the Chinese government in protected areas in recent years have achieved the dual goals of biodiversity conservation and poverty reduction. The widely study areas enhance the ability to apply the research findings to a broader context. Furthermore, this study improves the research methods by using multidimensional poverty indicators, including education, health, and livelihood levels, and a comprehensive conservation index, including conservation behaviour, support, and participation in conservation policies. These two indexes are used to represent the conservation and poverty reduction effects. The study uses the PSM method to overcome sample selection bias between inside and outside the protected areas and ensure the accuracy of the research results. Firstly, it examines the impact of regulatory policies on the poverty reduction effects of tourism operations for households near protected areas. Secondly, it investigates the impact of regulatory policies on the conservation effects of tourism operations for households near protected areas. By studying these two issues, this study aims to explore the impact of protected area tourism regulatory policies on poverty reduction and the attitudes and behaviors of households, thus validating the effectiveness of protected area policies. The research findings provide empirical evidence for evaluating the policy performance of current protected area tourism control policies.

2 Literature about pro-poor and conservation role of tourism

2.1 Study on the pro-poor role of tourism in protected areas

Protected areas often coexist with impoverished regions with comparatively low household income levels (Brockington and Wilkie, 2015). The conflict between biodiversity conservation in protected areas and poverty reduction is commonly known as the "vexing dilemma", The literature extensively discusses the impact of

protected areas tourism in alleviating community poverty (Ferraro and Hanauer, 2014; Ma and Wen, 2016; Garidzirai and Matiza, 2020). Some scholars have recognized the positive impact of tourism on poverty alleviation in the farm households surrounding protected areas (Duan et al., 2015; Wang, 2015; Thompson, 2022). Tourism is an important alternative livelihood path for balancing wildlife conservation and sustainable community development (Yang and Yang, 2023). Tourism substantially reduces poverty in Costa Rica's protected area poverty reduction practices (Ferraro and Hanauer, 2014). Protected areas in Bolivia and Thailand have effectively alleviated poverty in nearby communities (Sims, 2010; Canavire-Bacarezza and Hanauer, 2011). Ma et al. (2015) conducted a study on tourism operations carried out by farmers in the Qinling Mountains Protected Area in China. The study found that guiding farmers to participate in tourism activities can effectively alleviate poverty and implement ecological poverty alleviation measures within communities located in protected areas. In numerous conservation projects, ecotourism is regarded as a potential means of generating alternative income.

However, the positive impact of tourism on communities has also been questioned by numerous scholars. Tourism development is likely to cause price increases and inflation in protected areas, lowering the standard of living of residents (Weaver and Lawton, 2001; Veau and Marshall, 2008; Ma and Wen, 2016). Through government policy guidance, tourism can positively reduce poverty in the short term, but this positive role has been overestimated. If households lack long-term motivation to engage in the tourism business, the government's advocated efforts for tourism poverty alleviation will only lead to temporary solutions rather than fundamental ones (Ma and Wen, 2016). Research conducted by the Global Environmental Facility has confirmed that income from tourism is unlikely to be a significant source of revenue for all individuals and households within a community (Global Environmental Facility—Monitoring and Evaluation Unit, 2005). Tourism operations are dominated by elite groups, and most of the surrounding farmers are constrained by the lack of discourse power and professional skills, and are not truly involved in tourism (Li et al., 2020. Only a limited number of households residing in the nearest village have the opportunity to benefit from tourism revenue (Thompson, 2022; Wu et al., 2023). Tourism may result in an increase in income disparity among households (Zhang, 2021) and lead to an expansion of relative poverty and fall into the "growth trap" (Zhang et al., 2022). Considering the limited impact of tourism on poverty reduction, it is necessary to explore alternative solutions to alleviate income poverty among individuals with limited access to resources (Ezebilo and Mattsson, 2010).

2.2 Study on the conservation role of tourism in protected areas

Oldekop et al. (2015) suggested that protected areas that enhance human wellbeing (by permitting sustainable use) also tend to be correlated with better conservation outcomes. Greece World Wildlife Fund argues that successful conservation models require the support of local people and the integration of economic development with conservation. Ecotourism has been acknowledged by the World Wildlife Fund Greece for its potential in conservation and collaboration with local communities (Svoronou and Holden, 2005).

Tourism development in protected areas can generate conscious motivation for conservation through the economic incentives of tourism. From the perspective of protected areas in general, tourism can provide political incentives for protected areas management to establish and sustain protected areas as it offsets the socio-economic costs of conservation (Sevastiyanov et al., 2014). From the farmers' perspective, there is a strong relationship between positive perceptions of conservation benefits, conservation attitudes, and participation. Scholars have found a positive association between the livelihood level of households in protected areas and their attitudes and involvement in conservation efforts (Sanjay et al., 2022). Benefiting from tourism operations can prevent people from damaging wildlife, as they would want the wildlife to remain in order to generate more income in the future (Kathleen et al., 2022). On the other hand, transitioning livelihoods through tourism can effectively decrease reliance on natural resources. The conflict resolution plan of the Royal Chitwan National Park in Nepal includes implementing a grass-cutting program, which permits local farmers to enter the protected area at designated times. The results revealed a significant decrease in the amount of grass collected by farmers in the tourism-involved area compared to other areas. Tourism growth is crucial in cultivating a favourable attitude among the local population toward the conservation area (Straede and Helles, 2000). In the Dana Reserve in Jordan, implementing tourism and handicrafts as alternative livelihood options has effectively halved the density of goat farming, thereby mitigating the issue of land degradation within the reserve (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, 2018a). The engagement of farmers in ecotourism has led to a reduction in their out-of-town work. Furthermore, they have begun prioritizing preserving the village environment and have heightened their awareness of environmental protection. Consequently, there has been a decline in illegal logging and deforestation. Hence, both of these aspects confirm tourism's protective role in preserving the protected areas environment.

Some scholars believe that tourism development will negatively impact the environment of protected areas. Tourism and related infrastructure have negative impacts on protected areas. Conflicts can arise when there is a discrepancy between promoting tourism and placing restrictions on local use (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, 2018b). When tourism revenues fail to benefit more households while environmental pollution becomes apparent, it can lead to opposition from households towards tourism (Božidar et al., 2020; Thompson, 2022). More studies focus on the environmental impacts of tourism. Tourism development in high mountain ecosystems, mainly ski slopes, has been found to contribute to ecosystem fragmentation and land degradation (Sokratov et al., 2014). In order to meet the needs of tourists, cypress trees are continually felled for incense-making, land may be washed away by rivers (Heidi and Sanjay, 2021). The intensity and nature of development on specific islands in Greece have caused several adverse effects, such as habitat loss, aesthetic pollution, unauthorized construction, and increased pressure on natural resources, particularly water (Svoronou and Holden, 2005).

2.3 Literature review

Over the past years, many countries worldwide have increasingly embraced a decentralization trend in managing protected areas. However, there is a contrasting trend toward centralization in China's management of protected areas. The effectiveness of China's protected area management policies implemented since 2015 has been widely noticed by the Chinese and international political and academic communities. Therefore, there is a need for more rigorous quantitative research to evaluate the effectiveness of policies.

Firstly, the existing studies have focused on qualitative analyses of the correlation between regulatory policies and the tourism industry, mainly from a theoretical standpoint (Badola et al., 2018; Wu et al., 2022). Limited research has been conducted to quantitatively investigate the effects of protected area regulations on tourism (Ezebilo and Mattsson, 2010; Ekayani et al., 2019). Secondly, the researches focus on specific protected area, which limits its representativeness. Thirdly, variations in research methods and sample selection are the primary reasons behind the divergent findings regarding the impact of tourism in protected areas on poverty reduction and conservation performance. These quantitative studies commonly use descriptive statistical analysis or traditional linear regression methods, which lack consideration of sample heterogeneity. Biases in sample selection may obscure the influence of protected areas' distinct institutional arrangements and environmental characteristics on the behaviour and benefits of household tourism operations. In addition, many studies have focused only on the economic impact of tourism (Ma and Wen, 2016; He et al., 2023).

To address the aforementioned four issues. This study utilized a large sample survey data of 1,028 households from six natural protected areas to address the limited representatives of a single protected area. By using two indicators, the multidimensional poverty index (Alkire and Jahan, 2018) and the comprehensive conservation index, this study comprehensively considers the impacts of control policies on various aspects of households, including education, health, conservation behavior, and conservation attitudes, in addition to economic effects. The households near protected areas engage in tourism operations, which are influenced by various factors in addition to their own willingness. Therefore, to address the issue of sample selection bias between tourism-operating households and non-tourism-operating households, this study utilized the propensity score matching method to address the self-selection bias in tourism operations, thus improving the accuracy of the research results.

3 Study area and data sources

3.1 Study area

There are economic disparities between northern and southern provinces in China. Farmers in the northern regions have limited capacity to develop alternative livelihoods and are more dependent on protected area resources, leading to a more prominent issue of poverty in protected areas in northern provinces. Moreover, northern provinces face greater pressure in resource conservation, and their governments tend to lean towards excessive protection in the implementation of protected area policies. The lack of flexibility in policy implementation exacerbates the conflicts between protected areas and local farmers in the north. Liaoning is an important province in northern China. It has a higher population density compared to other northern regions, and there are a large number of farmers living around protected areas. Therefore, this study chose six protected areas in Liaoning Province as research samples.

Liaoning Province is located in the northeastern of China. It is situated between 118°53′to 125°46′east longitude and 38°43′to 43°26′north latitude. It has a temperate monsoon climate with characteristics of a continental climate. The altitude in Liaoning ranges from 300 to 1,000 m. The eastern and western regions of Liaoning are hilly and mountainous, where most of the protected areas are located. The total areas of natural protected areas in Liaoning are 2.44 million hectares, accounting for approximately 11.1% of the province's land area. The road network in Liaoning is well developed. Among them, the Lao tu Dingzi and Baishui Lizi protected areas are relatively far from the cities, within a range of 250 km by car, while the other four protected areas are generally within a range of 100 km by car from the cities.

3.2 Data sources

According to the World Data on Protected Areas. (2013), "peri-protected households" live within the protected area and 10 km of the protected area fence. The above criteria be followed to identify the villages located outside the protected areas that need to be surveyed. The data collection was conducted through face-to-face questionnaire surveys. A total of 44 villages of 6 protected areas were surveyed (Figure 1).

According to the list of farmers provided by the village committees, it was planned that 30 farmers would be sampled from each village. We inquired with the village committee about the number of households engaged in tourism operations. The samples were obtained using a combination of random sampling and typical sampling methods. The random sampling method is adopted for non-tourism-operating farmers in this village. For tourism-operating farmers, a typical sampling method was used. Every household engaged in tourism operations in the village participated in our survey. However, due to the busy work schedule of some village officials, they were unable to accompany the surveyors for household surveys, resulting in low cooperation of villagers. The other reason is the conflict between our research schedule and farmers' agricultural production schedule, which led to farmers' unwillingness to participate in the survey. Therefore, in some individual villages, the research goal of 30 samples cannot be achieved, but at least 25 or more farmers were surveyed in each village. Ultimately, a total of 1,028 households completed all the items on the questionnaire, resulting in 980 valid samples.

This survey was supported by the National Social Science Fund. In order to complete all the research contents set by the fund project, a total survey questionnaire was designed with 23 pages, including 10 major sections and a total of 806 variables. The 10 major sections include: basic information (protected area information, household members' situation), household assets, income and expenditure of

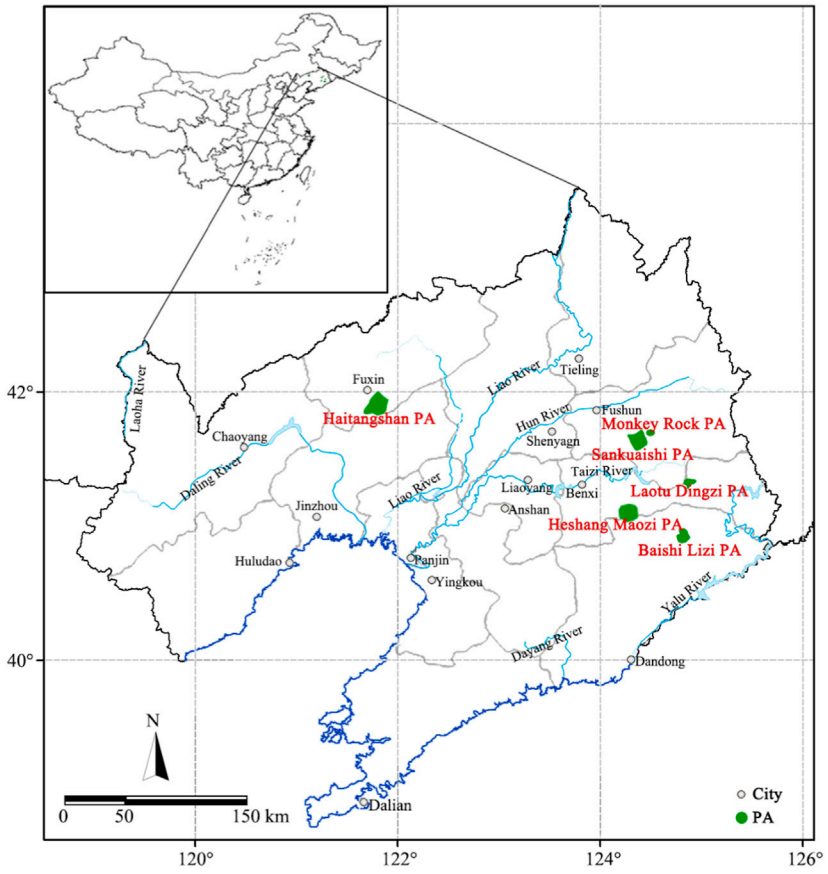

FIGURE 1
Six protected areas' locations in Liaoning Province of China.

household production and livelihood, farmers' perception of interests and risks (impacts on living near protected area), farmers' participation in tourism, ecological environment and policy awareness (evaluation of protected area policies), household energy consumption (fuel and charcoal collection), *etc.* All the required data for this study were extracted from the total survey questionnaire.

Each household was assisted by the head of the household. If the head of the household was not available, other family members who were familiar with the household's production and livelihood situation answered on their behalf. Each questionnaire was conducted through one-on-one interviews between a researcher and a household, with an average duration of approximately 2 h. The research was conducted from July to August 2021. However, it is essential to acknowledge that the COVID-19 pandemic had a negative impact on the tourism industry, which might have led to potential inaccuracies in the data collected. Therefore, instead of relying on data from 2021, we opted to collect farmers' recollections of pre-pandemic data from 2019. The distribution of the sample and the specific operations of the tourism operation farmers are detailed in Table 1.

Out of the 980 households, 116 are involved in diverse tourism operations, representing 11.84% of the total. The participation rate indicates a limited level of tourism engagement among the households residing near the protected area. Farm households are mainly involved in lower-end tourism operations, which limits their access to opportunities for participating in high-end tourism business decision-making. Farmers typically operate small-scale restaurants or guesthouses, providing accommodations and meals for tourists. According to the survey, 75 households are involved in catering, accommodation, and entertainment businesses, representing 65.66% of the tourism establishments. A total of 16 households selling local specialties independently, which represents 13.79% of the total number of tourism businesses. There are 25 employees working in foreign-owned large-scale tourism enterprises or other large-scale tourism enterprises, which accounts for 21.55% of the total number of tourism operations. However, in their work within the company, they typically occupy low-skilled positions, such as ticketing and sanitation, which restrict their involvement in the decision-making processes of major tourism enterprises. None of the 116 tourism operators in the protected area have granted franchise rights to farmers for important tourism projects. State-owned enterprises or large foreign tourism enterprises monopolize tourism concessions in protected areas.

4 Research methods

4.1 Research approach

Protected areas have a dual objective of conserving biodiversity and promoting economic development in neighboring communities

TABLE 1 Distribution of the research sample and the form of tourism operation.

Name of protected areas	Sample size	Sample distribution	Number of households	Number of tourism operators	Tourism business content[a] (number of households)
Sankuaishi	192	in protected area	98	18	A (11), B (2)
		outside protected area	94	2	C (7)
Haitangshan	312	in protected area	243	32	A (11), B (10)
		outside protected area	69	4	C (15)
Monkey Rock	119	in protected area	0	0	A (1), B (1)
		outside a protected area	119	15	C (13)
Laotu Dingzi	184	in protected area	13	0	B (2), C (5)
		outside a protected area	171	7	
Baishui Lazi	74	in protected area	0	0	C (1)
		outside a protected area	74	1	
Heshang maozi	99	in protected area	46	12	A (2), B (1)
		outside a protected area	53	25	C (34)
Total	980	in protected area	400	62	A (25), B (16), C (75)
		outside protected area	98	18	

[a]Description of the form of tourism business: A. Employee of a tourism enterprise B. Selling merchandise on a piecemeal basis C. Self-operated catering, lodging, and entertainment enterprise D. Part-time business (any two or more combinations of the above three forms of business).

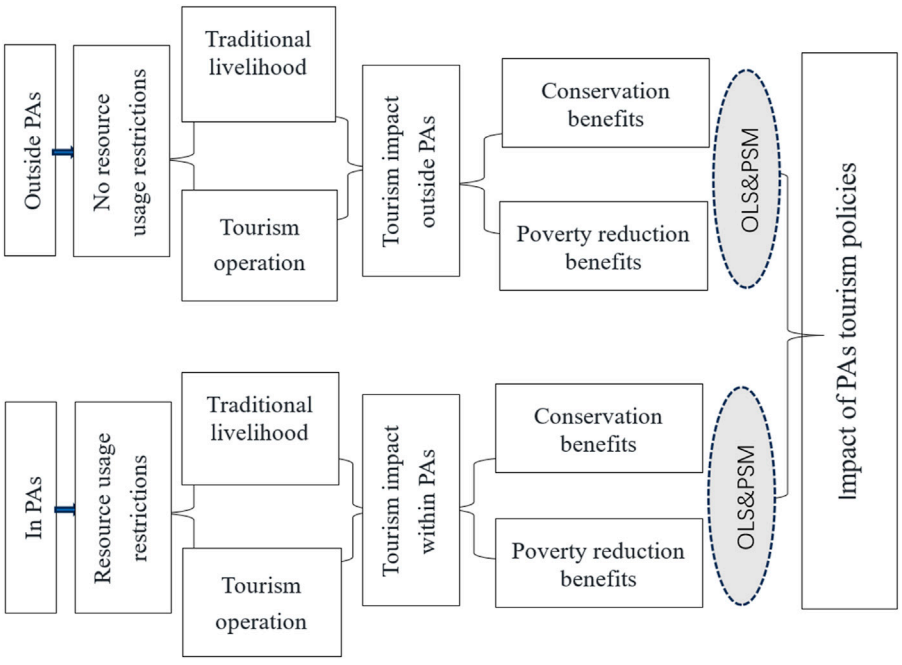

FIGURE 2
Research framework diagram.

(IUCN/UNEP/WWF, 1980). The existing management policies of protected areas protect the ecological environment, which to a certain extent contributes to the tourism operations. However, these protection policies also impose significant costs on the surrounding communities. Tourism operations have a dual mission of ecological conservation and alleviating poverty (Guri

et al., 2020). Tourism operations can increase household income and alleviate multidimensional poverty. In many cases of protected areas in different countries, the correlation between benefits and a positive attitude towards conservation has been consistently observed. Through this correlation, farmers can be motivated to protect the environment (Hamilton et al., 2000; Salafsky et al., 2001; Ezebilo and Mattsson, 2010), thus achieving the established policy goals of protection and development in protected areas. Therefore, the basis for judging the effectiveness of protected area tourism management policies is to assess the changes in conservation and poverty alleviation effects of tourism operations under these policies. As shown in Figure 2.

4.2 Multidimensional poverty index (MPI)

In 2019, the poverty alleviation standard for the impoverished population in China was approximately an average *per capita* net income of 3,747 yuan. It is worth noting that in 2011, China established the second decade-long outline for rural poverty alleviation and development, setting the poverty alleviation standard at 2,300 yuan at constant prices in 2010, with an anticipated annual growth rate of 6%. (State Council Information Office of the People's Republic of China, 2011). China initiated its poverty alleviation efforts in 2012, and after 8 years of concerted action, the country has made substantial progress toward its economic objective of eradicating poverty across the entire population by 2020. Impoverished households have met the national poverty alleviation standard due to their household economic income reaching the designated threshold, facilitated by targeted subsidies. Therefore, it needs to be more accurate to measure the living conditions of farm households around the reserve only by economic standards, as it fails to consider the multifaceted nature of poverty.

Poverty signifies more than just a shortage of income; it encompasses denying fundamental human rights, including access to healthcare, education, and adequate living standards. This study utilizes Alkire's multidimensional poverty theory and employs the multidimensional poverty index as a measurement method. The Multidimensional Poverty Index (MPI) not only assesses the poverty status of households but also quantifies the living conditions of agricultural households. One advantage of this method is its ability to simultaneously incorporate continuous and discrete data into the model. During the application of the multidimensional poverty index in China, adjustments were made to account for the specific circumstances of households residing near Chinese protected areas and the country's prevailing economic and social conditions (Table 2). In China, non-economic indicators for poverty alleviation encompass ensuring access to safe drinking water, compulsory education, primary healthcare, and housing security. To avoid subjective arbitrariness resulting from human empowerment, this study adopts the approach proposed by Duan et al. and assigns equal weights of 0.0833 to each of the 12 indicators measuring multidimensional poverty (Duan and Ouyang, 2020). The Multidimensional Poverty Index (MPI) ranges from 0 to 1, with a higher value indicating higher poverty levels. The calculation formula is as follows:

$$MPI_i = \sum_{j=1}^{m} W_j Y_{ij} \tag{1}$$

Where. MPI_i denotes the multidimensional poverty index of i farm household and W_j denotes the weight corresponding to each indicator of the multidimensional poverty index, and Y_{ij} denotes the value taken by household i on the j poverty indicator.

4.3 Comprehensive conservation index

Ecological conservation is an abstract concept manifested through the diverse interactions and connections between farmers and the ecological environment in their daily production and lives. To examine the conservation effects of farmers' tourism operations under the influence of regulatory policies, this study adopts the definitions of ecological conservation behaviors from previous related studies and measures farmers' ecological conservation behaviors based on specific actions, including discontinuing the collection of firewood by households in the protected area and its vicinity (Duan et al., 2016), as shown in Table 3.

The weight of each evaluation index can be determined using the entropy method. The method has been demonstrated to exhibit strong objectivity, thereby mitigating inherent biases resulting from subjective judgments. Assignment of ecological conservation behaviors (yes = 1, no = 0). The entropy method is used to calculate the comprehensive score of ecological conservation behavior for each sample household. As the value increases, households become more proactive in adopting ecological conservation behavior. The calculation process is as follows:

In the first step, the indicators were standardized to generate a standard matrix.

$$Z_{ij} = \frac{Z_{ij} - \min\left(Z_{ij},\ldots,Z_{nj}\right)}{\max\left(Z_{ij},\ldots,Z_{nj}\right) - \min\left(Z_{ij},\ldots,Z_{nj}\right)} + 1 \tag{2}$$

In Step 2, the proportion of the *i*th sample value under the *j*th index is calculated to transform the matrix.

$$p_{ij} = \frac{Z_{ij}}{\sum_{i=1}^{m} Z_{ij}} \tag{3}$$

In the third step, the entropy value of the *j*th metric is calculated E_j and redundancy D_j :

$$E_j = \left(\frac{1}{\ln n}\right)\sum_{i=1}^{m} p_{ij} \ln\left(p_{ij}\right) \tag{4}$$

$$D_j = 1 - E_j \tag{5}$$

In the fourth step, individual indicator weights are calculated W_j and comprehensive evaluation indicators V_j :

$$W_j = \frac{D_j}{\sum_{i=1}^{m} D_j} \tag{6}$$

$$V_j = \sum_{i=1}^{n} W_j Z_{ij} \tag{7}$$

Based on the aforementioned four steps, the weights of the seven specific behaviors exhibited by the surrounding farmers were

TABLE 2 Selection and definition of multidimensional poverty indicators.

Poverty dimension	Norm	Explanatory note on indicators	Indicator weights
Education	Head of household education	Household head's education ≤9 years assigned 1, the rest assigned 0	0.0833
	Children's education	Children aged 6 to 16 who have not completed compulsory education are assigned a value of 1, while the rest are assigned a value of 0	0.0833
Health	Health status	Family members with disabilities or significant illnesses are assigned a value of 1, while the rest are 0	0.0833
Living standards	Per capita income[a]	Per capita, household income is lower than the provincial rural income, assigned a value of 1, and the rest is assigned a value of 0	0.0833
	Medical and pension security	At least one of the missing items is assigned a value of 1 for pension and health insurance, and the rest are assigned a value of 0	0.0833
	Status of assets	No cars, motorcycles or electric vehicles in the home are assigned a value of 1, and the rest is assigned 0	0.0833
	Sanitation	No fixed/segregated garbage point near home is assigned a value of 1, and the rest are assigned a value of 0	0.0833
	Drinking water	Household drinking water other than tap water or protected alpine spring water is assigned a value of 1; the rest is 0	0.0833
	Domestic fuel	Fuel for cooking is mainly fuelwood or coal, assigned a value of 1 and the rest is assigned a value of 0	0.0833
	Form of toilet	The home is assigned a value of 1 for non-outdoor/indoor flush toilets and 0 for the rest of the home	0.0833
	Cultural recreation	Dissatisfaction with one's recreational activities is assigned a value of 1, and the rest is assigned a value of 0	0.0833
	Access to information	Family members with Internet access are assigned a value of 1, while the rest are 0	0.0833

[a]Disposable income *per capita* of rural residents in Liaoning Province in 2019 was 16,108.29 yuan.

TABLE 3 Selection and definition of comprehensive conservation indicators.

Actions	Description of indicators	Indicator weights
Cessation of fuelwood collection	Stop 1, Do not stop 0	0.286
Stopping the collection of forest by-products	Stop 1, Do not stop 0	0.013
Stop using pesticides and fertilizers	Stop 1, Do not stop 0	0.067
Resilient to the impact of protected area control policies	Able: 1, Unable 0	0.092
Willingness to comply with protected area control policies	Willing 1, Unwilling 0	0.050
Participation in the management of public affairs in protected areas[a]	Yes 1, No 0	0.285
Participation in wildlife rescue	Yes 1, No 0	0.207

[a]e.g., stopping or reporting violations such as logging and medicine harvesting; participation in forest protection, *etc.*

calculated in the evaluation index system of ecological conservation behavior. These weights are presented in Table 3.

4.4 OLS regression

This study aims to compare two distinct areas: one located within protected areas subject to regulation policies and the other located outside protected areas unaffected by regulation policies. By comparing the poverty reduction and conservation effects of tourism operators inside and outside protected areas, we can assess the influence of protected area management policies on tourism's poverty reduction and conservation effects. This assessment is based on the observed distinctions between the two groups. The valid sample consists of 400 households with regulated residences and 580 without regulation.

This study utilizes ordinary least squares (OLS) regression to estimate the effects of tourism operations on poverty reduction and conservation efforts in rural households. The regression equation is as follows:

$$MPI_i = \alpha + \beta_1 X_i + \beta_2 T_i + \mu_i \quad (8)$$

$$V_i = \gamma + \beta_3 X_i + \beta_4 T_i + \varepsilon_i \quad (9)$$

Where MPI_i is the multidimensional poverty index of the i rural household, andV_i is the comprehensive conservation index of the i rural household. X_{ii} is the household head's characteristic variables and resource endowment that can be observed by household i to influence the household multidimensional poverty index and comprehensive conservation index, including age, gender, education level, the political identity of the household head, number of household laborers, household forest land area, household cultivated land area, distance to the county government, proximity to the entrance of the protected area (with a value of 0 for farm households in the protected area), and tourism resources evaluation (self-evaluation by the researched rural households) of this village and resource evaluation (self-evaluation of the researched farmers).T_i for whether the household is involved in a tourism operation (i=1 farmers who operate tourism, i=0 farmers who do not operate tourism), and β_2 for the poverty reduction effect of a tourism operation, β_4 is the conservation effect of a tourism operation, and$\mu_i$andε_i represent the random error terms.

4.5 Propensity scoring matching

The participation of farm households around protected areas in tourism operations is not a random behavior but a choice that farm households may make based on their own household characteristics and resource endowments and is the result of self-selection. Using the traditional least squares method to estimate the effects of farm households participating in tourism operations on poverty reduction and conservation could introduce bias problems due to self-selection. Family characteristics and resource endowments influence the multidimensional poverty and conservation status of farm households, creating endogeneity issues when estimating the poverty reduction and conservation effects of tourism operations. Therefore, household participation in tourism activities is not only associated with reducing poverty but also with error terms (Ma and Wen, 2016).

To address the above concerns, this study employs propensity score matching to solve the bias arising from self-selection (Rosenbaum and Rubin, 1983; Naidoo et al., 2019). A counterfactual framework is constructed to approximately randomize the non-random data. We can only observe the multidimensional poverty index and comprehensive conservation index of families engaged in tourism operations. However, we cannot obtain the same indices for families not participating in tourism operations. Based on this rationale, "propensity scores" is recommended for establishing a quasi-natural experiment. The propensity score for each household based on the characteristics influencing farmers' participation in tourism operations will be calculated using the Logit model. This approach enables us to identify a comparable control group of households that do not engage in tourism operations, thereby creating an approximately randomized dataset (He et al., 2023). According to Rosenbaum's definition, the average treatment effect of the treatment group is as follows:

$$\mathrm{ATT1} = \frac{1}{N}\Sigma_{i:\ D_i}(MPI_{1i} - MPI_{0i}) \quad (10)$$

$$\mathrm{ATT2} = \frac{1}{N}\Sigma_{i:\ D_i}(V_{1i} - V_{0i}) \quad (11)$$

Where N is the number of farm households operating tourism, $\Sigma_{i:\ D_i}$ denotes the summation of only the farm households involved in tourism operation, and MPI_{1i} denotes the multidimensional poverty index of households participating in tourism, and MPI_{0i} denotes the multidimensional poverty index of the household of a farm household that is now involved in tourism if it is assumed that it is not involved in tourism. MPI_{1i} is observable, while MPI_{0i} is a counterfactual result that needs to be estimated among farmers not involved in tourism operations through the propensity score matching method. The basic step is to select the impact (MPI_{0i}, the MPI_{1i}) and D_i the variables of interest X_i, and then use the Logit regression model to estimate the propensity score of the probability of farmers' participation in the tourism business. The propensity scores are then matched based on their probabilities while ensuring that each component of X_i is standardized.

$$\frac{\left|\bar{X}_{treat} - \bar{X}_{control}\right|}{\sqrt{\left(S_{x,treat}{}^2 - S_{x,control}{}^2\right)/2}} \quad (12)$$

$\bar{X}_{treat}$ and $\bar{X}_{control}$ are the sample means of the processed and control groups after matching, respectively. $S_{x,treat}{}^2$ and $S_{x,control}{}^2$ are the sample variances of variable X in the treatment and control groups, respectively, and the matching reduces the standard deviation. The average treatment effect of poverty reduction is calculated from the matched samples ATT1. The same method calculates the average treatment effect of ecological protection ATT2.

To assess the robustness of the matching results, various propensity score matching methods are frequently employed for comparing their respective outcomes. Similar results imply the robustness of the matching results. In this study, the radius matching method is predominantly employed to match the samples based on their characteristics. Additionally, nearest neighbor and kernel matching is used to verify the matches.

5 Results

5.1 The regression results on the poverty reduction and protection effects of farmers' tourism operations under regulatory policies

The OLS model estimates the impact of farm household participation in tourism operations on household poverty reduction and protection effects in protected areas affected by tourism control policies and outside protected areas not affected by tourism control policies, as shown in Table 4.

The OLS model estimates the results for the multidimensional poverty index of households. First, there is a significant negative

TABLE 4 Regression results of the poverty reduction and protection effects of tourism operations on households using OLS models.

Variable name	Variable interpretation	Multidimensional household poverty index		Household comprehensive conservation index	
		In protected areas (subject to regulatory policies)	Outside protected areas (no control policy)	In protected areas (subject to regulatory policies)	Outside protected areas (no control policies)
Whether to operate tourism	Yes = 1, No = 0	−0.056***	−0.161***	0.156***	0.299***
		(-2.95)	(-8.54)	(4.38)	(8.49)
Age of head of household (X1)	Survey data	0.003***	0.003***	0.000	−0.001
		(4.08)	(5.14)	(0.34)	(-1.50)
Gender of head of household (X2)	1 = Male	0.027*	0.004	−0.028	−0.005
	0 = Female	(1.87)	(0.32)	(-1.01)	(-0.25)
Educational level of head of household (X3)	1 = no schooling	−0.056***	−0.049***	0.050***	0.024*
	2 = Elementary school 3 = Middle school 4 = High school 5 = College 6 = Bachelor's degree 7 = Postgraduate	(-5.80)	(-6.62)	(2.78)	(1.72)
The political identity of the head of household (X4)	1 = Village cadres 2 = Communist Party members (ordinary party members)3 = State cadres 4 = Deputies to the National People's Congress 5 = Committee members of the Chinese People's Political Consultative Conference 6 = members of other parties 7 = others	0.002	0.008***	−0.005	0.005
		(0.82)	(2.98)	(-0.81)	(0.96)
Number of family laborers (X5)	Actual survey data	−0.013**	−0.008	0.004	−0.026**
	18years ≤ X5 < 60 years	(-2.02)	(-1.35)	(0.36)	(-2.21)
Family woodland area (X6)	Actual survey data (acres)	−0.013***	−0.015***	−0.019***	−0.016***
		(-3.88)	(-5.07)	(-2.91)	(-2.97)
Household cultivated area (X7)	Actual survey data (acres)	−0.002	−0.010*	−0.008	0.016
		(-0.36)	(-1.71)	(-0.60)	(1.50)
Distance to county government (X8)	Actual survey data (kilometers)	−0.001	−0.000	0.018	−0.011
		(-0.14)	(-0.06)	(0.96)	(-1.10)
Distance to protected area entrance (X9)	Actual survey data (kilometers)	——	−0.001	——	0.001
		——	(-0.88)	——	(0.82)
_cons		0.498***	0.490***	0.210	0.378***
		(6.80)	(9.15)	(1.53)	(3.77)
N		400	580	400	580
adj. R2		0.226	0.319	0.096	0.126
Experienced *p*-value		0.0005***		0.0000***	

t Statistics in parentheses* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The regression coefficients needed to be compared as regressions were conducted for groups within and outside protected areas. The empirical *p*-value was used to test the significance of the difference between the coefficients for "whether or not they run a tourism business" between the groups, which was tested by the no-correlation method.

correlation between tourism operations and the multidimensional poverty index inside and outside protected areas, regardless of regulatory policies. Tourism in protected areas has a substantial impact on poverty reduction. Tourism operations conducted outside protected areas can decrease the multidimensional poverty index of families by 16.1%, while tourism operations conducted within protected areas can decrease the multidimensional poverty index of families by 5.6%. It indicates that despite the availability of abundant tourism resources in these protected areas, the impact of rural tourism operations on poverty reduction diminishes due to the constraints imposed by tourism control policies. Control policies have a constraining impact on the poverty alleviation outcomes of tourism operations. Furthermore, there is a significant positive correlation between the political identity of the household head

and the multidimensional poverty index both outside and within the household. Nevertheless, there is no correlation between the political identity of the household head within the protected area and the multidimensional poverty index, which indicates that the Chinese attach great importance to interpersonal relationships. Outside the protected area, the head of the household as a village cadre can improve the household's living conditions through more natural resources and social relations. However, within the protected areas, even if the head of household is a village cadre or has other political status, it is challenging to play a role in household poverty reduction. This interesting phenomenon suggests that implementing regulatory policies in the protected area inhibits the poverty reduction effect of farm households' families. But there is more fairness in the policy implementation process, which can treat all farm households in the protected area equally and without privileged classes. Furthermore, an additional noteworthy concern is the inverse relationship between the number of households in the labor force and the multidimensional poverty index within the protected area. Communities that rely heavily on natural resources are susceptible to economic losses when their resources are affected by external pressures. To mitigate these losses, households should reallocate labor away from traditional natural resource extraction activities and diversify their livelihood strategies through non-farm activities (Bown et al., 2013). In this process, families with a greater labor force can transition more smoothly, thereby highlighting the beneficial impact of protective zoning policies on non-agricultural employment. Furthermore, a substantial positive correlation exists between the age of the household head and the incidence of multidimensional poverty within the household. The average age of the investigated household head is 54.65 years old, and in this age group, along with the age of the household head, the working ability decreases and the multidimensional poverty of the household increases. The larger the household's forest land area, the more it is affected by protected area control policies such as fuelwood collection, increasing its multidimensional poverty. There is a negative correlation between household education and multidimensional poverty. Families with higher levels of education have a greater ability to enhance their living conditions.

The OLS model estimates the household comprehensive conservation index. First, tourism operations and the household comprehensive conservation index have a significant positive correlation. Whether inside or outside protected areas, tourism operators have significant ecological conservation effects compared to non-tourism operators. Additionally, tourism operations promote ecological conservation behavior among households, regardless of policy influence. Tourism operations outside the protected area increased the comprehensive conservation index of households by 29.9%, while tourism operations inside the protected area increased the comprehensive conservation index of households by 15.6%. It indicates that the effect of tourism operations on household ecological conservation behavior is decreasing under the effect of conservation policy, and the control policy plays a restrictive role in the conservation effect of tourism operations. Furthermore, there is a correlation between the education level of household heads and household ecological conservation behavior. A higher educational level among the head of the household leads to a stronger understanding and ability to implement conservation policies. As a result, there is an improvement in ecological conservation behavior within the conservation area, particularly in a noticeable manner. Moreover, a significant negative correlation exists between household forest land area and ecological conservation behavior. The greater the proportion of forest land in the natural resources owned by the household, the greater the impact of protected area control policies, such as stopping fuelwood collection, and the greater the difficulty of policy implementation. Additionally, outside of protected areas, there is a negative correlation between the number of family laborers and ecological conservation behavior. In areas without regulatory policies encompassing environmental protection, households with more labor force members tend to participate more frequently in collecting forest by-products and fuelwood. As a consequence, this behavior leads to a decline in environmental conservation practices among farmers.

5.2 Propensity score matching results for the poverty reduction and protection effects of farmers' tourism operations under regulatory policies

5.2.1 Estimation results for propensity score matching

The OLS regression results indicate that non-tourism households have higher multidimensional poverty indices than tourism-operating households, both within the protected areas affected by regulatory policies and outside the protected areas unaffected by regulatory policies. The study also shows that tourism-operating households exhibit better ecological conservation behavior than non-tourism households. However, it cannot be assumed that it is the poverty reduction and conservation effect of tourism operations. Farmers currently involved in tourism may possess inherent family and resource characteristics that contribute to better living conditions and ecological conservation behaviors, regardless of their involvement in tourism. A counterfactual framework needs to be constructed through the propensity score matching method to solve this problem. The first step in applying the propensity score matching method is to estimate the propensity score, carefully considering the selection of matching variables. Based on the OLS regression analysis in Table 4, it was determined that four variables, namely, gender of the household head (X2), farmland area of the household (X7), distance to the county government (X8), and distance to the entrance of the protected area (X9), do not exhibit a significant correlation with the household multidimensional poverty index (measured at a 95% level of significance). As a result, these variables are excluded from the propensity score matching analysis. To comprehensively select variables that influence the multidimensional poverty index and tourism business, we have chosen five variables for propensity score matching: head of household age (X1), educational level (X3), political identity of the head of household (X4), number of family labour force (X5), and family forest land area (X6). These variables will be used to calculate the propensity scores for the household's multidimensional poverty index. The propensity scores for household ecological conservation behavior were matched with three variables: education level (X3), number of family labor force (X5), and family forest area (X6).

TABLE 5 Treatment effects of the poverty reduction effect of tourism operations on farm households under the influence of regulatory policies.

Whether the control policy is implemented	Matching method	Multidimensional poverty index for farm households operating tourism	Multidimensional poverty index for households not operating tourism	Processing group/ control group	ATT1	*p*-value	T-value
Implementation (inside protected areas)	radius match	0.3749	0.4402	62/338	−0.0651	0.012	−3.10
	Nearest neighbor matching	0.3749	0.4375	62/338	−0.0624	0.010	−2.71
	nuclear matching	0.3749	0.4404	62/338	−0.0653	0.012	−3.11
Not implemented (outside protected areas)	radius match	0.2724	0.4364	54/526	−0.1639	0.000	−9.17
	nearest neighbor matching	0.2724	0.4276	54/526	−0.1552	0.000	−7.63
	nuclear matching	0.2724	0.4355	54/526	−0.1631	0.000	−9.11

Table 5 reveals a significant negative correlation between tourism operations and the multidimensional poverty index of households, with statistical significance at the 95% and 99% confidence levels. The estimated results of the average treatment effect on the treated (ATT) indicate that within protected areas influenced by regulatory policies, the absence of tourism operation results in a decrease in the poverty reduction effect for households by 6.51%–6.53%, with an average reduction of 6.43%. It suggests that after eliminating the significant bias caused by the participation of tourism households and the explicit bias due to the observable heterogeneity of non-participating households, the poverty reduction effect of households involved in tourism operations is 6.43% greater than that of households not involved in tourism operations. Furthermore, in areas outside of protected areas unaffected by regulatory policies, after controlling for observable heterogeneity and eliminating explicit bias, households engaged in tourism operations experience a poverty reduction effect of 15.52%–16.39% higher than households not involved in tourism operations. On average, this results in a 16.07% increase in poverty reduction. The results suggest that the regulatory policy has a noticeable inhibitory effect on tourism operations in protected areas, resulting in a decrease of about 9.64% in the poverty reduction effect of tourism operations on farm households. (When comparing the results of two regression analyses conducted inside and outside the protected areas, it is necessary to employ seemingly unrelated regression to assess the magnitude of inter-group residuals. Table 4 presents empirical *p*-values that validate the comparability of group regression coefficients between the areas inside and outside the protected areas). Furthermore, compared to the results of the OLS regression, the propensity score matching estimated an increase of approximately 0.83% in the poverty reduction effect within the protected areas affected by regulatory policies, whereas a decrease of approximately 0.03% was observed outside the protected areas unaffected by regulatory policies. Compared to traditional linear regression methods, utilizing the propensity score matching method for correcting sample selection bias led to more precise research findings. The use of radius matching, nearest neighbor matching, and kernel matching yielded similar matching results, indicating a certain level of stability in the research findings.

Table 6 reveals a statistically significant positive correlation at the 99% level between tourism operations and the index of comprehensive conservation of households among rural households. The ATT estimation results show that the absence of tourism operations within protected areas impacted by regulatory policies would result in a decrease of 17.65%–18.27% in the ecological conservation effect of households, with an average decrease of 17.88%., It suggests that after controlling for the confounding bias caused by differences in household characteristics between those participating and not participating in tourism, households involved in tourism operations have a conservation effect of 17.88% greater than households that do not engage in tourism operations. Similarly, outside of protected areas unaffected by regulatory policies, the protective effect of households engaged in tourism operations is 27.74%–28.55% higher in poverty reduction compared to households not involved in tourism activities. This represents an average increase of 28.21%. The findings suggest that the regulatory policies have had a moderate inhibitory impact on the functioning of the protected areas, resulting in an approximate decline of 10.33% in the effectiveness of tourism operations in supporting household livelihoods. In addition, compared to the OLS regression results, the protective effect of propensity score matching demonstrated an increase of approximately 2.28% within the protected areas affected by regulatory policies while exhibiting a decrease of approximately 1.69% outside the unaffected protected areas.

5.2.2 Stability test for propensity score matching

The accuracy of propensity score estimation should be evaluated through a balance test to determine whether there are any systematic differences between the treatment and control groups post-matching. As shown in Table 7, post-matching reveals that the values of Pseudo R are uniformly minimal. Before matching, the likelihood ratio test was rejected at the 1% or 10% significance level but not after matching. After matching, the median standard means and quasi-standard deviation significantly decreased. The value of B after matching is

TABLE 6 Treatment effects of tourism operations on the ecological conservation effects of farmers' households under the influence of regulatory policies.

Whether the control policy is implemented	Matching method	Index of comprehensive conservation of households operating tourism	Index of comprehensive conservation of households not operating tourism	Processing group/control group	ATT2	*p*-value	T-value
Implementation (in protected areas)	radius match	0.5409	0.3606	62/338	0.1773	0.000	4.55
	nearest neighbor matching	0.5409	0.3581	62/338	0.1827	0.000	4.27
	nuclear matching	0.5409	0.3643	62/338	0.1765	0.000	4.53
Not implemented (outside protected areas)	radius match	0.5617	0.2763	54/526	0.2855	0.000	5.76
	nearest neighbor matching	0.5618	0.2844	54/526	0.2774	0.000	5.38
	nuclear matching	0.5617	0.2783	54/526	0.2835	0.000	5.73

lower than 25%. The analysis of the balance test results indicates that propensity score matching successfully mitigated the substantial observable variable bias between the treatment and control groups. The balance test has been successfully passed, demonstrating the reliability of the propensity score matching results.

5.2.3 Robustness test for propensity score

Controlling selection bias through propensity score matching can only be adjusted based on observed or measured covariates, and selection bias due to unmeasured covariates remains a problem (Ma and Wen, 2016). Therefore, the Rosenbaum boundary method is used to perform sensitivity analysis, and Gamma is expressed as the odds of differential assignment due to unobserved factors. The larger the value of Gamma, the lower the sensitivity of the study and the more robust the results. This study cites several papers discussing the value of Gamma (Ma and Wen, 2016; Zhao et al., 2021). A value greater than or equal to 1.5 is considered robust. The primary propensity scoring matching method used in this study is the radius matching method. Hence, the radius matching method is employed to estimate the propensity scores, serving as an example for conducting robustness testing, as shown in Table 8. When assessing the effect of tourism operations on poverty reduction in rural households, the upper and lower limit confidence intervals CI+ and CI- exhibit consistent signs when the value of gamma is multiplied by a factor of 1.6. Furthermore, the significance levels (sig+ and sig-) have values lower than 0.1. The test results indicate that the model's average treatment effect (ATT) estimates are not affected by unobserved variables, and the propensity score matching (PSM) estimation results are robust. When the effect of tourism management on the ecological conservation behavior of households, the values of the upper and lower confidence intervals of CI+ and CI- are of the same sign when the value of Gamma is doubled, and the values of upper and lower significance levels of sig+ and sig-are 0. The test results indicate that the model's ATT results are insensitive to unobserved variables, and the PSM estimates are robust. Furthermore, robustness tests were conducted to assess the estimation values of both nearest neighbor matching and kernel matching methods using the same approach. The observed differences were not statistically significant. Moreover, the use of propensity score matching estimation demonstrated a higher level of robustness when evaluating the impacts of tourism operations on poverty reduction and conservation effects.

6 Discussion

Based on research data from 1,028 farm households in six protected areas using a counterfactual framework, the impact of farm household tourism operations on household poverty reduction and conservation effects under the role of protected area control policies was investigated. Empirical results show that tourism operations contribute to poverty reduction and conservation in protected areas. However, under the influence of regulatory policies, both the poverty reduction and conservation effects of tourism in protected areas are declining. This indicates that regulatory policies on protected area tourism are limiting the conservation and poverty reduction effects of tourism operations.

There is a high spatial overlap between global protected areas and impoverished regions (Nepal and Spiteri, 2011). In China, more than 60% of the poor are in mountainous areas, and nearly 50% of the protected areas are in poor areas (Lv, 2021). Of the 592 counties in China classified as impoverished, 496 are located in mountainous areas where protected areas have been established (Wang et al., 2010). In managing these protected areas, it is widely recognized as an ethical duty to ensure that financially disadvantaged families are not burdened with the costs of maintaining global public goods (Brockington and Wilkie, 2015). The existing management policies of protected areas result in substantial externalities regarding shared societal resources and environmental benefits. Conversely, the surrounding communities bear the costs of protection passively. Undoubtedly, the impoverished population in these communities will further descend into poverty while bearing the financial burden of protection. In addition, under the assumption of economic

TABLE 7 Stability test for matching quality.

Whether the control policy is implemented	Content		Matching method	Pseudo R2	Lr chi2	MeanBias	MedBias	B
Implementation (in protected areas)	Poverty reduction effects	Pre-match		0.029	9.93[a]	18.5	16.2	43.10[a]
		after matching	radius match	0.000	0.07	1.8	1.9	4.90
			nearest neighbor matching	0.000	0.07	1.8	1.9	4.90
			nuclear matching	0.000	0.07	1.8	1.9	4.9
Not implemented (outside protected areas)		pre-match		0.061	22.02***	26.6	19.6	70.5[a]
		after matching	radius match	0.010	1.51	8.3	7.8	23.8
			nearest neighbor matching	0.010	1.51	8.3	7.8	23.8
			nuclear matching	0.010	1.51	8.3	7.8	23.8
Implementation (in protected areas)	protective effect	pre-match		0.022	7.58[a]	17.4	16.2	37.7[a]
		after matching	radius match	0.002	0.33	5.1	4.7	10.2
			nearest neighbor matching	0.000	0.02	1.5	1.5	2.6
			nuclear matching	0.011	1.88	12.9	12.0	24.7
Not implemented (outside protected areas)		pre-match		0.042	15.16***	30.9	25.7	58.1[a]
		after matching	radius match	0.009	1.28	10.6	11.6	21.6
			nearest neighbor matching	0.009	1.28	10.6	11.6	21.6
			nuclear matching	0.009	1.28	10.6	11.6	21.6

[a]If B>25%, R outside [0.5; 2].

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TABLE 8 Rosenbaum boundary sensitivity analysis.

	Matching propensity scores for poverty reduction effects inside protected areas				Matched propensity score for poverty reduction effects outside protected areas			
Gamma	sig+	sig-	CI+	CI-	sig+	sig-	CI+	CI-
1.0	0.000	0.000	−0.098	−0.034	0.000	0.000	−0.198	−0.144
1.1	0.000	0.001	−0.103	−0.028	0.000	0.000	−0.204	−0.135
1.2	0.000	0.004	−0.109	−0.022	0.000	0.000	−0.207	−0.130
1.3	0.000	0.008	−0.115	−0.018	0.000	0.000	−0.209	−0.126
1.4	0.000	0.014	−0.120	−0.013	0.000	0.000	−0.213	−0.123
1.5	0.000	0.025	−0.124	−0.008	0.000	0.000	−0.217	−0.118
1.6	0.000	0.039	−0.129	−0.004	0.000	0.000	−0.223	−0.113
1.7	0.000	0.057	−0.134	0.002	0.000	0.000	−0.225	−0.107
1.8	0.000	0.081	−0.137	0.005	0.000	0.000	−0.226	−0.105
1.9	0.000	0.108	−0.141	0.009	0.000	0.000	−0.228	−0.100
2.0	0.000	0.141	−0.144	0.011	0.000	0.000	−0.230	−0.098
	Matching propensity scores for conservation effects inside protected areas				Matching propensity score for conservation effects outside protected areas			
Gamma	sig+	sig-	CI+	CI-	sig+	sig-	CI+	CI-
1.0	1.0	0.000	0.000	0.109	0.229	0.000	0.000	0.193
1.1	1.1	0.000	0.000	0.087	0.252	0.000	0.000	0.161
1.2	1.2	0.000	0.000	0.081	0.259	0.000	0.000	0.150
1.3	1.3	0.000	0.000	0.075	0.262	0.000	0.000	0.120
1.4	1.4	0.001	0.000	0.066	0.280	0.000	0.000	0.114
1.5	1.5	0.003	0.000	0.057	0.299	0.000	0.000	0.087
1.6	1.6	0.005	0.000	0.047	0.307	0.000	0.000	0.082
1.7	1.7	0.008	0.000	0.039	0.319	0.002	0.000	0.072
1.8	1.8	0.013	0.000	0.031	0.326	0.003	0.000	0.054
1.9	1.9	0.019	0.000	0.016	0.333	0.004	0.000	0.050
2.0	2.0	0.027	0.000	0.012	0.342	0.006	0.000	0.048

a = 0.9.

rationality of farmers around the protected areas, the unequal costs and benefits of ecological protection may trigger farmers' antagonism towards the protected areas, which in turn may lead to resource destruction behavior (Heinen and Mehta, 2000). Many countries are interested in identifying strategies for sustainable development in protected areas. Tourism is widely recognized as a highly effective approach to achieving sustainability goals in these areas (Wang et al., 2010; Sirivongs and Tsuchiya, 2012). It has a dual mission of coordinating ecological conservation and alleviating poverty in the surrounding communities of protected areas (Guri et al., 2020). Tourism-operating farmers rely on the regulatory policies of protected areas to guide their operations, allowing them to generate increased tourism revenue by adhering to these policies. The correlation between benefits and a positive attitude towards conservation has been consistently observed in numerous cases of protected areas across different countries. Through this correlation, farmers can be motivated to protect the environment and cultivate a strong sense of responsibility toward environmental conservation (Salafsky et al., 2001; Hamilton et al., 2000; Ezebilo and Mattsson, 2010).

The empirical results of this study show that tourism operations have been proven to have significant impacts on poverty reduction and conservation. Nevertheless, the present participation rate of tourism operators in the established protected areas is relatively low, comprising only 11.84% of the entire sample size. Furthermore, their involvement is predominantly limited to basic tourism activities. The core findings of this study based on both the propensity score and OLS regression results illustrated the implementation of a series

of regulatory policies in the protected area had a detrimental impact on the functioning of tourism in the region, thereby undermining its potential for poverty reduction and conservation efforts. According to the analytical framework of institutional ecological economics, a well-designed arrangement of institutions can alter the ownership and allocation of ecological resources, thus effectively guiding the behavioural change of related subjects and generating positive institutional performance. Therefore, it is necessary to revise the existing regulatory policies for tourism in protected areas in order to ensure that tourism policies have a positive impact on protected area tourism.

7 Conclusion

The OLS baseline regression and analysis of the research sample data showed a significant negative correlation between tourism operations and the multidimensional poverty index of households and a significant positive correlation between tourism operations and the index of comprehensive conservation of households.

The OLS baseline regression revealed a statistically significant positive correlation between the political status of the head of the household and the multidimensional poverty index in areas outside the protected area. However, there is no observed correlation between the political status of the head of the household and the multidimensional poverty index within the protected area. The research findings suggest that village leaders and other household heads who hold official positions can utilize their political identities to pursue increased benefits for their families beyond the protected area., Nevertheless, regulatory policies within the protected area impose restrictions on resource utilization for all individuals, thus undermining the privileges enjoyed by the privileged class in terms of resource use. The regulatory policies implemented within the protected area play a significant role in achieving social equity.

The OLS baseline regression showed a negative correlation between the number of household laborers and the multidimensional poverty index in the protected areas. The imposition of restrictions on farmers' utilization of natural resources within the protected area has compelled them to shift from conventional resource utilization patterns to diversified livelihood strategies. The transition is more seamless for households with higher labor participation, leading to reduced poverty levels.

The core findings of this study based on both the propensity score matching and OLS regression results illustrated the implementation of a series of regulatory policies in the protected area had a detrimental impact on the functioning of tourism in the region, thereby undermining its potential for poverty reduction and conservation efforts. After controlling for observable heterogeneity biases, the findings indicate that within protected areas affected by regulatory policies, households involved in tourism operations experience a poverty reduction effect that is 6.43% higher compared to households not involved in tourism operations. In contrast, outside of protected areas not influenced by regulatory policies, households engaged in tourism operations experience a poverty reduction effect of approximately 16.07% higher compared to households not involved in tourism operations. Despite the presence of abundant tourism resources within the protected area, tourism operation in the protected area is still not as good as outside the protected area, and the reasonable explanation is that the control policy has a certain inhibiting effect on tourism operation in the protected area, resulting in a decline of approximately 9.64% in the poverty reduction impact of tourism operations on rural households. In protected areas influenced by regulatory policies, the ecological conservation effect will diminish by 17.88% if households do not participate in tourism operations. Nevertheless, in protected areas unaffected by regulatory policies, the ecological conservation impact of households engaged in tourism operations is, on average, 28.21% greater than that of households not involved in tourism operations. The findings suggest that regulatory policies have diminished the protective impact on tourism operations in protected areas by approximately 10.33%.

8 Policy implications

To mitigate the adverse impacts of management policies on tourism in protected areas and advance the dual objectives of these areas, the government and relevant departments should consider policy enhancements in the following domains:

Firstly, protected area management agencies should incorporate the livelihood development of neighboring farmers into their management and provide more opportunities for them to operate tourism businesses. Conclusion revealed that the operation has significant poverty reduction and conservation effects. To enhance tourism participation in protected areas, it is necessary to provide guarantees in both policy and financial aspects. From the policy level, it is crucial to distinctly outline the significance of community participation and the manner and extent of community involvement in the pertinent laws and regulations of managing protected areas, ensuring the residents' rights to engage in the process. It is also essential to actively collaborate with local farmers in multiple areas, including granting franchising rights in protected areas, designing tourism products, managing visitor reception, and providing park services. Regarding funding, the issue of insufficient funds for rural households to establish tourism businesses can be addressed by implementing credit preferential policies and cooperative partnerships, which will lower the barrier for rural households to participate in tourism operations and promote greater involvement of rural households.

Secondly, establish a comprehensive societal oversight system to monitor protected area policy implementation. Conclusion indicated that implementing tourism management policies in protected areas has limited poverty alleviation and conservation effects of tourism. To closely monitor the process of policy implementation, governments of various countries often allocate additional resources for supervision during the initial stages of policy execution. Along with the time of policy implementation, it will be challenging to ensure the consistency of the policy without a long-term and effective supervision mechanism. China's protected area control policy is in the early stage of policy implementation. Although the policy has faced criticism, the public has acknowledged its fairness during the execution process. In the future, it is necessary to maintain transparency in implementing the protected area control policy and establish a long-term

mechanism for social supervision to ensure long-term fairness in policy implementation.

Thirdly, improve the residents' capacity to engage in tourism. Conclusion indicated that the protected area control policy had limited the use of traditional resources in the protected area and that livelihood conversion is a rational choice for farming households to avoid an increase in multidimensional poverty. In the livelihood conversion of farming households, tourism operation is an advantageous and accessible method for low-threshold conversion. It is particularly beneficial for households facing labor constraints and challenges transitioning their livelihoods. Special poverty alleviation measures can be implemented to support these households by encouraging their participation in tourism businesses and providing special public welfare positions by tourism enterprises or communities. Moreover, enhancing the workforce's competency in tourism management skills and other strategies will facilitate the transition of farmers in the protected area into tourism operations, thereby promoting their livelihood transformation.

Fourthly, it is essential to ensure governance under the law and establish partnerships while implementing an access system for tourism operations in protected areas. Approximately 50% of China's protected areas are situated in economically disadvantaged regions. To generate a strong motivation among the neighboring communities to protect the environment, it is crucial to effectively integrate the development of these protected areas with poverty reduction initiatives targeted at the surrounding farmers to make the neighboring communities witness and experience the benefits resulting from the establishment of protected areas and then generate a conscious motivation to protect the environment. Conclusion raises concerns about the policy of protected areas in China, as the weakening of poverty reduction and conservation effectiveness will ultimately hinder achieving the policy's goals. In the current government governance model of Chinese protected areas, the government employs a top-down decision-making approach that lacks responsiveness. Regulatory policies impose restrictions on agricultural tourism operations within protected areas. Specifically, in certain regions, local governments have reinforced restrictions following central protection policies, resulting in the closure and dismantling of several successful tourism projects within the experimental zones, impeding the rationalization of the farmers' tourism operations. The 2019 release of the "Guiding Opinions on Establishing a Protected Areas System with National Parks as the Main Body" is the central policy document for managing protected areas in China. It highlights the substantial presence of tourism activities in our protected areas as an objective reality. The fundamental principle of sharing resources in protected areas with the entire population dictates that tourism cannot be excluded from these areas. It is essential to provide sufficient support to nature education and wellness tourism and create business opportunities in the tourism industry for residents. Given the recognition of tourism management, it is essential to undertake infrastructure construction and maintenance, as well as impose restrictions on logging forest resources to ensure effective management, The relevant regulatory authorities can make informed decisions on approval based on the findings of environmental impact assessments rather than unconditionally rejecting them. Protected areas should be managed differently according to local conditions. Under the guidance of the central protected area policy, each protected area should consider its actual situation and allow farmers to participate in decision-making on essential matters in the protected area by building partnerships with neighbouring communities.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary Material, further inquiries can be directed to the corresponding authors.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent from the [patients/ participants or patients/participants legal guardian/next of kin] was not required to participate in this study in accordance with the national legislation and the institutional requirements.

Author contributions

DH: Conceptualization, Formal Analysis, Methodology, Writing–original draft. JW: Resources, Validation, Writing–original draft. XL: Investigation, Writing–original draft. XS: Resources, Validation, Writing–original draft. ZX: Conceptualization, Formal Analysis, Methodology, Writing–original draft. YW: Data curation, Validation, Writing–original draft. YQ: Investigation, Writing–original draft. KC: Conceptualization, Formal Analysis, Methodology, Writing–original draft, Writing–review and editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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