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Can Cooperatives Enhance the Income-Generating Effect of Eco-Industries for Farmers?—Empirical Evidence from the Crested Ibis National Nature Reserve, China

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Abstract: Promoting the development of eco-industries plays a significant role in achieving the harmonious symbiosis between economic growth and environmental protection as well as enhancing the comprehensive effectiveness of ecological and economic benefits. Due to their unique nature, cooperatives may play a crucial role in facilitating the integration between farmers and the development of eco-industries. To investigate whether cooperatives possess the capacity to enhance the income-generating effects for farmers involved in eco-industries, this study selected the Crested Ibis National Nature Reserve (CINNR), a representative area for eco-industry development, as the research site. Data were gathered through face-to-face interviews, and this research empirically analyzed the impact of cooperatives on the income-generating effect of farmers using endogenous switching regression (ESR). The findings are threefold. First, cooperatives indeed enhance the income-generating effects for farmers engaged in eco-industries. Second, variables such as the distribution of agroforestry materials, premium capacity, soil quality, and status of village cadres have a positive impact on farmers joining cooperatives, whereas punishment initiatives discourage their participation. Third, for farmers who have joined cooperatives, factors such as the distribution of agroforestry materials, premium capacity, low-cost conservation initiatives, land area, status of village cadres, the proportion of labor force, technical training, soil quality, and land area positively affect their income from eco-industries. Conversely, punishment initiatives, age, and land location negatively impact their income. The results of this study provide new ideas for farmers to participate in the development of eco-industries, new evidence showing co-operatives can improve farmers' income, and new directions for coordinating conflicts between conservation and development in protected areas.

Keywords: cooperatives; eco-industries; farmers' income increase; protected areas

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1. Introduction

As global awareness of environmental protection increases, the development of the ecological economy is increasingly being emphasized. Eco-industry, a crucial component of the ecological economy, refers to production methods that adopt green and sustainable development strategies, prioritize respect for nature and protection of the environment, and emphasize ecological balance and sustainability in the production process [1]. In vast rural areas that rely on unique and favorable environments, the development of eco-industries has become an important approach to increasing farmers' income and promoting rural revitalization [2,3].

The CINNR, one of China's significant ecological conservation areas, plays a crucial role not only in the livelihoods of local farmers but also in maintaining the ecological balance and biodiversity of the reserve. The development of eco-industries within the CINNR is of particular significance. The reserve is named after its primary species of concern, the *crested ibis* (*Nipponia nippon*), which is currently classified as a threatened species by the International Union for Conservation of Nature (IUCN). Historically widespread across East Asia and Russia, the *crested ibis* has faced habitat shrinkage and population decline due to environmental changes and human activities, leading to its extinction in regions like the Korean Peninsula and Japan by the 20th century, until its rediscovery in Shaanxi Province, China, in the 1980s [4]. Following this discovery, the Chinese government established the CINNR to protect the species in situ. Over forty years of conservation efforts have significantly improved habitat conditions, increasing the global population of the *crested ibis* from 7 to 11,000 individuals [5].

The *crested ibis* relies heavily on agroforestry production materials for survival, with their habitats and foraging areas overlapping significantly with rural residential areas [4]. Conservation policies prohibit mining, hunting, and deforestation within the ibis activity zones while restricting the use of pesticides and fertilizers and advising farmers to preserve natural wetlands and paddy fields during winter, ensuring feeding grounds for the ibis. These measures, although impacting agricultural practices and forestry exploitation by local farmers, have led to the development of a superior ecological environment within the reserve, laying a solid foundation for the growth of local eco-industries.

Residents within the reserve have leveraged the environmental advantages to develop eco-industries, achieving income growth and improving their livelihoods. Past initiatives by the government and international organizations to compensate farmers for their losses through payments for ecosystem services have been somewhat successful but have not established a long-term mechanism for reconciling conservation with development [6,7]. However, the CINNR has explored new avenues to balance these interests. Products produced within the reserve have received organic certification, commanding higher prices than those outside the reserve, with organic premiums for farmers ranging between 6% and 44% [8], highlighting the economic benefits of ecological conservation. Farmers' demand for the development of the organic industry is growing day by day. They see a large market demand for organic products, making organic agriculture an attractive direction for development. Organic products not only fetch higher prices but are also healthier and more environmentally friendly, winning the favor of consumers. Farmers hope to improve their income levels and quality of life by developing the organic industry. In protected areas, the awareness and demand of farmers are even more urgent. They are acutely aware of the preciousness of the ecological environment and hope to achieve a win–win situation for both ecology and the economy through the development of an organic industry [9].

Rural cooperatives are voluntary, democratically managed economic organizations that play an increasingly prominent role in the development of rural eco-industries [10–12]. Given their economic nature, it is imperative for cooperatives to distribute surpluses based on transaction volumes or amounts and ensure member participation in decision-making and operations, with robust regulations and organizational structures being fundamental to their functionality [13]. As unique entities, cooperatives often serve as vehicles for policy implementation by the government, which supports their development through financial and policy measures. Cooperatives have indeed played a crucial role in integrating small-scale farmers with modern agriculture and forestry, aggregating resources, enhancing scale economies, reducing production costs, and improving market negotiation power and product sales [14,15]. Moreover, cooperatives also have a technology and information-sharing function, which promotes the wide dissemination and application of agroforestry technologies and provides farmers with market information and agroforestry advice [16–18]. Therefore, cooperatives are not only a bridge linking farmers and the market [19] but are also making a significant contribution to the implementation of supply-side structural reforms in agroforestry and the rural revitalization strategy.

This paper aims to explore the mechanisms through which cooperatives enhance the income effects within the eco-industries of the CINNR. Data were collected through face-to-face interviews with farmers, and empirical analyses were conducted to identify the factors influencing their decision to join cooperatives and the resulting income increases. Additionally, the proportionate increase in farmers' incomes was quantified. This research contributes to the understanding of the relationship between cooperatives and farmer income enhancement in two main ways. First, it explores the effective role of cooperatives in increasing farmer incomes within or around protected areas that are suitable for developing eco-industries. Second, it introduces the ESR model as a methodological approach, achieving a threefold analysis: (1) the model assesses factors influencing farmers' decisions to join cooperatives; (2) it examines the heterogeneous impact of joining cooperatives on the eco-industry income of families with different capital endowments; and (3) it enables counterfactual estimation. The findings of this study are expected to provide valuable insights for the sustainable development of eco-industries and may also offer guidance and inspiration for the development of cooperatives in eco-industries in other regions.

The remainder of this article is organized as follows. Section 2 provides a theoretical analysis. Section 3 describes the study area, data, and methods. Section 4 presents the results. Section 5 offers evidence of how cooperatives can enhance farmer incomes and analyzes the factors influencing farmer participation in cooperatives and income enhancement. Section 6 concludes the study.

2. Theoretical Analysis

Establishing cooperatives can effectively drive the development of eco-industries and enhance their profitability, thereby enhancing farmers' income generation [20,21]. This manifests in several ways.

Firstly, cooperatives facilitate the integration and sharing of resources among farmers, including land, labor, seeds, and farming tools, thereby enhancing the efficiency of resource utilization. In some instances, sharing resources can significantly reduce costs and improve efficiency [15,22,23]. For example, compared to individual farming, members within a cooperative can collectively purchase production supplies, thereby obtaining lower prices and better terms. Resource sharing can enhance farmers' professionalism and skill levels and promote the exchange of experiences [24]. There are mainly two modes of farmer participation in cooperatives: one involves farmers engaging in the management of the cooperative, where members jointly manage and share resources, risks, and benefits; the second involves cooperative members entrusting assets like land to the cooperative for management, thereby increasing asset-based income for the farmers. Through the cooperative's unified management of production resources, it can acquire large contiguous lands at low costs and set the stage for scaled production, effectively releasing a surplus rural labor force. Agriculture and forestry are risk-prone industries, with factors such as weather changes, natural disasters, and market fluctuations affecting farmers' incomes [25]. As a collective entity, cooperatives can help farmers share risks. For instance, in the production of organic products, farmers can collectively purchase insurance through the cooperative, thereby mitigating individual risks and enhancing overall business stability.

Secondly, cooperatives provide technical guidance and training in the eco-industry to farmers, aiding them in mastering organic planting, fertilization, and pest control techniques, which enhances both production efficiency and quality [26]. The development of eco-industries requires advanced technologies, knowledge support, and continuous training. Cooperatives often serve as platforms for the dissemination of new technologies and practices. Cooperatives can provide technical support and training to help farmers learn best practices and technologies for eco-industries. Within cooperatives, members can enhance the quality and quantity of agroforestry products by sharing experiences and knowledge. Members of the cooperative can also improve farmers' productive capacities and creativity through close cooperation and the exchange of experiences [27].

Thirdly, cooperatives assist farmers with product marketing and in expanding sales channels for organic products, providing price guarantees to ensure farmers receive a fair income [28,29]. Cooperatives can enhance the market adaptability of agroforestry products by engaging in unified procurement of production materials and marketing of agroforestry products, thereby facilitating efficient market integration for farmers [30,31]. Particularly in the sales link, the unified operation of cooperatives ensures the effectiveness of agroforestry product market promotion, acting as a bridge between farmers and buyers and reducing the market risks borne by farmers. Elite negotiations within cooperatives can increase the selling price of products to secure higher profits. By establishing partnerships with large buyers, such as supermarkets and restaurant chains, cooperatives can expand sales channels, reduce intermediaries, enhance product sale prices and profitability margins, and improve farmers' economic returns.

Fourthly, cooperatives help farmers improve the quality of organic products and support product certification to enhance competitiveness, meeting consumer demands for high-quality organic products [32]. With the support of cooperatives, farmers can better control product quality, reduce the use of chemical pesticides and fertilizers, and enhance the nutritional value and taste of products. Additionally, cooperatives can assist farmers with product certifications, such as organic and eco-label certifications, ensuring products meet market entry requirements and enhancing the products' credibility and market competitiveness. Through unified brand promotion, marketing strategies, and strict brand management by cooperatives, the brand reputation is protected, which can enhance the market recognition of organic products, increase the competitiveness of organic products, and create more market opportunities and higher added value for farmers [33].

Fifthly, cooperatives encourage and support members to develop a diversified line of ecological products, including ecological fruits and vegetables, organic meats, and dairy products, to mitigate the risks associated with market fluctuations of single agricultural products. Through diversified planting and breeding, farmers can adjust their product mix based on market demand and seasonal changes, thereby reducing the impact of market risks and price volatility on farmers' incomes. Cooperatives provide market information and demand forecasts to their members, guiding them in selecting suitable directions for cultivating and breeding ecological products, thus enhancing the market adaptability and competitiveness of these products.

In addition, most of the current studies on the role of cooperatives in improving the profitability of eco-industries have used linear regression analysis, multiple regression analysis, Heckman probit models, multinomial logit models, etc. [10,24,28,34,35]. Some studies also used the ESR model to determine that membership in cooperatives is a key factor influencing the choice of marketing channels in China for apple growers, but the authors did not estimate the effect of cooperative membership on the counterfactual (non-cooperative membership) effects [36]. However, this gap was filled by another study that estimated the effect of cooperative membership on milk marketing channel choice using an ESR model [37].

3. Materials and Methods

3.1. Variables

3.1.1. Dependent Variable

The sample of farmers selected for this study included those involved in the management of eco-industries, producing organically certified products through contract-based order production modes. The farmers involved in the eco-industries adopt an "order-based" production method, where the seeding, management, collection, storage, and sales of organic products are conducted according to contract agreements. Businesses and farmers fulfill their rights and obligations based on the contract, with businesses choosing or deciding the variety of crops to be planted and signing production and sales contracts with farmers specifying the variety and purchase quantity. The contract outlines technical procedures related to the use of seeds, selection of fertilizers, pest control, and maintenance of the planting environment according to organic production standards and provides corresponding planting technical training. Some businesses, aiming to unify output standards, provide seeds and fertilizers to organic product producers. Upon harvest, businesses conduct moisture content inspections and pesticide residue tests. Quality-compliant products are purchased at a reasonable price and in an agreed manner; if the quality does not meet the standards, it is considered a breach of contract, and the business may choose not to purchase and impose a fine.

Current research on the selection of variables for farmer income enhancement primarily focuses on household income and consumption levels [38,39]. Considering consumption levels are significantly influenced by household income, which itself is composed of various income structures and does not perfectly explain the magnitude of income enhancement effects in eco-industries, this study selected the per unit area eco-industry income of farmers as the indicator to measure income enhancement effects. It primarily examined the income enhancement effects among farmers operating eco-industries within the nature reserve who are members of cooperatives compared to those who are not. To mitigate the impact of heteroscedasticity on the results, the eco-industry income in the regression model was transformed using the natural logarithm.

3.1.2. Independent Variable

While individual farming operations can maintain a certain level of production efficiency, small-scale operations mean that the scale of agricultural products entering the market is small, leading to excessively high transaction costs per unit of agricultural product due to a lack of scale efficiency in distribution. Cooperatives inherently possess a poverty alleviation function, providing production materials, production technology, sales information, and channels with scale effects. Additionally, the cooperative nature can effectively reduce the transaction costs of cooperative operations to achieve higher income [40]. The core independent variable of this study was whether or not one has joined a cooperative.

3.1.3. Identifying Variables

Farmers' decision-making behavior is often influenced by the "neighborhood effect", but whether people around them join a cooperative does not directly affect the farmers' own income levels. Based on this, the situation of other farmers in the same village (excluding the respondent) joining a cooperative in the surveyed area was selected as an instrumental variable, which meets the requirements for relevance and exogeneity of instrumental variables.

3.1.4. Control Variables

To ensure the accuracy of the results, four categories of control variables were set: characteristics of eco-industry production, characteristics of household heads, family endowments, and regional characteristics. Characteristics of eco-industry production included variables such as the distribution of agroforestry materials, penalty situations, premium capability, and low-price protection. Characteristics of household heads were measured by variables such as the age of the household head, level of education, whether they hold village official positions, and technical training. Family endowments were measured by variables such as the permanent population, labor force ratio, land area, and land quality. Regional characteristics included the variable relationship between the farmer's land location and the CINNR.

3.2. Data

3.2.1. Study Area

The study area was Yang County, located in the southwest of Shaanxi Province. It spans longitudes 107°11′ and 108°33′ east and latitudes 33°02′ and 33°43′ north, covering an area of 3206 km^2 with a total population of 442,100. Positioned along the Qinling-Huaihe River line, a significant north–south demarcation in China, Yang County boasts diverse topography. Its landscape comprises steep northern and eastern mountain slopes, flat central and western river plains, and gently sloping southern hill areas, combining mountainous, riverine, and hilly terrains. The elevation ranges from 327 to 3065 m, with the central-western plain district occupying 6.7% (215 km^2) of the area at an elevation of around 500 m; the eastern, southern, and northern mountainous regions account for 72.2% (2315 km^2) with elevations above 950 m; and the southern and northern hill regions cover 21.1% (676 km^2) with elevations ranging from 550 to 840 m. Yang County experiences a continental monsoon climate characterized by distinct seasonal changes, simultaneous occurrences of heat and rain, and concurrent dryness and cold. It receives abundant rainfall, with an average annual temperature of 14.5 °C, a maximum temperature of 38.7 °C, and a minimum temperature of −10.1 °C. The annual average precipitation is 839.7 mm, and the average frost-free period lasts 239 days, creating favorable conditions for agriculture and forestry. The forest cover rate in Yang County is 68.6%, with a total cultivated land area of 386.6667 km^2, accounting for 12.19% of the total area, and an average of 1060 m^2 of cultivated land per capita. The soil in the area has excellent permeability, moisture, and fertility retention properties, is free from geogenic pollution, and is rich in organic matter with an average of 16.8 g/kg and a pH ranging from 5.5 to 8.1, making it an excellent region for developing organic industries. The plains of Yang County are one of the best rice production areas in China.

Yang County is the most important habitat and breeding ground for the *crested ibis*. Within the county, there are two national protected areas, the CINNR and the Changqing National Nature Reserve, which together occupy 93.6% of the county's area. The living spaces of local farmers highly overlap with those of the *crested ibis*, with approximately one-third of the county's farmland serving as foraging areas and night roosts for the ibis. In these areas, farmers are unable to use pesticides and fertilizers, resulting in yields that are about 30% lower than conventional farmland. Furthermore, during winter, farmers are required to preserve some farmland as paddy fields to provide foraging grounds for the ibis, addressing the shortage of food sources in winter. This also impacts the sowing area for winter and spring crops, affecting crop yields. To compensate farmers for losses incurred due to *crested ibis* protection and to mitigate conflicts between conservation and development, various government departments and local villages have implemented multiple compensation measures, including cash compensation, labor employment, environmental rectification, and technical support. These measures have played a role to some extent but have not formed a stable and sustainable mechanism. However, years of *crested ibis* protection have created a superior natural environment, bringing opportunities for industrial development. Yang County boasts rich water resources, fertile soil, ample sunlight, and a mild and humid climate, offering excellent natural conditions. Moreover, due to the high ecological environment standards for *crested ibis* protection, the use of chemical fertilizers and pesticides and the operation of industrial and mining enterprises are strictly controlled within the county. This low degree of industrialization ensures good soil quality, minimal water pollution, and clean air, providing the environmental conditions necessary for organic production. The organic products in the CINNR are primarily centered around five major industries: grains, fruits, medicinal products, fungi, and livestock. The main products include organic pork, chicken, fish, eggs, black sorghum wine, multicolored rice, sweet potato noodles, black rice vinegar, shiitake mushrooms, and black fungus.

3.2.2. Data Collection

The research team conducted micro-level farmer surveys in Yang County in 2016 and 2017, accumulating experience in investigating the habitats of the *crested ibis*. This study commenced a preliminary survey in July 2021, expanding the range of survey locations based on the 2016 and 2017 surveys and making adjustments according to the content of this research. The formal survey was conducted from March to April 2022, with one-on-one household surveys carried out in various townships of Yang County, targeting household heads or main family members involved in production decisions. The study adopted a combined approach of stratified sampling and random sampling for sample selection. Stratified sampling was primarily employed in selecting the research areas. Prioritizing ecological conservation, survey sites were mainly chosen within and around the CINNR.

In China, based on the management intensity of protected areas, areas within the protected areas were categorized into core, buffer, and experimental zones. Each zone contained lands individually owned by farmers; hence, survey sites were selected from villages within these three divisions as well as villages outside the CINNR. Random sampling was mainly utilized in selecting households for the survey. The number of villages to be sampled from each region was determined based on the population distribution across four areas: the core zone, buffer zone, experimental zone, and areas outside the CINNR. From each village, approximately 20 households were randomly selected for the face-to-face interviews. These interviews were conducted with cognitively capable adult family members in their homes, facilitated by local village officials. The interviews, lasting about 1–2 h, began with researchers providing a detailed introduction to the purpose and questions of the survey to minimize potential misunderstandings by the respondents. Upon completing the survey, households received a thank-you gift. We sent out a total of 875 questionnaires and finally obtained 816 valid samples, with a validity rate of 93.26%, of which 226 samples were involved in eco-industries.

Table 1 presents the basic characteristics of the respondents in the full sample (N = 816). It can be observed that 72.3% of respondents are male, and the majority are aged between 51 and 65 years. Over 90% of the respondents are married, and approximately 80% have an educational level of middle school or below. Village officials make up 14.1% of the respondents. The spatial relationship between the respondents' residences and the CINNR indicates that more than half of the respondents live within the CINNR, with the vast majority residing in the experimental zone.

Table 1. Basic characteristics of the household heads (N = 816).

Index	Explanatory Variable	Proportion (%)	Index	Explanatory Variable	Proportion (%)
Gender	Male	72.3	Whether there are village officials at home	Yes	14.1
	Female	27.7		No	85.9
Age	Below 35 years old	1.7	Education	Illiteracy	7.2
	36–50 years old	13.8		Elementary school	28.8
	51–65 years old	51.6		Middle school	49.3
	Above 65 years old	32.8		High school	13.3
Health status	Good	62.6		Bachelor's degree and above	1.3
	Average	23.7	Spatial relationship between settlements and protected areas	Located outside the protected area	49.3
	Minor illness	13.5		Located in the experimental zone of the protected area	44.4
Marital status	Married	90.3		Located in the buffer zone of the protected area	1.8
	Unmarried	9.7		Located in the core area of the protected area	4.2

3.3. Methods

This study drew on previous research [36,37] and employed the ESR proposed by Maddala [41] in the empirical analysis section. Utilizing the ESR to construct a cooperative feedback mechanism model, this research investigated whether participation in cooperatives enhances income for farmers engaged in eco-industries, ultimately seeking methods to resolve the conflict between economic development and ecological conservation.

Based on the rational economic agent assumption of Western economics, the ultimate goal for farmers joining cooperatives is to maximize per unit area eco-industry income. Depending on whether farmers participate in eco-industries and their cooperative membership status, it is assumed that the risk of participating in a cooperative is neutral. Thus, the potential net profit for a farmer participating in a cooperative is denoted as D_{1i}^*, and the expected profit for a non-participating farmer is D_{0i}^*, with the profit difference between the two being D_i^*, $D_{1i}^* - D_{0i}^* = D_i^*$. If $D_i^* > 0$. This indicates that the net profit obtained by farmer i from joining the cooperative exceeds that from non-participation, leading to the decision to join. However, D_i^* is not directly observable but can be represented as a function of an observable variable in the following latent variable model:

$$D_i^* = \begin{cases} 1, D_i^* > 0 \\ 0, D_i^* \leq 0 \end{cases} \quad (1)$$

where D_i^* is the decision variable. $D_i^* = 1$ indicates farmer i joining a cooperative, and $D_i^* = 0$ indicates non-joining, upon which the model for the impact of joining a cooperative on farmer income is built:

$$Y_i = \alpha X_i + \beta D_i + \varepsilon_i \quad (2)$$

where Y_i represents the household eco-industry income; X_i represents control variables influencing household eco-industry income, such as individual and production characteristics of the household; α and β are the coefficients to be estimated; and ε represents the random error term.

If farmers were randomly assigned to groups of cooperative members and non-members, the β coefficient in Equation (2) would accurately measure the impact of cooperative membership on household eco-industry income. However, as mentioned earlier, farmers' decisions to join cooperatives are influenced by policy environments, individual heterogeneity, and self-selection issues, leading to unobservable variables affecting both decision D and income Y, resulting in sample selection bias. Commonly used solutions in academia include propensity score matching (PSM) and instrumental variables (IV); however, PSM cannot address endogeneity issues arising from unobservable variables, and IV does not consider the heterogeneity of farmers, leading to overestimated fits. Therefore, this study estimated Equation (2) using the ESR proposed by Maddala [41], which allows for (1) consideration of factors influencing whether farmers join cooperatives; (2) inclusion of unobservable variables in the selection model to address sample selection bias and endogeneity, examining the heterogeneous impact on household eco-industry income across different capital endowments; and (3) counterfactual estimation. The ESR entails a two-stage estimation process, first establishing the selection equation using probit regression to examine factors affecting farmers' decisions, then constructing outcome equations for both cooperative members and non-members to assess income differences under various scenarios.

Selection equation:

$$D_i^* = \gamma_i Z_i + \delta_i I_i + \mu_i \quad (3)$$

Outcome equations:

$$Y_{i1}^* = \beta_{i1} X_{i1}' + \varepsilon_{i1}, D_i = 1 \quad (4)$$

$$Y_{i0}^* = \beta_{i0} X_{i0}' + \varepsilon_{i0}, D_i = 0 \quad (5)$$

where Z_i represents control variables that influence farmer i joining cooperatives; I_i is an instrumental variable; Y_{i1}^* and Y_{i0}^* are the household eco-industry incomes of farmer i joining and not joining the cooperative, respectively; X_{i1}' and X_{i0}' are exogenous variables that may affect the household eco-industry income of farmer i joining and not joining the cooperative, respectively; γ_i, δ_i, β_{i1}, and β_{i0} are the coefficients to be estimated; and μ_i, ε_{i1}, and ε_{i0} are random disturbance terms.

Equations (2)–(5) assume that the decision to join a cooperative is determined by exogenous variables, neglecting the endogeneity of joining a cooperative. Moreover, unobserved factors can affect the error terms in both the selection Equation (3) and the outcome Equations (4) and (5), leading to a correlation between the error terms, thereby biasing ordinary least squares estimates. After estimating the selection equation, the inverse Mills ratios (IMR) λ_{i1} and λ_{i0} and covariance terms $\sigma_{i1} = cov(\mu_i, \varepsilon_{i1})$ and $\sigma_{i0} = cov(\mu_i, \varepsilon_{i0})$ were calculated and introduced into Equations (6) and (7) to control for selection bias caused by unobservable factors.

$$Y_{i1} = \beta_{i1} X'_{i1} + \sigma_{i1} \lambda'_{i1} + \varepsilon_{i1}, D_i = 1 \quad (6)$$

$$Y_{i0} = \beta_{i0} X'_{i0} + \sigma_{i0} \lambda'_{i0} + \varepsilon_{i0}, D_i = 0 \quad (7)$$

where $\lambda'_{\rm i1}$ and $\lambda'_{\rm i0}$ control for selection bias due to the unobservable variables, and the error terms ε_{i1} and ε_{i0} satisfy the zero-mean assumption. The full information great likelihood (FIML) method was chosen to estimate the selection and outcome equations simultaneously. The correlation coefficients of the covariance between the error terms in the ESR model estimation are $\rho_{\mu 1} (\rho_{\mu 1} = \sigma_{\mu 1} / \sigma_{\mu} \sigma_{\mu 1})$ and $\rho_{\mu 0} (\rho_{\mu 0} = \sigma_{\mu 0} / \sigma_{\mu} \sigma_{\mu 0})$. If $\rho_{\mu 1}$ or $\rho_{\mu 0}$ is statistically significant, it indicates the presence of selection bias from unobservable factors. Therefore, to obtain unbiased estimates of treatment effects, it is a prerequisite to consider both observable and unobservable factors.

The ESR facilitates counterfactual estimation, comparing the differences in household eco-industry income under actual and counterfactual conditions for farmers who joined cooperatives and those who did not, thereby assessing the income-enhancing effect of cooperatives.

The expected household eco-industry income for farmers who joined cooperatives (treatment group) is as follows:

$$E[Y_{i1} | D_i = 1] = \beta_{i1} X'_{i1} + \sigma_{\mu 1} \lambda'_{i1} \quad (8)$$

The expectation of household eco-industry income for farmers who are not members of cooperatives (control group) is as follows:

$$E[Y_{i0} | D_i = 0] = \beta_{i0} X'_{i1} + \sigma_{\mu 0} \lambda'_{i1} \quad (9)$$

The expected household eco-industry income of the treatment group in the production scenario without joining the cooperative is as follows:

$$E[Y_{i0} | D_i = 1] = \beta_{i0} X'_{i1} + \sigma_{\mu 0} \lambda'_{i1} \quad (10)$$

The control group's household eco-industry income expectations in the production scenario of joining a cooperative are as follows:

$$E[Y_{i1} | D_i = 0] = \beta_{i1} X'_{i0} + \sigma_{\mu 1} \lambda'_{i0} \quad (11)$$

Therefore, the average treatment effect (ATT) for farmers in the treatment group (joining the cooperative) can be expressed as the difference between Equations (8) and (10):

$$\text{ATT} = E[Y_{i1} | D_i = 1] - E[Y_{i0} | D_i = 1] = (\beta_{i1} - \beta_{i0}) X'_{i1} + (\sigma_{\mu 1} - \sigma_{\mu 0}) \lambda'_{i1} \quad (12)$$

Correspondingly, the average treatment effect (ATU) for the control group of farmers (not joining the cooperative) can be expressed as the difference between Equations (9) and (11):

$$\text{ATU} = E[Y_{i1} | D_i = 0] - E[Y_{i0} | D_i = 0] = (\beta_{i0} - \beta_{i1}) X'_{i0} + (\sigma_{\mu 0} - \sigma_{\mu 1}) \lambda'_{i0} \quad (13)$$

4. Results

4.1. Basic Situation of Farmers Engaged in Eco-Industry Operations

In the survey sample, there were 226 households involved in the management of eco-industries. According to the results shown in Table 2, the average income per unit area from eco-industries in 2021 was CNY 1698. Farmers participating in eco-industries as producers can independently choose the purchasers of their products, which include enterprises and cooperatives. Of the 226 households surveyed, 83.6% elected to forgo membership in cooperatives, preferring to establish direct contractual relationships with enterprises. Conversely, 16.4% of the households decided to affiliate with cooperatives, entering into agreements for the production and commercialization of organic goods with these organizations. During the organic product cultivation process, enterprises or cooperatives, as stipulated in the contracts, could provide farmers with necessary materials such as seeds, fertilizers, and pesticides that meet organic planting standards, free of charge. The results presented in Table 2 indicate that only 23.4% of the households did not receive any distribution of raw materials. Moreover, enterprises and cooperatives typically stipulate production standards in their contracts, and the analysis showed that 77% of households reported that their contracts include penalties if the products do not meet the specified technical requirements. Regarding the purchase price, the sample mean was greater than 3, suggesting that respondents acknowledge that the average purchase price for organic products exceeds market prices. Additionally, 74.3% of the households indicated that their contracts specify a minimum guaranteed price in advance to ensure a basic income during the harvest season and to mitigate the risks associated with organic production.

Table 2. Variable definitions and descriptive statistics.

Variable Type	Variable Name	Variable Definition and Assignment	Sample Involved in Eco-Industries Operations (n = 226)		
			Average Value	Minimum Value	Maximum Value
Dependent	Eco-industry income	Family unit eco-industry income per unit area in 2021	1698	128.6	12,100
Independent	Membership in cooperatives	Have you signed a contract with a cooperative to sell organic products to the cooperative? 1 = Yes; 0 = No	0.164	0	1
Identifying	Neighborhood effect	Ratio of the number of other households in the same village selling organic products to cooperatives to the total sample size of the village	0.171	0	0.870
Eco-industry characteristics	The distribution of agroforestry materials	Are seeds, fertilizers, pesticides, and other agroforestry materials distributed? 1 = Yes; 0 = No	0.765	0	1
	Punishment initiatives	Is there a penalty for not meeting the standards? 1 = Yes; 0 = No	0.770	0	1
	Premium capacity	Comparison of the purchase price with the average market price: 1 = lower than 20%; 2 = lower than 10%; 3 = equal; 4 = higher than 10%; 5 = higher than 20%	3.388	1	5
	Low-cost conservation initiatives	Is there a minimum protection price? 1 = Yes; 0 = No	0.743	0	1
Characteristics of the head of the household	Age	Actual age of the head of the household in 2021	60.70	36	85
	Education	Actual education level of the head of the household	8.105	0	15
	Status of village cadres	Is the head of the household a village cadre? 1 = Yes; 0 = No	0.169	0	1
	Technical training	Has the head of the household received training in organic product techniques? 1 = Yes; 0 = No	0.354	0	1

Table 2. *Cont.*

Variable Type	Variable Name	Variable Definition and Assignment	Sample Involved in Eco-Industries Operations (n = 226)		
			Average Value	Minimum Value	Maximum Value
Family endowment	The proportion of labor force	Labor force ratio = number of non-labor force individuals/resident population	0.332	0	0.833
	Land area	Actual cultivated land area of the family (m^2)	2368	200	20,666.67
	Soil quality	Quality of cultivated land: 1 = very poor; 2 = poor; 3 = average; 4 = good; 5 = very good	3.890	1	5
Regional characteristics	Land location	Relationship between the land and the CINNR: 1 = located in the core area; 2 = located in the buffer zone; 3 = located in the experimental area; 4 = located outside the area	3.544	1	4

4.2. Analysis of the Income-Enhancing Effects of Cooperatives

The simultaneous equation estimation results, as shown in Table 3, with $ln\sigma_{i1}$ and $ln\sigma_{i0}$ were significant at the 1% level, indicating the presence of sample selection bias. Thus, employing the ESR for correction was necessary. The error correlation coefficient was significantly negative, suggesting that farmers not joining cooperatives have lower per unit area eco-industry income compared to those who do.

Table 3. ESR estimation results on the impact of joining cooperatives on the per unit area eco-industry income of farmers.

Variables	Income Equation		Selection Equation
	Membership in Cooperatives	Not membership in Cooperatives	
Neighborhood effect			4.733 *** (5.815)
The distribution of agroforestry materials	0.783 *** (2.706)	0.034 (0.436)	0.504 * (1.049)
Punishment initiatives	−0.609 *** (2.652)	0.025 (−0.291)	−0.414 * (1.034)
Premium capacity	0.127 *** (0.942)	0.112 *** (3.328)	0.606 *** (2.590)
Low-cost conservation initiatives	0.287 * (0.964)	0.189 *** (2.654)	0.259 (0.643)
Age	−0.019 ** (−2.248)	−0.004 (0.874)	−0.014 (0.815)
Education	0.009 (0.308)	0.018 (1.507)	−0.021 (0.387)
Status of village cadres	0.118 *** (1.437)	−0.068 (0.743)	7.729 * (0.000)
Technical training	0.062 * (1.722)	0.029 * (1.645)	0.028 (0.335)
The proportion of labor force	0.694 * (1.791)	0.021 (0.116)	1.047 (1.404)
Land area	0.114 ** (2.338)	0.006 ** (0.659)	−0.103 (1.145)
Soil quality	0.211 * (1.693)	0.152 *** (2.912)	0.754 *** (2.940)

Table 3. *Cont.*

Variables	Income Equation		Selection Equation
	Membership in Cooperatives	Not membership in Cooperatives	
Land location	−0.241 * (0.837)	−0.144 ** (2.174)	0.014 (0.033)
Constant	9.669 *** (6.029)	6.680 *** (14.429)	−0.765 (0.314)
$ln\sigma_{i1}$	−0.764 ***		
σ_{i1}	0.554		
$ln\sigma_{i0}$		−0.816 ***	
σ_{i0}		−0.307 *	
Wald			52.73 ***
Log likelihood			−185.498 ***

Note: *, **, and *** represent significance levels of 10, 5, and 1%, respectively. Standard errors are indicated in parentheses.

4.3. Analysis of Factors Influencing the Decision to Join Cooperatives (Selection Equation)

The neighborhood effect and the decision to join cooperatives were significantly positively correlated at the 1% level, that is, the more the neighbors participate in cooperatives, the greater the trust farmers have in cooperatives, increasing the likelihood of their joining. The distribution of agroforestry materials and the decision to join cooperatives were positively correlated at the 10% level. Farmers receiving more organization-provided materials for agricultural production, such as fertilizers, pesticides, seeds, and farming tools, were likely more inclined to join cooperatives. The punishment initiatives variable negatively affected joining cooperatives; specifically, if farmers were penalized for non-compliance in product production, it affected their willingness and behavior towards joining cooperatives. Premium capability was significantly correlated with the decision to join cooperatives. The higher the selling price of the products produced by cooperative members above the market price, the more likely farmers were to join cooperatives. The soil quality significantly positively influenced farmers' decisions to join cooperatives at the 1% level, the better the quality of the land and the greater the likelihood of farmers joining cooperatives. Being a village official significantly positively influenced the decision to join cooperatives at the 10% level. Households with family members who are village officials were more likely to join cooperatives compared to those without village officials.

4.4. Analysis of Factors Influencing Farmers' Income

A step-by-step comparison of income equation estimates for farmers who have joined cooperatives and those who have not revealed that the distribution of agroforestry materials, premium capacity, low-cost conservation initiatives, land area, soil quality, age, village official status, technical training, the proportion of labor force, and land location significantly affected the per unit area eco-industry income of farmers. Among these, the distribution of agroforestry materials, age, village official status, and the proportion of the labor force significantly affected only the income of farmers who have joined cooperatives, with no impact on those who have not joined.

From the perspective of farmers' personal characteristics, age negatively affected the eco-industry income of households that have joined cooperatives at the 5% level. Being a village official significantly positively affected the eco-industry income of farmers who have joined cooperatives at the 1% level. The proportion of the labor force significantly positively influenced the eco-industry income of farmers who chose to join cooperatives at the 10% level. Regarding household characteristics, both land area and soil quality positively impacted farmers' eco-industry income, regardless of whether they have joined cooperatives. Technical training positively impacted household eco-industry income, whether or not farmers participate in cooperatives. Regarding eco-industry characteristics, the distribution of agroforestry materials significantly affected the eco-industry income of households choosing to join cooperatives at the 1% level. Joining cooperatives, with more abundant agricultural input distribution, led to higher farmer income. Premium capacity and low-cost conservation initiatives positively impacted the eco-industry income of both cooperative and non-cooperative farmer households. Regarding land location, this variable significantly negatively impacted eco-industry income at the 10% and 5% levels, indicating that regardless of cooperative membership, the farther a farmer's residence from the core area of the reserve, the lower the income enhancement effect from eco-industries.

4.5. Analysis of Income Enhancement Effects and Differences

The ESR model, grounded in a "counterfactual framework", examines the impact of cooperatives on the eco-industry income of farming households. As demonstrated in Table 4, generally, if a farmer with cooperative membership were to hypothetically lose this status and instead directly sell organic products to enterprises, the income per unit area from eco-industries would decrease from 7.486 to 7.255, marking a 3.09% decline (0.230/7.486). Conversely, if a farmer without cooperative membership were to gain such status in a counterfactual scenario and sell organic products through the cooperative, the income per unit area from eco-industries would increase by 1.59% (−0.115/7.255). This indicates that cooperative membership enhances the eco-industry income of farming households. The income effect is more pronounced for households without membership when considered in a counterfactual scenario, suggesting that cooperatives can boost the eco-industry income of households by 1.59% to 3.09%.

Table 4. Analysis of treatment effects.

Whether to Join the Cooperative	Membership in Cooperatives	Not Membership in Cooperatives	Treatment Effect	
			ATT	ATU
Yes	7.486	7.255	0.230 ** (0.102)	
No	7.111	7.226		−0.115 * (0.066)

Note: * and ** represent significance levels of 10 and 5%, respectively. Standard errors are indicated in parentheses.

5. Discussion

5.1. Analysis of the Income-Generating Effects of Cooperatives

The research findings confirmed that cooperatives indeed enhance income-generating effects for farmers engaged in eco-industries. The results of the average treatment effect further substantiate the significant role of cooperatives in increasing the income of farmers from eco-industries. The possible reasons include cooperatives optimizing resource allocation through collective strength, enhancing bargaining power, and providing technical support and market information. Cooperatives also offer farmers greater market access opportunities, allowing agricultural products to be sold at higher prices. Additionally, through scaled operations, cooperatives reduce the costs of production and sales, thereby increasing farmers' income levels. This aligns with the findings of other scholars in the field [20,21].

Through interviews with key members and ordinary members of the cooperatives, we learned that cooperatives typically enjoy more favorable prices through collective purchasing of raw materials than individual purchases. The specific extent of the price reduction depends on various factors, including the scale of the cooperative, the volume of purchases, and the discount policies of suppliers. Generally, collective purchasing by cooperatives can reduce prices by about 10% to 30% and sometimes even more. By selling ecological products collectively, higher prices can be obtained compared to individual sales. The increase in prices depends on factors such as the quality of the product, market demand, and sales channels. Generally, ecological products tend to command a premium over traditional agricultural and forestry products, with price increases typically ranging from 10% to 50% and sometimes even higher. With the positive outcomes of *crested ibis* protection and the increasing attention the species receives both domestically and internationally, the "*crested ibis*" brand has gradually emerged. To leverage the economic benefits of the *crested ibis* brand, the People's Government of Yang County officially registered the *crested ibis* trademark for a regional brand in 2002, covering a variety of products including grain, oil, fruit, vegetables, and medicine. Relying on the unique reputation of the rested ibis, the trademark has become a strong endorsement for producing safe, green, and healthy products, winning consumer trust and affection and bringing considerable economic benefits to local households.

Through interviews with key figures and feedback from farmers involved in the organic industry, we observed a trend where farmers have become aware of a significant increase in market demand for organic products in recent years. They report that with the advancement of economic and social development levels and the upgrading of consumer demands, the market for organic products has developed rapidly, leading to situations where supply cannot meet demand. Consequently, it is crucial to conduct in-depth studies on the factors promoting the development of the organic industry. Cooperatives play an important role as a bridge in facilitating farmers' access to the market. Many interviewees also stated that with the support of cooperative organizations, farmers can better integrate into the organic industry chain, gaining access to technical support, market information, and sales channels. This integration enhances production efficiency and product quality to meet market demands. Additionally, cooperatives help coordinate cooperative relationships among farmers, promoting resource sharing and technological exchanges, thus fostering the healthy development of the organic industry.

5.2. Analysis of Factors Influencing Farmers' Decisions to Join Cooperatives

The neighborhood effect was positively correlated with joining cooperatives. A possible reason is the rapid flow of information within closely knit villages. If a farmer benefits significantly from joining a cooperative, such as reduced costs and increased profits, this positive information will quickly spread to neighbors. Seeing successful cases around them, other farmers are more likely to be persuaded to join cooperatives. The distribution of agroforestry materials showed a positive correlation with cooperative membership. This could be because cooperatives often obtain lower prices through group purchasing from suppliers, so when the distribution of agricultural inputs increases, the cost for farmers to purchase or acquire these materials through cooperatives is lower. The punishment initiatives negatively impacted the decision to join cooperatives as penalties can cause farmers to worry about failing to meet production standards, affecting sales revenue and thus reducing their willingness to join cooperatives. The premium capacity was positively correlated with cooperative membership. This could be because, through collective marketing and brand building, cooperatives can enhance product competitiveness in the market. When cooperatives possess high premium capability, it indicates strong bargaining power and brand influence in the market, allowing farmers to share these advantages by joining. The soil quality was positively correlated with joining cooperatives. Soil quality directly affects crop growth and yield. High-quality land provides better growing conditions, thus improving the quantity and quality of agricultural products. Farmers with high-quality land have greater production potential and are therefore more willing to join cooperatives to further enhance production efficiency and profitability. Being a village official was positively correlated with joining cooperatives. Village officials usually have high levels of leadership and influence within the village. With an advantage in status, village officials can access market information more readily and clearly see the benefits of cooperatives. Choosing to join cooperatives aids in improving their household income, making them more inclined to join. These align with the findings of other scholars [42,43].

5.3. Analysis of Factors Affecting the Income of Farmers Who Join Cooperatives

From the perspective of the individual characteristics of farmers, age was negatively correlated with income from eco-industries. It is evident that as farmers age, their capacity for labor and innovative thinking in eco-industries may gradually diminish, impacting their income levels. Younger farmers, usually better educated, are more likely to possess modern agricultural and forestry techniques and management knowledge. After joining cooperatives, they can apply these skills to agricultural and forestry production, improving production efficiency and product quality, thereby enhancing eco-industry income [10,14,15,17]. Being a village official was positively correlated with income from eco-industries. Village officials, to lead by example, might have a larger share of investment, thus receiving more dividends compared to non-officials. The proportion of the labor force was positively related to eco-industry income, possibly because families with fewer labor resources might not independently complete all agricultural and forestry activities, thus seeking external help or adopting other production methods. After joining cooperatives, these families can use the services and resources provided by cooperatives to compensate for their labor shortages, thereby increasing production efficiency and product quality and earning more income and dividends.

Regarding household characteristics, both land area and soil quality were positively correlated with income from eco-industries. Land area is a crucial factor in determining production scale. Generally, larger land areas allow farmers to plant more crops, resulting in higher yields and income. Additionally, a larger land area facilitates scale production, lowering costs, improving efficiency, and further increasing household income. Soil quality directly influences crop growth and yield. High-quality land usually has better soil fertility, moisture conditions, and ecological environments, benefiting crop growth and development and thus increasing yield and product quality. Moreover, high-quality land can reduce production inputs, such as fertilizers and pesticides, lowering production costs and increasing agricultural income. Therefore, having a large area of high-quality land benefits eco-industry income, regardless of cooperative membership. Technical training was positively correlated with eco-industry income. Training enhances farmers' production skills and knowledge, making them more familiar with various production techniques and management methods. Through learning and practice, farmers can master planting, breeding, fertilization, irrigation, and other technologies, improving production efficiency, increasing yield, and thus enhancing eco-industry income [14,19,22,23].

Regarding eco-industry characteristics, the distribution of agroforestry materials was positively correlated with eco-industry income, likely because rich input distribution helps reduce production costs. Farmers can buy needed agroforestry materials, such as fertilizers, pesticides, and seeds, at lower prices through cooperatives, thereby reducing per-unit production costs and increasing profits. Premium capacity and low-cost conservation initiatives were positively correlated with eco-industry income. Premium capacity refers to the ability to sell organic products at prices higher than the average market price. This ability allows farmers to earn higher profits and improve eco-industry income. For cooperative members, the cooperative provides a unified brand and sales channels, enhancing bargaining power and market competitiveness, thus improving premium capacity. For non-members, they can enhance premium capacity by improving product quality, expanding market channels, and establishing personal brands. Low-cost conservation initiatives mean farmers receive a certain price guarantee when facing market price fluctuations, preventing losses due to price drops. This protection helps stabilize income and reduce market risks. For cooperative members, the cooperative offers unified purchasing and sales services, providing low-price protection through scale operation and risk-sharing mechanisms. For non-members, they can achieve low-price protection by diversifying crops, reserving grain, and participating in government subsidy programs, thus ensuring stable growth in eco-industry income.

Regarding regional location, land location was positively correlated with eco-industry income. This underscores that protected areas provide advantageous resources and environments for the development of eco-industries. Protected areas typically boast rich biodiversity and natural resources, supplying continuous raw materials for eco-industries. For example, certain rare plants and animals can be used to produce high-value ecoproducts, such as organic food and health products. Additionally, the natural environment within reserves often receives better protection and restoration, offering a favorable production environment and ecological landscape for eco-industries. These align with the findings of other scholars [44,45].

6. Conclusions

To investigate whether cooperatives possess the capacity to enhance the income-generating effects for farmers involved in eco-industries, this study selected the CINNR, a representative area for eco-industries development, as the research site, Data were gathered through face-to-face interviews, and this research empirically analyzed the impact of cooperatives on the income-generating effect of farmers using the ESR. The findings are threefold. First, cooperatives indeed enhance the income-generating effects for farmers engaged in eco-industries. Second, variables such as the distribution of agroforestry materials, premium capacity, soil quality, and status of village cadres have a positive impact on farmers joining cooperatives, whereas punishment initiatives discourage their participation. Third, for farmers who had joined cooperatives, factors such as the distribution of agroforestry materials, premium capacity, low-cost conservation initiatives, land area, status of village cadres, the proportion of labor force, technical training, soil quality, and land area positively affect their income from eco-industries. Conversely, punishment initiatives, age, and land location negatively impact their income. Therefore, it is recommended that in typical regions, for the development of eco-industries, governments and NGOs implement relevant policies to enhance support for cooperatives. This support would enable cooperatives to develop agricultural and forestry products with local characteristics according to market rules, enhance cooperatives' capacity for sustainable development, and subsequently increase the income of farmers.

It must be acknowledged that the research area selected for this study exhibits certain unique characteristics; the long-term, stringent protection of the protected area has established a solid environmental foundation for the development of eco-industries. Thus, in the context of farmers engaged in these industries, joining cooperatives has played a positive role in enhancing their income. However, the generalizability of these findings remains to be further validated. Future research should aim to broaden the geographical scope of study areas and extend into multiple industries to substantiate the potential of cooperatives as vital facilitators of rural eco-industries prosperity.

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