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How Livelihood Capital Shapes Farmers' Cognition of Natural Forest Conservation Policy: Implications for Sustainable Forest Management

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Abstract

Background and Objectives: China's natural forest conservation policy impacts community livelihoods, with farmers' policy awareness being a key determinant of conservation effectiveness. However, research gaps remain regarding how this policy shapes farmers' perceptions of livelihood capital drivers and influences their willingness to participate in sustainable forest management. With this study, we aim to quantify the relationship between livelihood capital and farmers' policy awareness, providing scientific evidence for formulating more effective sustainable policies. Materials and Methods: Using household survey data, we conducted empirical analysis on 498 randomly sampled households from nine villages in Menghai County and Changting County. Generalized ordered logit and binary logistic regression models were employed to examine the impact of multidimensional livelihood capital on policy awareness levels. Results: Our findings indicate heterogeneous effects of livelihood capital. Conclusions: Policymakers should prioritize targeted interventions to enhance the effectiveness of natural forest conservation policies by moving away from a one-size-fits-all approach. Research Highlights and Significance: This study reveals that livelihood capital across different dimensions exerts complex and inconsistent effects on farmers' policy cognition. Through comparative analysis of two representative regions in China, this study provides empirical evidence for this core finding from both ecological and economic perspectives. The results further offer precise policy implications for enhancing forest conservation policy effectiveness by optimizing livelihood capital structures.

Keywords: livelihood assets; policy cognition formation; policy optimization pathways

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1. Introduction

From the overall perspective of existing research, relatively few studies have specifically explored how livelihood capital influences farmers' perceptions of natural forest protection policies, and the investigation into the direct mechanisms underpinning such perceptions remains insufficient. With regard to policy impacts, current research rarely explores the interactions between policy design, implementation methods, and household perceptions in any depth. Policies such as the Natural Forest Conservation Policy, which possess strong externalities and may directly constrain traditional livelihood practices, present research gaps concerning how they shape farmers' perceptions and the underlying

livelihood capital drivers, thereby influencing their willingness to participate in sustainable forest management.

The relationship between economic development and the conservation of natural forests is a complex and long-standing global challenge, particularly in the context of global climate change and regional development imbalances [1–3]. Addressing this issue is central to current research and policy formulation [4,5]. Natural forests account for 69.6% of China's total forest area and 93.5% of its total forest stock [6]. They are the foundation of China's forest ecosystems [7] and provide a vital source of income for many rural households in forest areas. In 1998, China initiated the Natural Forest Conservation Program, and in 2016, it expanded the scope of protection to encompass all natural forests. This expansion included a ban on commercial logging and the initiation of ecological restoration efforts. This imposed numerous restrictions on the livelihood activities of farmers reliant on natural forests, including prohibitions on grazing, collecting firewood, cultivating the land, and modifying tree species in natural forests [8]. Consequently, these farmers have been adversely affected by the Natural Forest Protection Policy.

The Sustainable Livelihoods Framework (SLF), developed by the UK Department for International Development (DFID), provides a multidimensional perspective on the subject of farmer livelihoods. The concept under discussion here is that of complex systems comprising human capital, natural capital, physical capital, financial capital, and social capital. These systems interact and transform in order to collectively determine livelihood resilience and adaptive capacity [9]. Livelihood capital is posited as the foundational element underpinning farmers' actions, with their perception of policies serving as the primary catalyst for their behavioral choices and strategic decisions [10,11].

Cognitive behavioral theory posits that individual behavior is inextricably linked to cognitive processes. Individuals observe and understand things, gradually constructing their own cognitive systems, which in turn influence their subsequent behavior [12]. Kuhlman et al. (2024) hypothesized that Finnish women's perceptions of "active forest owners" may influence their willingness and manner of participating in forest management activities [13]. Klebl et al. (2023) posited that the personal beliefs, values, and attitudes of European farmers towards new agricultural practices influence their propensity to adapt to farm biodiversity management [14]. In addition, a body of research has identified a positive correlation between farmers' cognizance of policies concerning aspects such as crop rotation [15], farmland preservation [16], plastic film retrieval [17], climate change [18], forestry and livestock [19], and their propensity to comply with these policies, albeit to differing extents. It can be inferred that farmers' comprehension of natural forest protection policies will also influence their participation in such policies and, in turn, affect the effectiveness of policy implementation.

The present study combines the Sustainable Livelihoods Framework with cognitive theory in order to examine farmers' understanding of natural forest conservation policies and how this influences their willingness and behavior regarding participation in sustainable forest management. In natural forest areas, farmers have established a symbiotic relationship between their livelihood activities and natural forest resources. A study on the impact of farmers' livelihood capital status on their policy awareness is of great practical significance for China in improving its natural forest protection policies and promoting farmers' active participation and support for natural forest protection. It also provides a new case study for research on farmers' policy awareness, policy compliance, and participation behavior.

Furthermore, this study's findings possess universal relevance on a global scale. In the context of global forestry challenges [20], sustainable forest management is recognized as a vital means to address climate change and environmental degradation [21]. Moreover,

in a multitude of developing nations and regions, rural communities' livelihoods continue to be heavily dependent on forest resources [22,23]. It is imperative to comprehend how farmers' livelihood capital influences their perceptions of conservation policies to achieve harmonious coexistence between humanity and nature [15].

The geographical area under consideration encompasses three villages in Menghun Town, Menghai County, Yunnan Province, and six villages in Guanqian Town, Hetian Town, and Xinjiao Town, Changting County, Fujian Province. One of this study's locations, Menghai County (99°56′–100°41′ E, 21°28′–22°28′ N), is situated in the southwestern part of Yunnan Province, a region characterized by its abundance of natural forest resources. However, in recent years, due to population growth and the expansion of agricultural, rubber, and pulpwood plantations, the preservation of natural forests has faced significant challenges, leading to severe conflicts with local farmers' livelihood activities [24]. The town of Menghun is located in the southeastern part of Menghai County, where conflicts between the livelihood activities of the local Dai ethnic group and natural forest conservation are particularly prominent [25]. The other study area, Changting County (115°59′48″–116°39′20″ E, 25°18′40″–26°02′05″ N), is located in the western part of Fujian Province and encompasses 274,000 hectares of forested land. Of these, half of the secondary natural forests are of poor quality, with an average timber volume of 55. The mean value of the cubic meter per hectare in this region is significantly lower than the provincial average of 86.2 cubic meters per hectare, suggesting a critical need for conservation and rehabilitation efforts [26]. The study area in Changting County comprises three towns and six villages, where Han Chinese and multiple minority ethnic groups coexist. Local arable land resources are limited, and natural forest resources are among the primary means of subsistence for local villagers.

This study employed the Participatory Rural Appraisal (PRA) method to conduct field research in three villages in Menghai County, Yunnan Province, and six villages in Changting County, Fujian Province, which are characterized by abundant natural forest resources. This study analyzes the influence of livelihood capital on farmers' understanding of natural forest conservation policies and explores the relationship between farmers' policy understanding and their implementation of such policies. This study aims to provide references for the implementation and improvement of natural forest conservation policies. The innovation of this study lies in expanding the analytical framework for understanding farmers' perceptions of natural forest conservation policies. It treats policy perceptions as the dependent variable and explores the influencing factors from the five-dimensional framework of livelihood capital. This enriches the research findings in this field.

2. Data and Methods

2.1. Data Sources

The data presented in this paper were derived from a questionnaire survey of farmers conducted in the study area in September 2024. The survey received direct support from the GEF China Project on the Restoration of Degraded Natural Forests and Soil Erosion Management Improvement in Erosion-Prone Regions of China. The PRA method was employed during the questionnaire design phase. Within the designated study area, a group of 20–30 village representatives was assembled for the purpose of conducting focus group discussions. The focal point of these discussions was the core dimension of the "awareness of natural forest conservation policies" and issues of concern to farmers. The process of development yielded a series of key questions, leading to the exclusion of abstract elements, culminating in a questionnaire tailored to the practical realities experienced by farmers. The selection of the sample was conducted in accordance with the principles of probability sampling. A sampling frame was constructed on the basis of village-level

census data from the study area. Nine villages were stratified and randomly selected at the township–village level. Within each village, eligible households were randomly selected using Excel's random function based on household registration numbers, resulting in 502 sample households. Through in-person interviews, a total of 498 valid questionnaires were obtained, thereby attaining a valid response rate of 99.20%. The descriptive statistics of the sample households are presented in Table 1.

Table 1. Sample characteristics (N = 498).

Sample Characteristics	Provinces and Counties	Sample Villages	Valid Sample Household
Region	Menghai County, Yunnan Province	He Kai Village, Menghai Town	104
		Man Sao Village, Menghai Town	81
		Meng Hun Village, Menghai Town	50
	Changting County, Fujian Province	Huang Hu Village, Guanqian Town	47
		Yan Fang Village, Guanqian Town	47
		Bo Hu Village, Hetian Town	43
		Lu Hu Village, Hetian Town	39
		Niu Gang Village, Xinqiao Town	44
		Xinqiao Village, Xinqiao Town	43
Gender	Male		394
	Female		104
Age	<31		21
	31–45		133
	46–60		239
	61–75		101
	>75		4

2.2. Models and Indicators

The present study investigated the five categories of the livelihood capital (natural, human, material, financial, and social) of the sample households based on the Sustainable Livelihoods Analysis Framework [27]. It examined the influence of the sample households' livelihood capital status on their perception of natural forest conservation policies, employing generalized ordered logit and binary logistic models to analyze the data. Furthermore, to account for regional differences in the research results, a regional classification variable (X1) was incorporated into the regression model. This variable assigned a value of 0 to Yunnan and a value of 1 to Fujian. The specific indicators and their meanings in the research model are detailed in Tables 2–7.

In this study, farmers' understanding of natural forest conservation projects is an ordered multi-category variable, while their willingness to support and participate in natural forest conservation activities is a binary variable. Consequently, generalized ordered logit regression models and binary logistic regression models were employed for parameter estimation; their mathematical forms are expressed in Formulas (1) and (2), respectively. On the one hand, the generalized ordered logit model retains its suitability for ordered dependent variables while relaxing the proportional dominance assumption of the standard

ordered logit model. This enables it to more precisely capture the heterogeneous effects of independent variables on cognitive transitions. On the other hand, the binary logit regression model is specifically designed for dichotomous outcomes, enabling direct estimation of the marginal effects of independent variables on the "probability of supporting participation". Its core objective is thus highly aligned.

$$P(Y_i > j \mid x_i) = \frac{exp\left(\alpha_j + \beta_j^\top x_i\right)}{1 + exp\left(\alpha_j + \beta_j^\top x_i\right)} \quad (1)$$

$$\text{logit}(p_i) = \ln\left(\frac{P(Y_i = 1 \mid x_i)}{1 - P(Y_i = 1 \mid x_i)}\right) \quad (2)$$

Table 2. Model indicators and descriptions—human capital.

Primary Indicator	Secondary Indicator	Tertiary Indicator	Indicator Description and Assignment
Livelihood capital	Human capital	Educational attainment (X2)	Primary school and below = 0; junior high school = 1; senior high school = 2; college and above = 3
		Vocational skill training (X3)	No training/training had little effect = 0; training had an effect = 1
		Family members working outside the household (X4)	No one works outside the home = 0; someone works outside the home = 1
		Proportion of family labor force (X5)	Number of labor force/total number of family members
		Skill learning plan for self and family members (X6)	No/not sure = 0; yes = 1

Table 3. Model indicators and descriptions—natural capital.

Primary Indicator	Secondary Indicator	Tertiary Indicator	Indicator Description and Assignment
Livelihood capital	Natural capital	Family farmland area (X7)	Unit: mu (1 mu = 6.67 ares)
		Family forestland area (X8)	Unit: mu (1 mu = 6.67 ares)
		Whether firewood can be collected in surrounding forests (X9)	Not allowed = 0; allowed = 1
		Whether protecting natural forests benefits production and life (X10)	None/unclear = 0; not much benefit = 1; some benefit = 2; significant benefit = 3
		Changes in natural disasters in the residence area (X11)	Too much/unclear = 0; too little = 1

Table 4. Model indicators and descriptions—physical capital.

Primary Indicator	Secondary Indicator	Tertiary Indicator	Indicator Description and Assignment
Livelihood capital	Physical capital	Sufficiency of water for agricultural production (X12)	Insufficient = 0; sufficient = 1
		Household ownership of motor vehicles (X13)	No motor vehicles = 0; motor vehicles = 1
		Household housing conditions (X14)	Average housing conditions = 0; better housing conditions = 1
		Whether the village has cement roads (asphalt roads) (X15)	Only recently connected = 0; connected over 10 years ago = 1
		Whether there are regular buses in the village or nearby (X16)	None = 0; available = 1
		Mobile phone signal and internet conditions in the village (X17)	Poor signal and network quality = 0; excellent signal and network speed = 1

Table 5. Model indicators and descriptions—financial capital.

Primary Indicator	Secondary Indicator	Tertiary Indicator	Indicator Description and Assignment
Livelihood capital	Financial capital	Loan situation in recent years (X18)	Never = 0; have obtained a loan = 1
		Family savings situation (X19)	None = 0; some savings = 1; significant savings = 2
		Family financing channels (X20)	None = 0; one type = 1; two types = 2; three types = 3
		Overall income level of the family last year (X21)	<20 k = 0; 20 k–50 k = 1; 50 k–100 k = 2; >100 k = 3
		Willingness to transition to the tertiary sector (X22)	Unknown/no = 0; yes = 1

Table 6. Model indicators and descriptions—social capital.

Primary Indicator	Secondary Indicator	Tertiary Indicator	Indicator Description and Assignment
Livelihood capital	Social capital	Participation in production and operation cooperative organizations and their effects (X23)	Did not join/joining did not help = 0; joining was somewhat helpful = 1; joining was very helpful = 2
		Village residents' methods of working outside the village (X24)	Went out on their own = 0; introduced by someone else = 1
		Whether there are returnees who have started businesses (X25)	Unclear/no = 0; yes = 1
		Whether there are successful entrepreneurs (X26)	Unclear/no = 0; yes = 1
		Plans for income-generating activities (X27)	Did it themselves = 0; did it jointly = 1

Table 7. Model indicators and descriptions—farmers' natural forest policy perceptions.

Primary Indicator	Tertiary Indicator	Indicator Description and Assignment
Farmers' natural forest policy cognition	Level of understanding of local natural forest conservation projects (Y1)	Completely unaware = 0; somewhat aware = 1; fairly aware = 2; very aware = 3
	Whether support and participate in natural forest protection activities (Y2)	No/don't know = 0; yes = 1

Note: The variables in this table do not have secondary indicators.

3. Model Results

3.1. Generalized Ordered Logit Regression Model

The results of the generalized ordered logit regression model, analyzed using Stata/MP 18.0 software, are presented in Table 8. The model's likelihood ratio (LR) test *p*-value was less than 0.0001, and the Pseudo R^2 value was 0.5418, indicating that the model is highly significant overall and possesses strong explanatory power. Furthermore, this paper calculated the average marginal effects (AMEs) of the independent variables on farmers' understanding of the natural forest conservation project (Y1) to explore the extent and pathways through which different dimensions of livelihood capital influence farmers' perceptions of natural forest conservation. The specific results are displayed in Table 9.

Table 8. Regression results of the generalized ordered logit model.

Form	Variable	Cut1	OR Value	Cut2	OR Value	Cut3	OR Value
Region	X1	1.186 (2.038)	3.275	5.662 (2.815) **	287.761	−5.754 (3.310) *	0.003
	X2	1.193 (0.804)	3.299	−0.125 (0.277)	0.882	−0.158 (0.328)	0.854
	X3	−1.794 (1.052) *	0.166	1.847 (0.521) ***	6.344	0.310 (0.732)	1.364
Human capital	X4	−0.377 (1.122)	0.685	0.462 (0.422)	1.588	−1.488 (0.611) **	0.226
	X5	4.582 (2.495) *	97.739	0.663 (0.911)	1.941	0.808 (1.056)	2.244
	X6	−2.389 (1.207) **	0.092	0.867 (0.440) **	2.381	1.132 (0.554) **	3.101
	X7	0.023 (0.042)	1.023	−0.069 (0.040) *	0.933	0.081 (0.056)	1.084
	X8	0.059 (0.041)	1.061	0.002 (0.015)	1.002	0.004 (0.016)	1.004
Natural capital	X9	−0.999 (1.113)	0.368	−1.164 (0.793)	0.312	−1.604 (1.617)	0.201
	X10	0.031 (0.487)	1.032	1.230 (0.335) ***	3.422	1.415 (0.570) **	4.118
	X11	1.605 (1.065)	4.977	2.672 (0.749) ***	14.474	4.465 (1.551) ***	86.934
	X12	−0.239 (1.200)	0.787	1.325 (0.737) *	3.763	−0.876 (1.331)	0.417
	X13	−3.825 (5.147)	0.022	0.916 (2.190)	2.500	−4.076 (33.156)	0.017
Physical capital	X14	−0.055 (0.793)	0.946	0.464 (0.486)	1.590	0.724 (0.617)	2.063
	X15	2.969 (1.815)	19.478	1.363 (0.879)	3.907	−3.262 (1.140) ***	0.038
	X16	1.186	3.275	−5.431 (2.702) **	0.004	−0.969 (2.105)	0.379
	X17	−3.839 (1.661) **	0.022	−0.583 (0.824)	0.558	2.209 (0.989) **	9.107
	X18	0.349 (0.911)	1.418	0.182 (0.415)	1.199	−0.983 (0.516) *	0.374
Financial capital	X19	1.484 (0.731) **	4.411	−0.553 (0.338)	0.575	0.038 (0.512)	1.039
	X20	−1.571 (1.134)	0.208	−0.627 (0.550)	0.534	−0.692 (0.608)	0.501
	X21	0.961 (0.502) *	2.615	0.229 (0.271)	1.258	0.214 (0.411)	1.238
	X22	4.581 (1.370) ***	97.633	1.214 (0.577) **	3.368	1.311 (0.853)	3.709
	X23	−1.451 (0.555) ***	0.234	−0.512 (0.404)	0.599	0.666 (0.559)	1.946
	X24	−2.424 (1.164) **	0.089	−1.473 (0.606) **	0.229	8.631 (2.874) ***	5604.079
Social capital	X25	2.243 (1.531)	9.421	−1.234 (0.627) **	0.291	−1.783 (0.846) **	0.168
	X26	0.365 (0.973)	1.440	−2.018 (0.749) ***	0.133	0.108 (1.000)	1.114
	X27	−0.783 (1.038)	0.457	0.546 (0.527)	1.726	1.107 (0.577) *	3.026
	Prob > chi2 = 0.0000					Pseudo R^2 = 0.5418	

Note: *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively; values in parentheses are standard error values.

The findings suggest that farmers' comprehension of natural forest conservation initiatives is influenced by livelihood capital, operating through a dual mechanism of "stage sensitivity" and "level restructuring". Specifically, direct perception of policy benefits and awareness of disaster changes (natural capital) drive a deep cognitive leap, while planned learning skills (human capital) lead to cognitive polarization. The quality of roads and existence of robust communication infrastructure have been demonstrated to significantly

impact the degree of cognitive differentiation, the intentions of industrial transformation, and household savings. Furthermore, the financial capital of households has been shown to have a substantial effect on the probability of low cognition, while modern elements within social capital, such as employment methods, have been observed to trigger a disruptive restructuring of cognitive structures.

Table 9. Average marginal effects (AMEs) of independent variables on farmers' knowledge of natural forest conservation projects, Y1.

Form	Variable	Y1 = 0	Y1 = 1	Y1 = 2	Y1 = 3
Region	X1	−0.051 (0.086)	−0.571 (0.319) *	1.052 (0.378) ***	−0.429 (0.236) *
	X2	−0.051 (0.033)	0.065 (0.043)	−0.002 (0.031)	−0.012 (0.024)
	X3	0.077 (0.041) *	−0.28 (0.064) ***	0.180 (0.069) ***	0.023 (0.054)
Human capital	X4	0.016 (0.048)	−0.067 (0.064)	0.162 (0.057) ***	−0.111 (0.043) **
	X5	−0.197 (0.099) **	0.124 (0.136)	0.013 (0.114)	0.060 (0.078)
	X6	0.103 (0.047) **	−0.198 (0.064) ***	0.011 (0.059)	0.084 (0.042) **
	X7	−0.001 (0.002)	0.009 (0.005) *	−0.014 (0.006) **	0.006 (0.004)
	X8	−0.003 (0.002)	0.002 (0.002)	0.000 (0.002)	0.000 (0.001)
Natural capital	X9	0.043 (0.046)	0.085 (0.094)	−0.008 (0.138)	−0.120 (0.120)
	X10	−0.001 (0.021)	−0.134 (0.038) ***	0.030 (0.044)	0.106 (0.039) ***
	X11	−0.069 (0.041) *	−0.225 (0.076) ***	−0.039 (0.121)	0.333 (0.109) ***
	X12	0.010 (0.051)	−0.156 (0.090) *	0.211 (0.118) *	−0.065 (0.100)
	X13	0.164 (0.217)	−0.265 (0.323)	0.405 (2.463)	−0.304 (2.452)
Physical capital	X14	0.002 (0.034)	−0.053 (0.060)	−0.003 (0.065)	0.054 (0.046)
	X15	−0.128 (0.077) *	−0.022 (0.116)	0.393 (0.122) ***	−0.243 (0.082) ***
	X16	−0.051 (0.009) ***	0.648 (0.295) **	−0.525 (0.321)	−0.072 (0.156)
	X17	0.165 (0.061) ***	−0.101 (0.103)	−0.229 (0.112) **	0.165 (0.072) **
	X18	−0.015 (0.039)	−0.005 (0.058)	0.093 (0.053) *	−0.073 (0.038) *
	X19	−0.064 (0.027) **	0.125 (0.043) ***	−0.064 (0.048)	0.003 (0.038)
Financial capital	X20	0.066 (0.047)	0.001 (0.072)	−0.017 (0.066)	−0.052 (0.044)
	X21	−0.041 (0.020) **	0.016 (0.033)	0.009 (0.039)	0.016 (0.030)
	X22	−0.197 (0.042) ***	0.063 (0.070)	0.036 (0.083)	0.098 (0.063)
	X23	0.062 (0.021) ***	−0.006 (0.047)	−0.106 (0.057) *	0.050 (0.041)
	X24	0.104 (0.047) **	0.058 (0.078)	−0.806 (0.194) ***	0.644 (0.185) ***
Social capital	X25	−0.096 (0.063)	0.232 (0.090) **	−0.003 (0.077)	−0.133 (0.065) **
	X26	−0.016 (0.042)	0.238 (0.082) ***	−0.230 (0.100) **	0.008 (0.075)
	X27	0.034 (0.044)	−0.094 (0.072)	−0.023 (0.064)	0.083 (0.042) **

Note: *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively; values in parentheses are standard error values.

3.2. Binary Logistic Regression Model

The binary logistic regression model was estimated using SPSS 27.0 software. The findings from the relevant statistical measures indicate that the overall model fit is significantly superior to the null model containing solely the intercept term (X^2 = 137.017, $p < 0.001$). The Hosmer and Lemeshow test p-value is 1.000, indicating an adequate model fit. The independent variables have statistically significant explanatory power for the dependent variable, as demonstrated in Table 10.

The model parameters demonstrate that farmers' propensity to endorse and engage in natural forest conservation initiatives is considerably influenced by specific livelihood capital factors. Among these factors, a personal perception of policy benefits (natural capital) and a favorable willingness to transform livelihoods (financial capital) assume the most pivotal roles. Concurrently, human capital (the composition of the labor force) and physical capital (housing conditions) also exhibit considerable influence, albeit in disparate directions.

Table 10. Results of binary logistic regression model.

Variable	Y2	Exp (B)
X2 = 3	−9.494 (4.989) *	0
X5	−7.051 (3.458) **	0.001
X7	0.282 (0.159) *	1.326
X10	**	

Table 10. *Cont.*

Variable	Y2	Exp (B)
X10 = 2	5.881 (3.216) *	358.068
X10 = 3	10.722 (3.99) ***	45351.917
X14 = 1	4.634 (1.826) **	102.912
X19	*	
X19 = 2	7.102 (3.32) **	1214.028
X21	*	
X21 = 2	−10.018 (4.269) **	0
X21 = 3	−9.333 (4.352) **	0
X22 = 1	7.56 (3.793) **	1919.124
Model coefficient Omnibus test Chi-square	137.017	
Model coefficient Omnibus test Sig.	$p < 0.001$	

Note: *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively; values in parentheses are standard error values. Some variables in the table only mark significance symbols (no coefficients), which correspond to the overall significance of multi-category independent variables.

4. Analysis and Discussion

4.1. Human Capital

With respect to human capital, the proportion of household labor force (X5) exhibited substantial outcomes for both dependent variables; however, the direction of the impact differed. The findings indicate that the promotion of fundamental cognitive abilities (cut1 OR = 97.7) exerts a substantial impact on the likelihood of Y = 0 (AME −19.7%), as demonstrated by the results obtained from the AME. Research has demonstrated that households with a higher proportion of household labor force typically possess stronger information processing capabilities [28]. Households with abundant labor resources are more likely to obtain policy information through social networks, and members with higher educational levels can quickly understand policy details. Furthermore, a study corroborated the hypothesis that an augmentation of 10% in the labor force ratio is associated with a 23% increase in the probability of policy awareness (OR = 1.23, $p < 0.01$) [29]. This phenomenon can be attributed to an increase in the frequency with which individuals partake in village-level meetings and are exposed to promotional materials. The findings of the study indicate a negative correlation between the household labor force ratio and farmers' propensity to offer support and participate. Specifically, the data reveal that as the household labor force ratio increases, farmers' willingness to participate and offer support declines (OR = 0.001). According to the principles of opportunity cost and alternative choice theory, the allocation of labor resources to conservation activities results in higher opportunity costs and a reduced appeal of alternative livelihood choices. This phenomenon aligns with the "diminishing marginal effects of conservation policies" proposed by Liu et al. [30]. Households with abundant labor resources are more likely to engage in activities with higher short-term economic returns (e.g., wage labor or cash crop cultivation). Consequently, direct subsidies for natural forest conservation struggle to cover their labor costs.

It is noteworthy that planned learning skills (X6) exert both an inhibitory and a transition effect on Y1: they increase the probability of remaining "completely unaware" (Y = 0) by 10.3%, reduce the probability of being "somewhat aware" (Y = 1) by 19.8%, but significantly increase the probability of becoming "very aware" (Y = 3) by 8.4%. On the one hand, the planned learning skill requires time and economic resources, which may temporarily reduce opportunities to participate in public policy activities [31]. Conversely, the intention to acquire skills signifies a readiness to engage in active learning. In instances where skills pertain to ecological conservation, a phenomenon referred to as the "cognitive synergy effect" is observed. According to Ren's ecological cognition theory, skill learning plans enhance individuals' information screening abilities, enabling them to efficiently

obtain high-value policy information [11]. Moreover, acquiring new skills broadens farmers' long-term perspectives, helping them recognize the indirect benefits of natural forest conservation for ecosystem services, climate adaptation, and sustainable livelihoods. This aligns with the conclusion drawn by Orimoloye et al. (2021): "Understanding the benefits of ecosystem services for human well-being helps foster scientific and political collaboration to address global challenges" [32].

4.2. Natural Capital

In terms of natural capital, policy benefit perception (X10) demonstrated significant positive results for both dependent variables. For Y1, the probability of farmers who believed that the policy had significant benefits being in the "very knowledgeable" category increased by an average of 10.6% (AME). For the second year, X10 emerged as the most significant and robust factor, with farmers' propensity to engage increasing exponentially as their awareness of the policy's advantages grew. The fundamental question of whether the conservation of natural forests enhances production and living conditions is, at its core, an assessment of the value of ecosystem services. Research has demonstrated that when farmers perceive natural forests as sources of water conservation, disaster buffers, or livelihood resources (e.g., non-timber forest products), their acknowledgment of the direct use value and insurance functions (e.g., climate regulation) of natural capital considerably amplifies their propensity to protect them [11]. This association aligns with the Theory of Planned Behavior, which posits that utility assessments positively influence behavioral attitudes ("whether to support") and subjective norms ("level of understanding" represents information internalization) [33]. Furthermore, the findings of the present study demonstrate that perceptions of disaster change (X11) exert a positive and significant effect on Y1, thereby corroborating the aforementioned discussion.

4.3. Physical Capital

With regard to the physical capital component, both the quality of road conditions (X15) and efficacy of communication conditions (X17) demonstrate substantial outcomes for Y1. However, the direction of these effects is not straightforward. The probability of being "completely unaware" is reduced by 12.8% in the presence of certain road conditions (X15), while the probability of being "somewhat aware" is increased by 39.3%. However, these substances impede the process of attaining a more profound comprehension, thereby decreasing the likelihood of becoming "somewhat aware" by 24.3%. This phenomenon aligns with the "infrastructure efficiency paradox" theory, which posits that while road accessibility accelerates the dissemination of superficial information, such as the existence of policies, rural road networks primarily facilitate the transportation of basic materials rather than the transmission of structured knowledge [29]. A case study of Yunnan's mountainous regions reveals that increasing road coverage by 10% leads to a 15.2% increase in basic policy awareness. However, there is no significant change in understanding technical details [34].

The communication conditions (X17) under scrutiny in this study have been shown to exacerbate cognitive differentiation by simultaneously increasing the probability of being "completely unaware" or "very aware" by 16.5%, while compressing intermediate cognitive levels. This phenomenon is indicative of the multifaceted nature of the digital divide. The initial issue is the "access gap," which occurs when uneven hardware coverage has the effect of marginalizing vulnerable groups. Second is the "usage gap," in which farmers who use government apps demonstrate significantly higher accuracy in understanding protection regulations than those who rely solely on oral transmission [35]. The intermediate cognitive

group exhibits an inability to discern when confronted with information overload and is predisposed to relinquishing further exploration of the subject matter [34].

Furthermore, family housing (1) (X14 = 1) exhibited a substantial positive association with Y2 (OR = 102.912, $p < 0.05$), with households possessing superior housing conditions demonstrating a notably elevated propensity to engage in participation. According to the livelihood capital buffer theory, improved housing conditions have the potential to reduce livelihood vulnerability. Consequently, households may be better equipped to shoulder the short-term opportunity costs associated with ecological protection policies. Secondly, housing conditions serve as a visible indicator of social status within rural communities. Households with superior housing conditions exhibit greater propensity to engage in environmental protection activities, which serves to reinforce their identity as "community stewards." This, in turn, contributes to the maintenance of their social reputation. However, there may be reverse causality in this result—rather than better housing directly increasing willingness to conserve, it may be the case that farmers with high environmental awareness and willingness to participate accumulate wealth through other livelihoods in order to improve their housing, while environmentally conscious farmers may improve their housing by increasing their income through sustainable livelihoods [36]. In addition, the definition of "good" varies significantly across regions and cultures [37]. For example, housing improvement is associated with urbanization in Cambodia and with homestead policies and household demographics in rural China, and the generalizability of the findings would be compromised if the housing condition measures did not capture this complexity [38,39].

4.4. Financial Capital

With regard to financial capital, the propensity to undergo industrial transformation (X22) exhibited substantial positive outcomes for both dependent variables. For Year 1, the propensity to transition between industries (X22) substantially diminishes the likelihood of being "completely unaware" (−19.7%), thereby establishing a foundation for profound comprehension. For Year 2, farmers who are inclined to transition to the tertiary sector exhibit a noticeably elevated propensity to endorse and engage in forest conservation initiatives (OR = 1919.124, $p < 0.05$). Farmers who transition to the tertiary sector—low-resource-dependent industries such as tourism services, handicrafts, and e-commerce—see a reduction in their direct reliance on forest resources, while concurrently enhancing their recognition of ecological conservation value. This livelihood transition establishes an economic incentive mechanism in which "conservation equals benefits", thereby prompting farmers to proactively understand policies and participate in conservation activities [37].

It is noteworthy that the coefficients for the middle-high income levels (2) and (3) of household income from the previous year (X21) are negative (OR $\approx$ 0) for Y2, indicating that middle-high income farmers exhibit a substantially lower propensity to engage. High-income households demonstrate a greater propensity to preserve and augment existing income sources, such as business operations or wage labor, rather than engaging in conservation activities that could potentially diminish short-term economic returns. Theoretically, this phenomenon stems from rational economic decision-making: as household income increases, opportunities for reallocating resources also increase, leading to a decreasing willingness to participate in conservation and welfare programs [33,40].

4.5. Social Capital

With regard to social capital, the mode of migrant work (X24) exerts a complex and significant influence on Y1. While it increases the probability of being in the Y = 0 category by 10.4%, it eliminates the "fairly knowledgeable" (Y = 2) group by 80.6% and directly pushes 64.4% of farmers into the "very knowledgeable" (Y = 3) category. Firstly, the mode

of migrant work through personal referrals reinforces specific information channels. In contexts where labor opportunities are contingent on local social networks, the transmission of information exhibits a phenomenon known as "homogeneous filtering". This suggests that migrant workers are more likely to access information pertaining to economic benefits, while information related to environmental policy is often marginalized [41]. Secondly, the mode of labor migration exerts a significant influence on the cognitive frameworks employed by farmers. Migrant workers who secure employment through intermediary organizations are exposed to a variety of information sources, leading to the development of a more systematic understanding of policies. In contrast, those who secure employment through family connections anchor their policy perceptions to the individual experiences of the "referrer" [35].

Additionally, the presence of returning migrants who have initiated business ventures within the village (1) (X25 = 1) exerts a modest positive influence on Y2, which is concomitant with an elevated propensity among farmers to engage in participation (OR = 37.499). However, the p-value falls short of the conventional significance level of $p < 0.1$, thereby classifying this effect as marginally significant or indicative. The return of entrepreneurs to the community can facilitate the introduction of novel ideas, demonstration effects, or organizational resources, thereby indirectly promoting villagers' recognition and willingness to participate in the protection of local natural forests.

4.6. Regional Differences

With respect to regional disparities, regional variables exert a multifaceted and substantial influence on Y1. While these measures effectively reduce the probability of being "somewhat familiar" (Y = 1) by 57.1% and the probability of being "very familiar" (Y = 3) by 42.9%, they concomitantly result in a significant increase in the probability of being "fairly familiar" (Y = 2) by 105.2%. Fujian, a pioneering region in China's collective forest rights reform initiated in 2003, has progressively developed a nuanced understanding of forestry policies. A study by Tian et al. (2023) revealed that farmers in Fujian have significantly higher policy exposure frequency than those in Yunnan, with an average of 3.2 times per year compared to 1.8 times per year, respectively [23]. This finding suggests that farmers in Fujian have a more systematic grasp of intermediate policy layers. However, Fujian's market-oriented policy dissemination has resulted in a certain degree of information fragmentation, with foundational policy points being interpreted in a scattered manner [11,23]. This has led to farmers more frequently forming an "intermediate state of understanding", thereby weakening the stability of foundational and in-depth understanding. In contrast, Yunnan is characterized by a predominance of state-owned forests and those classified as ecological public welfare forests. The implementation of policies in this region is predominantly reliant on the top-down administrative promotion of forestry initiatives [42]. Furthermore, due to the limited availability of information channels, farmers are more prone to form polarized cognition, that is, either being completely unaware or deeply knowledgeable [43,44].

5. Conclusions and Recommendations

5.1. Conclusions

The present study employs the livelihood capital framework to systematically examine the mechanisms by which human, natural, material, financial, and social capital, as well as regional differences, affect farmers' awareness (Y1) and willingness to participate (Y2) in the Natural Forest Protection Policy (NFPP). The primary conclusions that can be drawn from this analysis are as follows:

The present study identifies a contradictory phenomenon in the influence of certain variables on the livelihood capital component. These variables, when considered in relation to the dependent variable "level of understanding of local natural forest conservation projects" (Y1), demonstrate a complex and multifaceted relationship. The planned learning skills of human capital (X6), the road conditions of physical capital (X15), and the communication conditions of social capital (X17) have been identified as significant factors in the study. Additionally, the out-migration patterns of social capital (X24) and regional variables have been found to exert a complex influence on Y1. The probability of Y1's four levels following a "U-shaped" or "inverted U-shaped" distribution is influenced by these variables.

A contradictory phenomenon is observed between the livelihood capital variables and the two dependent variables (cognition vs. behavior). In the context of human capital, the proportion of family labor force (X5) has been shown to significantly improve policy awareness (Y1) through information network advantages. However, this improvement is counterbalanced by a significant suppression of participation willingness (Y2) due to high opportunity costs and alternative livelihood choices. This outcome confirms the "diminishing marginal effect of protection policies" as demonstrated by Liu et al. (2024) [30].

The perceived policy benefits of natural capital (X10) and willingness of financial capital to undergo industrial transformation (X22) both demonstrate positive and significant results for both dependent variables. Material capital's household housing (1) (X14 = 1) demonstrates a positive and significant effect on Y2, while social capital's presence of villagers returning to initiate business ventures (1) (X25 = 1) exhibits a weak positive impact on Y2. Moreover, the medium-to-high income level of households last year (X21) has a significantly negative coefficient on Y2, thereby reducing the probability of farmers supporting and participating in natural forest conservation activities.

The following factors were identified as key variables that influence farmers' understanding of local natural forest protection projects: regional factors, the proportion of family labor, planned learning skills, perceived policy benefits, family housing, road conditions, communication conditions, family income last year, willingness to undergo industrial transformation, and methods of working away from home. These factors are also important considerations that influence farmers' participation in natural forest protection activities.

This study has certain limitations. Firstly, there are the inherent limitations of the SLF: this approach simplifies rural realities through static resource categorization and struggles to capture dynamic changes in natural resources. Moreover, assessing intangible assets such as social and cultural capital involves subjectivity and quantitative challenges. Secondly, there are spatial scope limitations: this study focuses solely on two specific regions, restricting the generalizability of its conclusions. Thirdly, there is the absence of a temporal dimension: lacking longitudinal data support, this study cannot evaluate the long-term effects and lagged impacts of policy interventions. To address these limitations, future research may be enhanced in four areas: expanding the spatial scope to improve the generalizability of findings; incorporating a temporal dimension through longitudinal data such as panel data to accurately assess long-term policy effects; and innovating research methodologies by exploring techniques like machine learning to enhance predictive accuracy while also integrating implementation factors such as policy enforcement intensity and local government interventions to deepen mechanistic analysis.

5.2. Recommendations

The intricate nature of livelihood capital underscores the necessity for meticulous policy design. This study aims to enhance farmers' comprehension of local natural forest

protection initiatives and to cultivate their engagement in these conservation efforts. The study's findings underscore the necessity to realize the following.

Institutional design serves as a critical conduit, effectively bridging the structural gap between cognition and behavior. It is imperative to establish a differentiated, flexible compensation mechanism. Furthermore, subsidy standards must be raised based on the proportion of labor. Finally, policy adaptability must be improved. It is imperative to advocate for a strategy that prioritizes the cultivation of non-agricultural skills. This strategy should be meticulously designed to establish a nexus between engagement in protection programs and the acquisition of vocational skills certification. According to the proportion of family labor (e.g., <30%, 30%–60%, >60%), there are three levels, corresponding to the basic subsidy increases of 10%–15%, 15%–20%, and 20%–30%, superimposed on the dynamic adjustment of "participation in conservation" (e.g., the length of time spent patrolling the forests), and the subsidy is paid out through a "one-card" for the benefit of the people. The subsidies are paid out through the "One Card", and the details are announced quarterly. The strategy of bundling non-agricultural skill training is implemented, linking conservation participation with vocational skill certification. Training content is set according to the characteristics of regional industries, and farmers accumulate points for participating in conservation activities; 10 points are exchanged for one period of training, and a certificate of vocational skills is issued to those who pass the training. Research by Ullah and Bavorova (2024) indicates that such bundling strategies can increase participation rates by 41%, suggesting that they are a valuable subject worthy of further study [40].

It is imperative to fortify cognitive guidance and behavioral transformation and redirect the emphasis of publicity endeavors toward the articulation of non-economic values, with a particular focus on the implicit benefits of natural forests in microclimate regulation and biodiversity conservation. This reorientation of focus should supersede the current practice of relying exclusively on compensation incentives [43]. Additionally, there is a need to integrate infrastructure with knowledge services, such as the establishment of "policy information corners" at road junctions for the purpose of conducting regular on-site training [45]. In the year 2019, the following recommendations were made: first, digital technologies should be adapted for the elderly population; second, voice-interactive applications should be promoted; and third, usage barriers should be lowered for this demographic [35]. Moreover, the incorporation of housing improvement into ecological compensation systems should prioritize the coverage of farming households with substandard housing in protected natural forests and those involved in conservation for a long period of time in order to accelerate the achievement of ecological conservation goals.

In light of the impact of regional differences on farmers' understanding of natural forest conservation policies, a differentiated strategy is recommended. In Fujian Province, it is imperative to enhance the systematic dissemination of policies by providing regular, in-depth interpretations to consolidate fragmented information and enhance farmers' foundational and in-depth understanding. On a quarterly basis, county-based "Policy Interpretation in the Countryside" activities are carried out, after which a graphic version of the "Policy Essentials Handbook" is pushed out through the village WeChat group to consolidate the basic and in-depth knowledge of farmers. In Yunnan Province, expanding information channels by combining new media and rural radio broadcasts to balance polarized perceptions is advisable. For young farmers, official accounts dedicated to "Natural Forest Conservation" have been established on short video platforms, releasing two short videos weekly. These feature animated policy explanations and stories of farmers' conservation efforts. For middle-aged and elderly farming households, key policy points are broadcast daily via village loudspeakers (once at 7 a.m. and once at 7 p.m.), each lasting five minutes and delivered in both local dialect and Mandarin. This approach

ensures coverage across different age groups of farming households. Furthermore, Fujian Province has the potential to leverage its high policy exposure frequency to promote the establishment of community forestry protection groups. In contrast, Yunnan Province can utilize administrative initiatives to establish village-level incentive programs, thereby enhancing farmer participation.

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Abbreviations

The following abbreviations are used in this manuscript:

NFPP	Natural Forest Protection Policy;
SLF	Sustainable Livelihoods Framework;
DFID	The UK Department for International Development;
PRA	Participatory Rural Appraisal;
GEF	Global Environment Facility.

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