Mechanism for Achieving Balance between Ecological Conservation and Community Forest Products Benefits: A Case Study of a Typical National Park in China

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Abstract

The establishment of national nature reserves has led to the protection of ecosystem diversity. In the context of China's ecological protection system, controversies have arisen over the guarantee of dwellers' well-being from forestland. This study uses Wuyi Mountain National Park (WYMNP) in China as an example to discuss the balance between ecological conservation and forest community benefits from forest products. Based on a cross-sectional survey, a logit regression method was adopted to explore factors influencing the ability of forestland holders within WYMNP to make productive financing decisions for forest production without policy intervention. Additionally, the government's integrated management strategy that accelerates positive social externalities was explored. The results reveal that: before the establishment of WYMNP, forestland holders in this region that operated in the nontimber forest product (NTFP) industry had more incentives to make proactive productive financing decisions on forest production; second, enterprise forestland holders were more motivated to expand their forest products operations than individual forestland holders; finally, after the establishment of WYMNP, the government departments conducted adaptive policies including redemption of forestland and classifying the extent to which production activities could be performed. The government provides a compromise solution that supplies long-running payments in core ecological conservation areas to secure dwellers' livelihoods, while in regular control areas, the opportunity to operate the NTFP industry is finitely provided with regular monitoring. This strategy provides insight that holistic optimization for the development of forest communities and dwellers could be incorporated into the mechanisms for the management of national parks globally.

A national park is a specific land or marine area where the main purpose is to protect a representative national large-scale natural ecosystem and to accelerate the scientific protection and rational use of natural resources (Wan et al. 2021). In recent years, the establishment of national parks in many countries and regions has led to the protection of genetic diversity, species diversity, and ecosystem diversity (Ramkissoon et al. 2017, Li et al. 2022). Simultaneously, in the context of the establishment of national parks, controversies have arisen over ensuring the well-being (economic benefits from forest products) of the people living in these forest communities (Tessema et al. 2010).

Since the beginning of the 21st century, China has accelerated the establishment of national forest reserves and the protection of undeveloped ecoregions (Ouyang et al. 2016, Li and Pimm 2020). The Decision on Several Major Issues Concerning Comprehensively Deepening Reform, adopted at the Third Plenary Session of the 18th Central Committee of China's central government, explicitly proposed the "national park system." This national park system serves as a vital element in the construction of China's ecological civilization system in addition to advancing the scientific protection and rational use of natural resources (Yang 2017).

During the process of constructing the national park system, concerns about the well-being of forest community

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dwellers have increasingly attracted the discussion of international society (Ramkissoon et al. 2017). Concerns about the social problems involved in the national park system include community economic benefits from forest products, employment of dwellers, migration of rural laborers, and community welfare protection (Allendorf 2006, Holmern et al. 2007). Therefore, the optimization path to achieve balance between the establishment of national parks and the protection of dwellers' benefits from forestland should be explicitly considered in systematic ways. Tessema et al. (2010) have suggested that while the establishment of national parks has protected local species and ecological diversity, the consequent reduction or prohibition of forest production activities simultaneously poses a potential threat of poverty for the residents living in the forest communities. The extension of conservation to previously unprotected areas has inevitably impacted the livelihoods of local dwellers who have become part of those environmental protection policies, and some of those dwellers were previously heavily dependent on natural resources (e.g., timber forestry, animal husbandry; Duan and Wen 2017). A substantial amount of literature has discussed the issues of residents' resettlement or compensation after the establishment of national parks; among these articles, the key question of whether to completely prohibit residents from engaging in forest product production on forestland has not yet reached a consensus between the protection of rights, the economy, and the ecology (Gadd 2005, Allendorf 2006). With methodological policy guidance, forestland use also could be considered a critical issue for the new wave of incentive-based policy instruments that aim to ensure ecosystem goods and services (such as carbon sink value, water, and biodiversity; Robinson et al. 2014, Price 2018).

In this study, the Wuyi Mountain National Park (WYMNP) in Southeast China was used as an example to discuss the balance between ecological protection goals and dwellers' rights and benefits of forestland use within the upstream protection zone of the water source. The main objectives of this study are threefold: first, statistically analyze the basic characteristics of forestland management right[1] (hereinafter referred to as forestland right) holders using the sample in selected areas of the WYMNP, in order to objectively capture the challenges that community dwellers may face in the context of the national park system; second, conduct a regression analysis to examine the factors influencing the productive motivation of forestland right holders before the establishment of the national park, from which further adaptive policy could be summarized to prevent serious negative impacts on the economic benefits of the dwellers; and third, integrate the regression results of forestland use with the management policies implemented by the WYMNP Management Committee (WYMNPMC), so as to share the corresponding mechanisms to provide experiences for other countries and regions to achieve a balance between the establishment of a national park and the protection of dwellers' benefits from forestland.

[1] After the reform of China's collective forestland rights system, the management rights of forestlands have been gradually decentralized to a diversity of subjects, including households.

This study has several possible contributions to the literature. First, several previous research works on nature reserves or ecological restoration have focused more on ecosystem protection, and many discussions appear to miss the forest productive activities under such a system (Xu et al. 2017, Peng et al. 2018, Chen et al. 2022). However, investigations at the landholder level are the key points to seek for adaptive policies of forest management (Quine et al. 2013). Again, this study innovatively exploited the regression analysis of forestland holders' data before the establishment of the national park, which could help to obtain the actual productive behavior model before the implementation of the national park system. This model may reflect the actual intentions of forestland holders who are not affected by the ecological policy. Finally, our research is based on a case study in low- and middle-income regions, where the governance of poverty due to the loss of benefits from forest products in ecologically protected areas has been increasingly challenging and arguable (Allendorf 2006).

Materials and Methods

Study area

Wuyi Mountain Range is one of the most representative mountain ranges along the southeast coast of China (Shi et al. 2019). The region has a wide range of rare and endangered species, an extensive concentration of endemic and ancient relict species, and a pristine subtropical mountain forest ecosystem (Yang et al. 2022). The conservation and research value of natural and human resources in such regions is irreplaceable in China and even globally (Xu et al. 2021). To explore the formation of replicable and scalable experiences in national park construction, China's National Development and Reform Commission as well as 13 other government departments jointly launched the pilot plan of the national park system in 2015 (Xu et al. 2017). In total, 12 provinces and municipalities in China were selected to carry out the pilot plan for national parks. Among them, the Wuyi Mountain region in Fujian Province was identified as one of China's first national park pilot zones. In 2021, China systematically established the first batch of national parks, including Sanjiangyuan, Giant Panda, Northeastern Tigers and Leopards, Hainan Tropical Rainforest, and Wuyi Mountain (Chen et al. 2023b), of which WYMNP is the only national park certified as a "World Natural Heritage Site" and "World Cultural Heritage Site" by the United Nations Educational, Scientific and Cultural Organization (UNESCO; Wang et al. 2015).

WYMNP borders Jiangxi Province, Jianyang City, Guangze County, and Wuyishan City in Fujian Province, China (27°31′20″N to 27°55′49″N, 117°24′13″E to 117°59′19″E; Fig. 1). The scope of WYMNP includes Wuyi Mountain National Nature Reserve, Wuyi Mountain National Scenic Spot, the upstream protection zone of Jiuqu Stream, Wuyi Tianchi National Forest Park, and part of the state-owned Longhu forest farm. WYMNP protects a total area of 1,280 km^2, of which an area of 1,001.41 km^2 is in Fujian Province (Chen et al. 2023b). WYMNP is located at the intersection of China's key biodiversity areas (KBA) and preserved subtropical mesophyll forests. Additionally, the region is the key area for biodiversity conservation in Southeast China (China's national first-class protected animals, including *Manis pentadactyla*, *Teinopalpus aureus*,

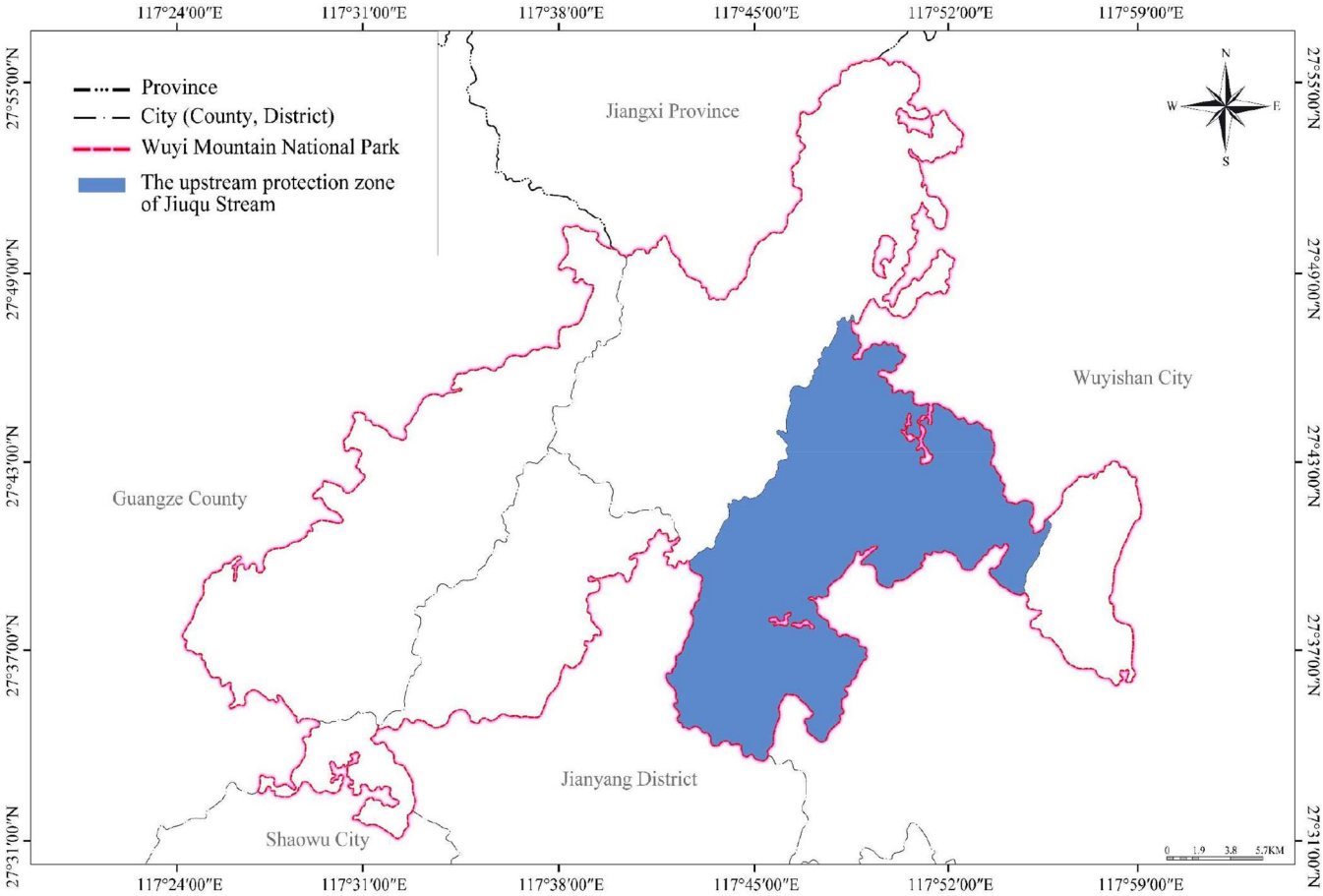

Figure 1.—Location of the sample area in Wuyi Mountain National Park, Southeast China.

Tragopan caboti, etc.), encompassing wholesale types of plants in China's meso-subtropical region (China's national first-class protected plants, including *Glyptostrobus pensilis*, *Taxus wallichiana var. chinensis*, and *Taxus wallichiana var. mairei*), and possessing one of the most well-preserved areas of evergreen broad-leaved forests in China (Wuyi Mountain National Park Management Committee 2017).

The conservation value of the forest ecosystem in WYMNP has been highlighted when compared with other areas in similar latitudes around the world. Ecosystems in a similar latitude with Wuyi Mountain in Eurasia include India's Thar Desert, southern Iran, Saudi Arabia, Egypt, Libya, Algeria, Morocco, etc., and in North America, there is the northern part of Mexico, most of which are desert areas with scarce and specialized biological species. Thus, the construction of WYMNP and the protection of the ecosystem integrity in WYMNP are conducive to ecological protection in China and even in the world. Referring to the trade basis of forest products, WYMNP is the birthplace of oolong tea products with a wide range of timber and bamboo products, which are also significant parts of the "Tea Road of Ten Thousand Mile" and the "Maritime Silk Road" initiatives constructed by China's central government. In the process of establishing WYMNP, the government management departments have practiced the concept of "mountains, water, forests, fields, lakes, and grasses as a holistic life community."

Data sample

WYMNP encompasses nine towns and 29 villages in Wuyishan City, Guangze County, Jianyang District, and Shaowu City under the administration of Fujian Province, China. In this case, one of the most representative components of ecological protection within the scope of the WYMNP was selected for further data analysis (Fig. 1): all forestland rights within the upstream protection zone of the water source (the upstream protection zone of Jiuqu Stream) in WYMNP (Wuyi Mountain National Park Management Committee 2017). The upstream protection zone was selected for two critical reasons: In part, the source of water plays a critical role in supporting holistic forest ecosystems throughout the national parks (Chen et al. 2023a); further, the areas near the water sources were important habitats for the production and residence of forest community dwellers prior to the establishment of the WYMNP, making the forestland use of the surrounding communities highly representative (Tu et al. 2023).

The data sample and information of relevant policies was collected and collated by the authors from the statistics and work reports of the local forest management department and WYMNPMC during our fieldwork in Wuyi Mountain Area between June 2023 and September 2023. The data sample consists of two parts: (1) characteristics of all forestland rights in the upstream protection zone of the water source, which involves seven administrative villages, and (2) the financing situation of all forestland rights within the

scope of the upstream protection zone of the water source in 2014. According to collected data sets, there were 2,158 registered forestland rights within the scope of the upstream protection zone of the water source in WYMNP. When excluding forestland rights that had been deregistered, the sample totaled 1,667 records. The financing situation of all forestland rights within the scope of the upstream protection zone of the water source was collated by the authors based on an original cross-sectional survey of the local forestland rights management department in 2014. As previously described, in 2015, China's National Development and Reform Commission as well as 13 other departments jointly launched the pilot plan of the national park system (Xu et al. 2017), and the Wuyi Mountain region was identified as one of the first pilot zones in China. Accordingly, cross-sectional data on the financing situation of forestland rights prior to 2015 were selected, and the reason for using the most recent cross-sectional survey data prior to the establishment of the WYMNP was to reflect the actual behavior pattern of community forestry operators and explore the factors influencing the motivation of forestland right holders before they were exposed to the effects of the conservation policy. After establishment or the WYMNP, it would not be practical to develop a comparable control group due to the policy's partial restriction of forest experience activities. Therefore, we complemented our analysis with policy implementation data focusing on the impact of policies on forest management in the surveyed region. This sample could effectively support the analysis of our study for the critical reason that it is a full sample data set rather than a sampling survey data set. Thus, the collected data could provide complete coverage of all forestland holders in the surveyed study area, which contributed to the exclusion of potential bias from sampling methods.

To supplement the results of the regression analysis, we supplemented our fieldwork with policy implementation by the local forest department and WYMNPMC. Additionally, the redemption of forest rights in the WYMNP from 2020 to 2022 is included in the supplementary analysis, with information sourced from the work reports of the local forestland rights management department (initially recorded by the local forest rights registration center) and collated by the authors.

Conceptual background, estimation method, and variables

The regression examination in this study refers to the Institutional Analysis and Development (IAD) model (Elinor 2005), which is centered on the participant decision-making path. The main idea of the IAD model demonstrates that in addition to the influence of the external environment and culture, participants' decision-making is influenced by information about the participants' own situation, control of conditions, expectations, and the extent to which participants perceive these conditions. Moreover, decision-making could be affected by the extent to which participants are aware of the potential outcome before acting (Fig. 2).

According to the IAD model, the dependent variable in this study could be adopted as whether or not forestland right holders made proactive financial decisions, i.e., used forestland rights to mortgage financing (yes = 1, otherwise = 0). With reference to Liu (2011) and Xu et al. (2013), the estimated model was adopted in the form of a logit regression:

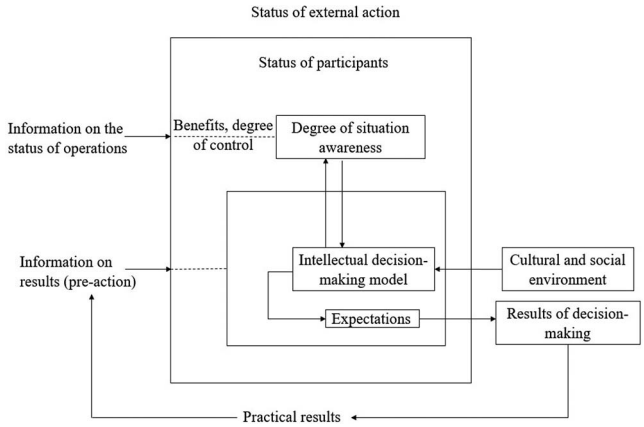

Figure 2.—Decision-making path described in the Institutional Analysis and Development (IAD) model (Elinor 2005).

$$P\ [y\ =\ 1|\ x]\ =\ \ F(x,\ \beta)\ =\ \Lambda\ (x'\beta) \equiv \frac{\exp(x'\beta)}{1+\exp(x'\beta)} \tag{1}$$

where P represents the probability that $y = 1$ (used forestland rights to mortgage financing, yes = 1) for given x (explanatory variables in our study); x' represents the vector of explanatory variables and β represents the set of coefficients to be estimated; F is the link function of the connection between y and x, i.e., the cumulative distribution function of the logistic distribution; Λ captures the probability density function of $y = 1$ based on the $x'\beta$; the function $\exp(\cdot)$ represents the natural exponential function form.

Regarding the explanatory variables, the IAD model and its adjusted model by Liu (2011) were considered with regard to the objective of this study (how to achieve balance between ecological protection and dwellers' forest production activities). Thus, three key explanatory variables related to their own situation, condition control, and possible benefits from forest products were adopted as follows:

1. Organizational form of the holder. The internal motivation of forest farmer holders and micro- and small enterprise (MSE) holders to operate forestland rights may be heterogeneous (Quine et al. 2013). According to the IAD model, decision-maker status, perception, and expectation of potential future benefits from products will determine whether to implement the decision or not (Elinor 2005). Compared with farmers, enterprise holders have an enhanced understanding of their own financial status, potential future profitability, and external market information (Zhang et al. 2012). Hence, the type of holder (enterprise = 1, otherwise = 0) was selected as one of the key explanatory variables.
2. Nontimber forest products (NTFPs) as major products. NTFPs refer to forest products that do not result in economic gain from harvesting, which include roots, stems, leaves, and fruits (Shen et al. 2021). These types of forest products have stimulated much interest owing to their contribution to the prevention

of deforestation and degradation as well as antipoverty (Delgado et al. 2022). In this case, whether NTFPs were the main output of the forestland rights was selected as the key explanatory variable for two important reasons: First, according to the IAD model, the perception of potential future benefits and risks will influence decision-making. In the context of the trend of the nature reserves and China's harvesting quota policy in 2006 (Xie et al. 2019), opportunities became evident for operation of NTFPs with flexibility, low input, and considerable benefit. Second, the objective of this study was to find an optimized way to balance ecological preservation with the forest community benefits, and the production of NTFPs proves to be one of the key paths (Frey et al. 2021). Therefore, NTFPs as major products was adopted as another key explanatory variable according to the IAD model, which could simultaneously explore whether forest community dwellers have the actual willingness to choose NTFPs as long-term income without the intervention of ecological protection policy.[2]

3. Area of forestland rights. Study results of Xu et al. (2013) show that the expansion of the management scale of forestland rights is positively related to forestland right area. From the preliminary statistical results on the collated sample, the smallest forestland right held by private holders is 0.07 hectares, while the largest is 210.67 hectares, with a standard deviation of 17.25 hectares. Referring to the analysis of Xu et al. (2013) together with the distribution of forestland rights, the area of forestland rights was selected as a key explanatory variable in the basic model.

In addition, based on the IAD model in conjunction with Liu (2011) and Duan et al. (2021), the operation status in the previous cycle (natural or plantation forests in the current period), whether other surrounding operable forestland rights are being held, and the length of time covered by the forestland rights certificates issued by the government after the reform of China's collective forestland rights system were selected as the control variables in the basic model. The specific regression model is presented as follows:

$$Ln\left(\frac{P_{idecision}}{1-P_{idecision}}\right) = \beta_0 + \beta_1 Form_i + \beta_2 NTFPs_i + \beta_3 Area_i + Controls_i + \varepsilon_i \quad (2)$$

In Equation 2, i represents forestland rights holders; $P_{idecision}$ represents the odds that i makes decision to use forestland rights to mortgage financing; $Ln\left(\frac{P_{idecision}}{1-P_{idecision}}\right)$ is the log-odds ratio; β represents the coefficient to be estimated, i.e., the change in the odds ratio caused by one unit increase in the explanatory variable; ε is the error term.

The variance inflation factor (VIF) test was adopted to exclude the multicollinearity problem of the regression model (Salmerón et al. 2018). Moreover, to avoid autocorrelation caused by replications of holders/villages, the cluster-robust standard error was further adopted. Marginal effects were simultaneously examined using Equation 2. Although the basic regression model was used to explore the factors influencing the forestland rights holders' decisions to engage in operational financing for forest production, due to the limitations of the data type (the data used in this study were full-sample data rather than sampled data collected based on questionnaires, whereas the personal information was partially missing and inaccurate), further detailed characteristics of the holders (asset, education, etc.) were not included in the basic model, thus resulting in some limitations with the interpretation.[3]

Notably, referring to the sample structure, before the establishment of WYMNP, private holders (enterprises or forest farmers) had conducted productive financing decisions on forestland rights to further develop forest production; however, government department or other official organization (village or town collectives) holders did not implement the financing of forestland rights (values of dependent variable were all equal to zero). Based on the preliminary observation results of the data set and the objective of this study, the factors influencing the proactive financial decisions made by private holders of forestland rights were further selected in the logit regression analysis to identify what the of private holders that might face challenges as the result of the ecological policies.

Results

Statistical characteristics of forestland rights holders

As presented in Table 1, there were 1,667 forestland rights within the upstream protection zone of the water source in WYMNP, of which 192 were held by the government departments (National Scenic Area Management Committee, state-owned forest farms, or state-owned scientific and technological experimental forest farms), accounting for 11.52 percent of the sample; 644 were held by town/village collectives, accounting for 38.63 percent of the sample; 46 were held by enterprises (company or joint-stock forest farm), accounting for 2.76 percent of the sample; and 785 were held by villagers individually (forest farmer) or jointly by several villagers, accounting for 47.09 percent of the sample.

The average rate of forestland rights that produced NTFPs held by forest farmers and enterprises was 91.08 percent higher than that of forestland rights held by government departments and town/village collectives. However, the area of forestland rights held by the official departments (average

[2] According to the collated fieldwork data, NTFPs in the samples of this study include bamboo products, medicinal herbs, mushrooms, honey, and oolong tea (*Camellia sinensis*) products.

[3] According to the research results of Xu et al. (2013), holders' individual characteristics did not have significant effects on their expansion decisions at the management scale. Further, these characteristics have no influencing effect on the explanatory variables in the basic model. Hence, the omission of this type of characteristic would not essentially affect the holistic explanatory power of this model (Wooldridge 2016).

Table 1.—*Characteristics of forestland rights in the upstream protection zone of Jiuqu Stream.*

Variables	Total sample				Privately held[a]				Officially held[a]			
	Avg.	SD	Min.	Max.	Avg.	SD	Min.	Max.	Avg.	SD	Min.	Max.
Dependent												
Has been used for financing (yes = 1, 0 otherwise)	0.0125	0.1113	0.0000	1.0000	0.0253	0.1570	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000
Explanatory												
Organizational form of the holder (enterprise = 1, 0 otherwise)	—	—	—	—	0.0554	0.2288	0.0000	1.0000	—	—	—	—
NTFPs as major products[b] (yes = 1, 0 otherwise)	0.3629	0.4810	0.0000	1.0000	0.4777	0.4998	0.0000	1.0000	0.2500	0.4333	0.0000	1.0000
Area (hectares)	29.5176	58.2883	0.0700	341.4700	7.4575	17.2484	0.0700	210.6700	49.8286	72.6159	0.0700	341.4700
Controls												
Planted forest (yes = 1, 0 otherwise)	0.0246	0.1548	0.0000	1.0000	0.0361	0.1867	0.0000	1.0000	0.0132	0.1140	0.0000	1.0000
Other surrounding forestland rights held by the same holder[c] (Yes = 1, 0 Otherwise)	0.3959	0.4892	0.0000	1.0000	0.1685	0.3745	0.0000	1.0000	0.6244	0.4846	0.0000	1.0000
Length of time holding the forestland right certificate (Year)	6.4955	2.6964	0.0000	11.0000	6.7196	2.4440	0.0000	11.0000	6.3146	2.8892	0.0000	11.0000
Number of observations	1,667				831				836			

[a] Forestland rights in this paper refer to the forestland management rights, rather than the ownership of forestland; Classification of forestland holders refers to Zhang et al. (2012): privately held indicates individually (forest farmer), jointly by several villagers, and enterprises (company or joint-stock forest farm); officially held indicates National Scenic Area Management Committee, state-owned forest farms, state-owned scientific and technological experimental forest farms, and town/village collectives.

[b] NTFPs = nontimber forest products.

[c] Forestland rights have transferrable functions after China's reform of the collective forestland rights system in 2003.

= 49.8286 hectares) was 6.68 times larger than the area of forestland rights held by private holders (average = 7.4575 hectares). In addition, the rate of holding two or more bordering forestland rights by the government departments and town/village collectives (average = 0.6244) was 3.71 times higher than that of forest farmers and enterprises (average = 0.1685). Obviously, forestland rights held by forest farmers and enterprises are more decentralized than those held by the government departments and town/village collectives. This result is consistent with the general characteristics of small-scale and part-time operation characteristics of households in China's rural areas.

Factors influencing the proactive productive financing decisions of forestland right holders

Table 2 presents the logit regression analysis of the factors influencing the proactive productive financing decisions of forestland right holders before the establishment of WYMNP (prior to the ecological policy intervention). According to the characteristics of the logit regression, the coefficients for marginal effect are also reported in Table 2, illustrating the change in the dependent variable when the independent variable changes by one unit (Table 2, columns 2, 4, and 6). The VIF values of explanatory variables of the model are all less than 5, which could exclude the significant multicollinearity problem in the basic regression model. According to the basic logit regression results, the coefficient between the holder's type and their financing decisions is statistically significant ($P < 0.01$), indicating that the organizational form as an enterprise has a positive effect on the holder's productive financing decision. This result supports the conclusion of Zhang et al. (2012), showing that enterprise holders conduct more intensive, specialized, and sustainable management of forestland, resulting in an intrinsic motivation and positive decision-making tendencies for forestry production. Referring to the IAD model, decision-maker status, perception, and expectation of potential future benefits from products would influence their decisions. The significant relationship between holder's type (related to the degree of awareness of their own financial status, potential future profitability, and external market information) and their financing decisions further demonstrates the explanatory power of the IAD model for forestland right holders engaged in productive decisions.

In addition, the coefficient between NTFPs as major products and the productive financing decision of forestland right holders was statistically significant ($P < 0.01$), suggesting that performing NTFP production on the forestland rights has a positive contribution to the holder's proactive productive behavior (Table 2). This intrinsic motivation for ecofriendly industries may provide continued opportunities after the establishment of the national park. Finally, the coefficient between forestland right area and the holder's proactive financing decision was not notably significant, and this influential mechanism will require further examination. Moreover, results in Table 2 illustrate that forestland rights classified as planted forest were positively related to the holder's productive financing decisions (coefficient > 0, $P < 0.01$). This result could be attributed to the fact that the previous period's investment and operational preparation represent sunk costs, and these factors enhance the proficiency in forestry production, which could contribute

Table 2.—Influential factors on the forestland right holders' productive financing decisions within the upstream protection zone of the water source in Wuyi Mountain National Park in 2014.

Variables	VIF[b]	Basic model[a]		Basic model cluster at holder level[a]		Basic model cluster at village level[a]	
		Coefficient[c] [1]	Marginal effect[c] [2]	Coefficient[d] [3]	Marginal effect[d] [4]	Coefficient[d] [5]	Marginal effect[d] [6]
Organizational form of the holder	1.18	3.4593*** (0.8454)	0.0796*** (0.0251)	3.4594*** (1.1376)	0.0796** (0.0361)	3.4594*** (0.8894)	0.0796** (0.0353)
NTFPs as major products[e]	1.04	2.5456*** (0.4348)	0.0586*** (0.0170)	2.5456*** (0.6213)	0.0586*** (0.0217)	2.5456*** (0.6899)	0.0586* (0.0311)
Area	1.13	−0.0212** (0.0096)	−0.0005** (0.0002)	−0.0212** (0.0101)	−0.0005* (0.0003)	−0.0212 (0.0150)	−0.0005 (0.0004)
Planted forest	1.02	2.0474*** (0.7538)	0.0471** (0.0184)	2.0474*** (0.6848)	0.0471** (0.0185)	2.0474*** (0.5456)	0.0471** (0.0202)
Other surrounding forestland rights held by the same holder	1.19	0.3546 (0.6367)	0.0082 (0.6367)	0.3546 (0.4152)	0.0082 (0.0105)	0.3546 (0.6083)	0.0082 (0.0129)
Length of time holding the forestland right certificate	1.18	0.0798 (0.1344)	0.0018 (0.0031)	0.0798 (0.1379)	0.0018 (0.0032)	0.0798 (0.0859)	0.0018 (0.0023)
Constant		−6.4065*** (1.0575)		−6.4065*** (1.0707)		−6.4065*** (0.9020)	
Number of observations		831		831		831	
Prob > chi^2		0.0000		0.0000		0.0000	
Pseudo R^2		0.1533		0.1533		0.1533	

[a] Significance at given probability levels: *** = $p < 0.01$, ** = $p < 0.05$, * = $p < 0.1$.
[b] VIF = variance inflation factor.
[c] Robust standard errors in columns 1 and 2.
[d] Clustered standard errors in columns 3 to 6.
[e] NTFPs = nontimber forest products.

to the security for future earnings (van den Berg et al. 2018). Consequently, these holders are more likely to take a proactive financing decision before the next productive period. Furthermore, although the carbon sequestration capacity of natural forests is six times higher than that of sustainably managed agroforestry complexes and 40 times higher than that of planted forests, planted forests are significantly more effective than natural forests in their forestry production function (also the security for future earnings; Edwards and Balmford 2022). Thus, the relationship between forestland type and a holder's productive financing decision supports the finding that operation status in the previous cycle is a critical influential factor on the participant's decision, which again verifies the mechanism of the IAD model.

From the regression results presented in Table 2, it is evident that the coefficient between the forestland right area and a holder's productive financing decisions in the basic model is negative, which contradicts the conclusions of Xu et al. (2013). To further examine the effect of area on the productive financing decisions of forestland right holders, the model was adjusted by adding the square term of area to the basic model. In Table 3, the pseudo R^2 value shows a remarkable increase in the adjusted regression. Moreover, the effect of the square term of the area is negative and significant, while the effect of the area term is statistically significant and positive, suggesting that there may exist an inverted "U"-shape effect of area on forestland holders' proactive decision-making (Balli and Sørensen 2012). Based on the IAD model framework, a potential explanation is that medium-sized holders of forestland have a higher stability of predictable future profits from their operations and have lower financing costs in comparison to the largest forestland holders (i.e., expectations in Fig. 2), which facilitates their positive financing decisions.

Ultimately, to verify the robustness of the model, regional fixed effects (at the village level) were further controlled. The results in Table 3, column 2, reveal that the inclusion of regional fixed effects improved the model's pseudo R^2 but resulted in no remarkable changes in the significance of the explanatory variables, which supports the robustness of the adjusted model.

Adaptive management approaches to secure biodiversity, forest ecosystem services, and social externalities

As crucial complements to the logit regression, the results of our fieldwork also showed that after the establishment of the national park, WYMNPMC and the local forest department have responded to the nation's goal of building a national park system with advanced policies to secure biodiversity, ecosystem services, and social externalities. A set of experimental regulations was implemented to achieve a balance between the protection of ecosystems and forest community benefits, which can be summarized as an integrated management model with two key approaches.

The first approach of the integrated management model is to divide the area of WYMNP into two control subdivisions and four secondary functional zones for refined management. The two control subdivisions include (Fig. 3):

1. Core Protected Area. The core protected area includes the core area, buffer area, part of the experimental area

Table 3.—Relationship between area of the forestland rights and the forestland right holder's productive financing decisions.

Variables	[1] Adjusted model[a]		[2] Adjusted model—controlled fixed regional effect[a]	
	Coefficient (SE)	Marginal effect (SE)	Coefficient (SE)	Marginal effect (SE)
Organizational form of the holder	3.3837*** (0.9825)	0.0754*** (0.0242)	3.0449*** (1.1140)	0.0756*** (0.0286)
NTFPs as major products[b]	3.1168*** (0.8874)	0.0694*** (0.0225)	3.4478*** (1.1429)	0.0856*** (0.0300)
Area	0.2406** (0.0971)	0.0054** (0.0023)	0.4036*** (0.1181)	0.0100*** (0.0031)
Area^2	−0.0082** (0.0041)	−0.0002* (0.0001)	−0.0100** (0.0048)	−0.0002** (0.0001)
Planted forest	1.9948*** (0.7529)	0.0444** (0.0179)	2.3805*** (0.9096)	0.0591** (0.0235)
Other surrounding forestland rights held by the same holder	0.1529 (0.6071)	0.0034 (0.0135)	0.9223 (0.6504)	0.0229 (0.0165)
Length of time holding the forestland right certificate	0.0654 (0.1073)	0.0015 (0.0024)	−0.0478 (0.1271)	−0.0012 (0.0032)
Constant	−7.3734*** (1.2604)		−8.8208*** (1.7258)	
Fixed effect			Yes	
Number of observations	831		831	
Prob > chi^2	0.0000		0.0000	
Pseudo R^2	0.2043		0.3115	

[a] Significance at given probability levels: *** = $p < 0.01$, ** = $p < 0.05$, * = $p < 0.1$.
[b] NTFPs = nontimber forest products.

of Wuyi Mountain National Nature Reserve, and part of the upstream protection zone of Jiuqu Stream near the nature reserve, with an area of 505.76 km^2, accounting for 50.50 percent of the total WYMNP area (excluding the area in Jiangxi Province).

2. Regular Control Area. The regular control area covers other areas outside the core protection area of WYMNP, mainly including the rest of the experimental area of Wuyi Mountain National Nature Reserve, the Wuyi Mountain National Scenic Spot, and the rest of the upstream protection zone of Jiuqu Stream, the Wuyi Tianchi National Forest Park, and the state-owned Longhu forest farm in Shaowu City, with an area of 495.65 km^2, which accounts for 49.50 percent of the total area.

The four secondary functional zones include (Fig. 3):

i. Special Protected Zone. The special protected zone is defined as areas for the protection of natural ecosystems, biological processes, and the concentrated distribution of rare, endangered plants and animals, mainly including the core area and buffer area of Wuyi Mountain National Nature Reserve, with an area of 418.14 km^2, accounting for 41.75 percent of the WYMNP.

ii. Strictly Controlled Zone. The strictly controlled zone was defined for the protection of representative and important natural ecosystems, species, and relics, covering the experimental area of Wuyi Mountain National Nature Reserve and the first-level protection area of Wuyi Mountain National Scenic Spot, excluding the village production and living area. The area of the strictly controlled zone is 98.41 km^2, accounting for 9.83 percent of the total area.

iii. Ecological Restoration Zone. As a priority area for ecological restoration, the ecological restoration zone also serves as an area for natural ecology education and display of heritage values to the public. This zone mainly includes the second- and third-level protection areas of Wuyi Mountain National Scenic Spot; the upstream protection zone of Jiuqu Stream; the Wuyi Tianchi National Forest Park and surrounding public welfare forests; and the state-owned Longhu forest farm in Shaowu City, excluding production and living areas in villages, with an area of 364.53 km^2, accounting for 36.40 percent of the total area.

iv. Traditional Utilization Zone. The traditional utilization zone covers the areas where dwellers live and produce, which mainly include the production and living areas of villages in Wuyi Mountain National Nature Reserve, scenic spots, the upstream protection zone of Jiuqu Stream, the Wuyi Tianchi National Forest Park, and surrounding public welfare forests. Particularly, as a regenerative nontimber forest resource, scientific and reasonable utilization of Moso bamboo forests could be conducive to

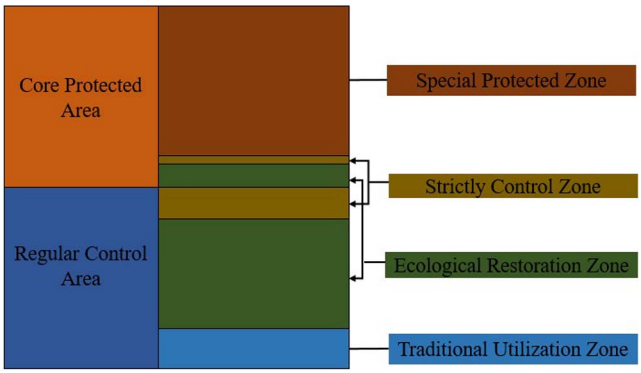

Figure 3.—Proportions of two control subdivisions and four secondary functional zones in Wuyi Mountain National Park.

taking advantage of their carbon sink values while simultaneously maintaining an important source of income for the local community (Hao et al. 2021). Therefore, the Moso bamboo forests in the experimental area of Wuyi Mountain National Nature Reserve, the upstream protection zone of Jiuqu Stream, the state-owned Longhu forest farm in Shaowu City, and the Wuyi Tianchi National Forest Park (data source: the 2016 Forest Resources Type II Survey) are also classified as traditional utilization areas (Fujian Provincial Department of Forestry 2021). The area of the traditional utilization zone totals 120.33 km^2, accounting for 12.02 percent of the national park.

Another approach of the integrated management model could be summarized as the redemption of some of the forestland rights by the government based on the willingness of the residents. To explore the effectiveness of the local forest department in balancing ecological protection and dwellers' well-being, data on the redemption of commercial forests within the scope of the WYMNP from 2020 to 2022 were collected and collated as a supplemental discussion to the regression analysis (Table 4; Fig. 4). As presented in Table 4 and Figure 4, the redeemed forestland rights in WYMNP between 2020 and 2022 include three types: rights held by villagers individually, rights held jointly by several villagers, and rights held by town/village collectives. In 2020, the interquartile ranges for the area of redeemed forestland rights were respectively: 1.33 to 8.40 for rights held by villagers individually, 0.60 to 4.47 for rights held jointly by several villagers, and 4.23 to 7.60 for rights held by town/village collectives. It is evident that the type of right held by villagers individually exhibited a greater individual variation in the area of redeemed forestland rights compared to the other types. As for the 2021, the type of right held by town/village collectives showed minimal variation in the area of the forestland rights during this year. Finally, all three types demonstrated significant individual variation in the area of redeemed forestland rights for the year 2022. Regarding the number of extreme outliers, there were five outliers in the data set: 22.53, 13.53, 15.40, 71.13, and 85.87. These outliers occurred exclusively in the type held by villagers individually and held jointly by several villagers from 2020 to 2021, indicating that a few villagers had engaged in substantial redemption of the forestland rights.

Table 4.—Forestland rights redeemed in Wuyi Mountain National Park (2020 to 2022).

Year	2020					2021					2022				
Redemption area (hectares)	Obs.	Mean	SD	Min.	Max.	Obs.	Mean	SD	Min.	Max.	Obs.	Mean	SD	Min.	Max.
Held by villagers individually	7	5.8371	7.8857	0.1300	22.5300	18	10.9806	16.2889	0.3300	71.7300	3	17.2233	14.0099	1.6000	28.6700
Held jointly by several villagers	11	3.9327	5.4002	0.1300	15.4000	11	21.4718	25.5410	0.9300	85.8700	2	16.1000	21.5384	0.8700	31.3300
Held by town/village collectives	4	5.9175	2.3369	3.8000	9.1300	2	1.3000	0.9899	0.6000	2.0000	7	15.9914	23.5488	1.0700	62.6000

Discussion

From the regression analysis, it can be concluded that NTFP production (flexibility and part-time) could motivate productive financing decisions by forestland rights holders to maintain or expand their production. According to research results of Shen et al. (2021), residents who depend heavily on the forest may face challenges after the establishment of the national park system in China, while the NTFP industry may help them pursue alternative livelihoods. Also, small-scale production means that the forestland right holders within the selected scope of the national parks have more incentives to make productive financing decisions to maintain or expand their production. The potential reason for this result might be that for small-scale, part-time forest farmers,

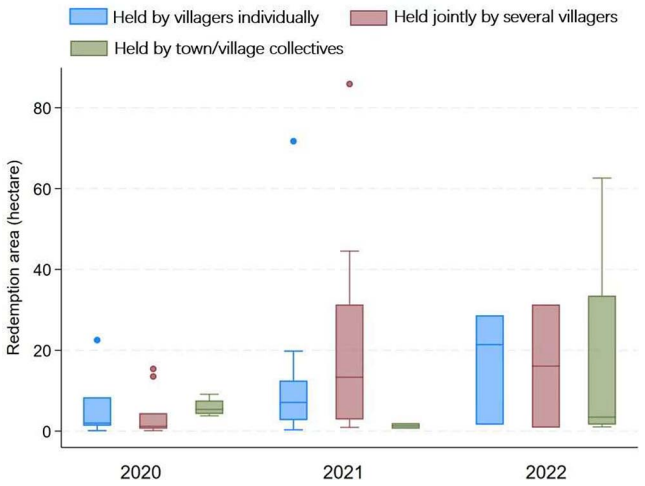

Figure 4.—Statistical characteristics of forestland rights redeemed by the local forest department in Wuyi Mountain National Park between 2020 and 2022.

microfinance decisions pose no excessive financial risks and give a flexible chance to those holders, while for specialized forestry enterprises or other larger holders, expanded productive financing decisions could be related to economies of scale (Zhou et al. 2022).

Combined with the adaptive policy analysis results, the characteristics of the community dwellers have been noticed by the WYMNPMC and the local forest department and have also been considered in the adaptive management strategy, with diverse objectives. On one hand, the subdivision management approach implies that the establishment of WYMNP requires limited dwellers' use of core areas with extensive ecological value, and on the other hand, considering the dwellers' internal motivation, the government has designated the regular control area, which allows local villagers to conduct appropriate forestry production activities under monitoring, where the data set was selected in this study. Within national park areas, exact restrictions may have the reverse conservation effect (Linkie et al. 2008), whereas establishing a system of trust within the community may lead to better protection of its ecological diversity (Lunstrum 2014, Rao et al. 2019). Alternatively, the purpose of the redemption approach is to address the livelihoods of some holders whose forestland rights are located in core protected areas without the permissions to engage in forest production after the establishment of the WYMNP. By integrating these two approaches, the management departments expect to achieve an optimization that balances ecological protection with the protection of community dwellers' well-being in the future. Partial redemptions based on refined zones provide a further adaptive enhancement to the sole use of monetary subsidies.

Analysis results revealed that a systematic management mechanism is required, involving multidimensional networks of community dwellers, natural ecosystems, management departments, and even forest products traders. Therefore, the advanced management mechanism in the future should not focus only on the optimization of a partial point, but assess the systematic benefits holistically, so as to achieve growth in the management efficiency (Xu et al. 2020). Such a holistic optimization should be based on real-time evaluation of the system network: including feedback from community dwellers, monitoring of ecological conditions (including forest fire risk control), and evaluation of management efficiency (Pandeya et al. 2016, Hlásny et al. 2021, Prichard et al. 2021).

In terms of the externalities initiated by the protection of ecosystems, the establishment of national parks has significant positive effects in China and even globally; however, partially, the conflict between ecological protection and the benefits to management rights holders may bring about localized imbalances, and such imbalances may have an irreversible impact on the local community dwellers, which may cause intergenerational effects (Ehara et al. 2023). Accordingly, while practicing the national government's policy of ecological protection, local governments are required to appropriately retain forest production activities that may be the only source of household livelihoods.

At this stage, the development of agroforestry faces two major challenges: One is to ensure that people's growing consumption needs can be met; nonetheless, unsustainable farming and forestry, urban sprawl, and pollution are the top pressures to blame for the drastic decline in biodiversity, threatening the survival of thousands of animal species and habitats (Khosravi et al. 2018, Kubacka et al. 2022, Clemente et al. 2023). The construction of national parks reduces the productivity of local agroforestry and poses the challenges of unstable forest product supply chains in local markets as well as increases in cleaner production standards (Tang et al. 2020). In this case, it is emphasized that the production of NTFPs in the regular control area enables the livelihoods of the dwellers to be sustained while simultaneously contributing to the stabilization of the local supply chains of NTFPs.

The mechanism of actors in the national park system under the integrated management model is summarized in Figure 5, which illustrates a potential mechanism for achieving a balance between the ecological conservation and forest community benefits. This multidimensional mechanism could provide much-needed stability in long-term environmental management and reduce the impact of policy interventions by enhancing holistic consideration of the actors' motivation.

According to previous regression results, forestland right holders organized as enterprises are more strongly motivated to operate forestland rights. Nevertheless, this type of holder has not yet been the focus of the management strategy of the government departments. Indeed, this type of holder is still a form of organization operated by dwellers. Another concern in the next stage of promoting the balanced mechanism has become: How to take advantage of enterprise holders while partially restricting their production? In the fieldwork, it can be observed that enterprises, in addition to their production function, also take on the significant role of intermediate traders. Hence, after the establishment of the national park, the realization of this function of enterprises could be a way to resolve the limitations on the expansion of their production scale. Meanwhile, this function may also provide a more effective service for the construction of the local forest products supply chain (Fig. 5).

Conclusions

This study used WYMNP in China as a case study to provide an expression of the intended balance between ecological protection and preservation of dwellers' well-being from forestland. By collecting forestland rights information in the upstream protection zone of the water source within

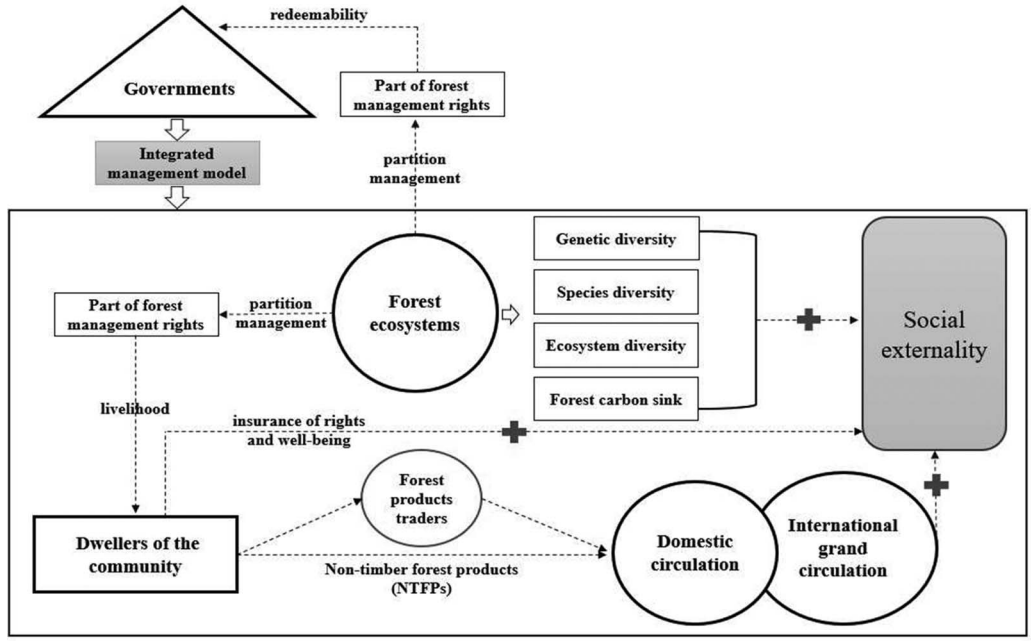

Figure 5.—The mechanism of actors in the ecological protection system under the integrated management model.

the WYMNP, we analyzed factors influencing the motivation of forestland holders before the establishment of the national park. Additionally, the government's integrated management model, which accelerates the optimization of social externalities after the establishment of the national park, was explored and summarized. The results reveal that: prior to the establishment of the national park, among the private forestland right holders, those producing NTFPs had more incentives to make proactive financing decisions to expand their production; then, prior to the establishment of the national park, enterprise holders were more motivated to make proactive productive financing decisions than individual holders; finally, after the establishment of the national park, the local government applied an integrated management model including redeeming part of the forestland rights and classifying the extent to which the forest production could be performed according to the level of importance of ecological protection to cope with potential conflicts.

In such a typical case, the government sought to balance the realization of the welfare of multidimensional actors and leveraging of the externalities of national park establishment. Eventually, the concept of protecting the integrity of forest ecosystems could play a certain positive role in achieving the goal of a holistic and sustainable development of society. Despite this, considering the livelihood security of the local dwellers and the potential irreversible and intergenerational negative impacts imposed on this group, the establishment of national forest parks must be accompanied by a sustainable income program for the forest community dwellers. Therefore, reassessment of the benefits of national park areas as forestlands of dwellers should be encouraged while establishing effective adaptive transition mechanisms. In our study, the management model provides a compromise solution by offering long-term lease payments in core ecological conservation areas to allow income compensation for community dwellers who have limited access to forestland, while in regular control areas, the opportunity to flexibly operate the NTFP industry on forestland is appropriately provided with regular monitoring of production behaviors.

For other countries, especially developing countries, the widespread poverty in rural areas makes ecological conservation a challenge of long-term planning. Rapid urbanization has led to a steady migration of capital, labor, and other vital economic factors from the villages to the cities, and urban-based industrialization has resulted in significant environmental pollution, which intensifies the difficulty of protecting the forest ecosystems. However, the trends of aging and poverty of households in vast rural areas still plague some of the primary forest communities. Consequently, if the implementation of a completely restrictive protection policy cuts off the only source of income for the local old, weak, and young dwellers' livelihoods, such an ecological policy would not realize its desired social externality effects (Geldmann et al. 2015). Facing these two conflicting objectives, governmental planning for holistic optimization and sustainability of rural area development should be embedded in the mechanism of establishing national parks.

The findings of this study still have some limitations. Although this study elaborates a framework for the protection of households' rights during the construction of national parks from the perspective of WYMNP in Southeast China, this framework was constructed on the general status of China's present economic development and the characteristics of local industries in China's rural areas. Specifically, China's rural forest economic development has formed a specific paradigm based on the nation's traditional rural culture and practices of development policies. As a result, the applicability of this framework to other countries without an established industrial base and dynamic trade environment, needs to be further examined.

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