

# Influence of collective forest tenure reform on rural households' forestry management investment: the case from seven provinces in China

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Influence of  
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reform

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## Abstract

**Purpose** – The main objectives of collective forest tenure reform in China are to stimulate rural households to invest in forestry management, protect the ecosystem and improve their livelihood. By constructing the unbalanced panel data of household investment, this study discusses the dynamic changes and influencing factors of household investment, which will lay a foundation for further research and provide a reference for decision-making.

**Design/methodology/approach** – Based on 3,500 samples from rural households in the provinces of Fujian, Hunan, Yunnan, Shaanxi, Jiangxi, Gansu, and Liaoning collected during field investigations from 2010 to 2015, this study conducts an empirical analysis of the household investment in forestry management and its factors with nonbalanced panels.

**Findings** – According to the analysis, the average investment in forestry management per household from 2010 to 2015 fluctuates greatly; the age of the householder, increased forestry area, subsidies, joining professional cooperatives, and forest tenure mortgage show positive effects on achieving the objectives.

**Originality/value** – The discussions are drawn from the study that supporting policies such as the forest tenure transfer system, professional cooperatives, financial services and subsidies should be further improved to sustain a positive in the forestry industry.

**Keywords** Collective forest tenure, Reforms, Rural household, Forestry investment

**Paper type** Research paper

## 1. Introduction

The collective forest is an important part of China's forest resources and collective economy with Chinese characteristics. The collective forestry rights system refers to the rights of possession, use, income and disposal of forests, trees and forest land enjoyed by economic organizations or units under collective ownership.

The collective forest is an important part of the collective economy with Chinese characteristics. According to the results of the ninth national forest resources inventory, the area of collective forest land is 134 million  $\text{hm}^2$ , accounting for 61.34% of the total area of forest land in China. The collective forestry rights system refers to the right of possession, use, income and disposal of forests, trees and woodlands enjoyed by the collective ownership

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economic organizations or units. In the past 40 years, China has carried out two rounds of collective forest rights system reform. The first round began during the period of reform and opening up and established the forestry development policy of “stabilizing mountain and forest rights, designating self-reserved mountains, and determining the responsibility system for forestry production”, which achieved certain results. During this period, family contract management was still dominant in collective forest management.

Since then, in order to solve the fundamental problems of unclear property rights, nonimplementation of management subjects, inflexible management mechanisms and unreasonable distribution of benefits in collective forest areas, China started a new round of collective forest rights system reform in 2003, and achieved remarkable results, establishing the status of farmers as the main body of collective forest management and safeguarding their rights and interests.

Compared with other large countries, China’s demand for the growth of forest resources is more urgent (Richardson, 1990). While, 43% of collective forest land has been classified as ecological public welfare forests, which is of great significance in maintaining national ecological security. The collective forest is not only an important natural resource in the national ecological construction but also plays an indispensable role in the supply of forest products. The commodity timber output, economic forest output value and forestry output value of collective forest areas exceed 90% of the corresponding national indicators. At the same time, the collective forest is an important means of production to help farmers get rid of poverty and become rich (Wen *et al.*, 2022). Collective forest management has an important contribution to increasing farmers’ income and improving farmers’ livelihoods, especially for poor farmers (Liu, 2020). Improving the management level of collective forests is of great significance for maintaining national ecological security, wood supply security, alleviating poverty and promoting the sustainable development of the rural economy.

In recent years, China’s forest resources have increased under the action of relevant national policies. However, at present, the demand for the growth of forest resources, especially the improvement of the quality of forest resources, is still urgent (Yang *et al.*, 2021). As a major component of China’s forest resources, the management level of collective forests is limited by the risk-taking capacity of farmers in forest areas and the input of forestry production factors, and there is still much room for improvement (Shi *et al.*, 2017). Collective forest areas still face problems such as low quality of forest resources and insufficient ecological functions. There are still large tracts of barren mountains and wastelands suitable for forestry that has not been put into production. The contribution rate of forestry to regional economic development and farmers’ income is low, which affects the enthusiasm of farmers for forestry production and management and the sustainable development of forestry. With the development of the social economy and the improvement of people’s living standards, the forestry development of collective forest areas is difficult to meet the comprehensive needs of society for the ecological, economic and social benefits of forest resources.

In order to solve the problems mentioned above, China has carried out the reform of the collective forest right system with the main goal of determining the ownership of forest rights to households. Since the start of a new round of collective forest right system reform in 2003, farmers have become the most basic and important forestry management subjects in collective forest areas, and their management behavior will affect the protection and utilization of forestry resources, the livelihood and employment of farmers in forest areas, etc. (Liu and Can, 2016). Forestry capital investment is the first starting force of forestry economic development. Farmers’ forestry operation and investment behavior will directly affect the management level of collective forests, forestry output level and farmers’ income and have an important impact on national forestry development, building a beautiful China and promoting the construction of ecological civilization (Yang *et al.*, 2018). Therefore, it is of great significance to study whether the supporting policies related to the reform of the collective

forest right system play their due role and to what extent they can stimulate farmers to increase investment in forestry management for improving farmers' enthusiasm for production and management, promoting the implementation and improvement of relevant policies, and bringing ecological protection into people's lives.

In the previous studies, the key areas in which researchers pay much attention to farmers' forestry operation and investment behavior are as follows: one is the efficiency evaluation of forestry input and output (Yang *et al.*, 2021; Tian and Xu, 2012), the other is the influencing factors of farmers' forestry operation and investment. Scholars generally believe that farmers' risk preference (Chen and Duan, 2019), the degree of forest land fragmentation (Kong and Liao, 2012), property rights security (Liu *et al.*, 2019) The proportion of forestry income in household income, nonagricultural employment opportunities (Zhang *et al.*, 2017) and other factors will significantly affect the level of farmers' forestry operation investment. According to the research of Beach and other scholars, among the four common factors affecting the forestry management of forest farms, including market factors, land resource conditions, characteristics of forest farm owners and policy factors, the impact of policy factors is the most significant, but there are few policy-related targeted studies (2001, 2005).

The impact of the reform on farmers' forestry management investment is mainly through improving the security and stability of the land tenure system (Wen *et al.*, 2022), the adjustment of the tax system (Cao *et al.*, 2014) and increasing the area of family forest land (Yu *et al.*, 2017) to promote farmers to increase forestry operation investment. At the same time, some scholars have also studied the impact of forest land characteristics such as the degree of forest land fragmentation, and personal characteristics such as age and education level on household investment willingness, but their conclusions have not been widely agreed (Kang *et al.*, 2012).

After China began to implement the collective forest tenure reform, scholars studied the impact of forest reform and related supporting policies on farmers' investment behavior. Mainly from the availability of funds (Xu *et al.*, 2021), the cutting quota system (Liu, 2011), forestry technical services (Yang and Song, 2015), forestry cooperation organization (Zhao and Li, 2013), forestry subsidies (Hu *et al.*, 2019) and other aspects to analyze the impact of policy conditions on Farmers' forestry operation and investment behavior, but it is limited by the research area, realization span and other aspects, The empirical results are not completely consistent.

Researchers have carried out a lot of rich studies on the influence of the collective forest tenure reform on farmers' forestry investment, but there are still some deficiencies: Firstly, most of the effects of policies have long-term lag effects. However, most of the studies use cross-sectional data of a certain year, which cannot fully reflect the long-term effects of reform and policy stimulus, and ignore the changes at the time series level; secondly, at present, most of the sample data of the study come from a province or even a city. The sample size is not large enough to fully demonstrate the relationship between reform and household forestry investment. Also, the empirical results are still not consistent.

For these reasons, this paper uses data collected during a national program that keeps tracking the reform, which contains 3,500 household samples from the provinces of Fujian, Hunan, Yunnan, Shaanxi, Jiangxi, Gansu and Liaoning from the year 2010–2015. We construct unbalanced panel data of household investment and analyze the dynamic changes and the factors. This study will hopefully lay a foundation for further study in the field and provide references for policymaking.

## 2. Theoretical basis and research hypothesis

### 2.1 Theoretical basis

The forestry production process is long-term and complex, which will be affected by the natural environment, human factors, policy factors and so on, leading to the complexity of

forestry production and investment behavior of forestry farmers. Western economics proposes that as an “economic man”, the purpose of forest farmers’ forestry management activities is to maximize profits during the forestry contract period without affecting ecological benefits (Lin, 1988).

Assuming that  $R$  is the income of farmers through the management of forest land, and  $C$  is the cost of farmers’ forestry management investment, the profit  $S$  obtained from the contracted forest land can be given by:

$$S = R - C \quad (1)$$

To further measure maximum profit and simplify analysis, we take the production process of forest land used for afforestation for the first time in year 0 as a representative. These forest lands will be reforested at the end of each rotation. The production function for a given hectare is  $Q = Q(t, E)$ , where  $Q$  is quantity of products produced, which is a function of time  $t$ , and the level of initial period silvicultural effort,  $E$ . And we convert all income in the forest land into homogeneous units, and  $P$  represents the unit price of homogeneous income. Therefore, households’ forestry income  $R$  can be expressed by:

$$R = PQ(t, E) \quad (2)$$

Some silvicultural efforts, such as site preparation, planting and fertilization, are applied in the initial period. Others, such as second fertilization, herbaceous weed control and prescribed burning, are applied in later years. To simplify the analysis, we convert all these efforts into homogeneous investment units and convert them to the beginning of the first period according to the appropriate discount rate to obtain the total investment in forestry management  $C$ :

$$C = wE \quad (3)$$

If the discount factor with discount rate  $r$  is expressed by  $e^{-rt}$ , the present value of expected profit  $V_s$  can be given by:

$$V_s = \frac{PQ(t, E)e^{-rt} - wE}{1 - e^{-rt}} \quad (4)$$

Before the critical point of land productivity, with the increase of management input, the output level of forest land can be improved. And the net income level of farmers can be increased, thus stimulating farmers to expand forestry production and management under certain other conditions, until the net income reaches the maximum when the marginal equilibrium input and output level is maintained. It can be seen that the profit and forestry management input of farmers during the contract period will be directly affected by the quantity and price of products, interest rate and the quantity and price of inputs.

In actual production, farmers’ forestry income includes income from forest product output, forestry subsidies and forest property mortgage loans. And a plot of forest land may produce a variety of forest products, whose types and quantities will be affected by the characteristics of the forest land, while farmers’ access to subsidies and loans is affected by policies related to collective forest tenure reform, especially those directly related to income.

The property right of forest resources is the core of forestry policy, and the strength of property right determines the extent to which farmers can obtain benefits from it. The more complete the property right is, the higher the value of forest resources will be. According to Coase theorem, under a long-term, stable, safe and reliable property right system, the transaction cost is low and the lower transaction cost is the basis for farmers to invest in forestry management (Zhang, 2001). In other words, the security and stability of forest

resource property rights is one of the important factors affecting farmers' forestry operational investment.

In addition, according to the theory of farmers' planned behavior, farmers' investment behavior in forestry management will be affected by farmers' past forestry income and farmers' expectations for future forestry income, while farmers' individual characteristics and family resource endowment will affect farmers' investment behavior decisions (Wan *et al.*, 2017). To sum up, households' forestry operation and investment will be comprehensively affected by forest land characteristics, forestry policies, property rights security, past forestry income and individual characteristics.

## 2.2 Research hypothesis

Forestry has the attributes of noncompetitive and nonexclusive public goods. The scarcity of forestry resources, the practical needs for clear rights and responsibilities, and the interest drive of forest farmers' income increase are the main drivers of forest property system reform. Whether the forestry property right is clear and whether the property right system is perfect is not only related to the effective protection and rational utilization of forest resources but also related to the allocation efficiency of forestry production factors and the healthy development of forestry. Compared with other production departments such as agriculture, the income of forestry practitioners is generally low. Imposing various regulations and constraints on the forestry production process to maintain ecological security will further deepen the burden on forestry production subjects, resulting in low production enthusiasm of forestry practitioners, and causing hidden unemployment and long-term poverty. Therefore, clarifying ownership, liberalizing management rights, implementing disposal rights, ensuring income rights and reshaping forestry micro business entities are essential to enhance the enthusiasm of production personnel and promote the improvement of forestry production efficiency. The policy changes under the reform, especially those directly related to profits, such as forestry financial subsidies, the difficulty of obtaining cutting indicators, whether there is a mortgage payment of forest rights and whether to join forestry cooperatives play a decisive role in the level of forestry management.

As one of the policy incentives, forestry financial subsidies will change farmers' expectations of risks, credit constraints and household income and then lead to differences in farmers' input behavior of production factors. By reducing the cost of forestry production, forestry subsidies make up for the lack of farmers' capital endowment of forestry production and improve farmers' forestry expected income and risk tolerance, so as to encourage farmers to increase forestry shadow investment and promote the sustainable management of forest resources. The opinions of the CPC (Communist Party of China) Central Committee and the State Council on comprehensively promoting the reform of the collective forest right system (hereinafter referred to as the "opinions") pointed out that to improve the forest cutting management mechanism, the cutting quota system can not only scientifically arrange the protection and utilization of forest resources, but also increase the concerns and risks of forest farmers' investment. Farmers who are easy to obtain cutting indicators can ensure their forestry income, have a strong sense of security in forestry production and management, and are more willing to invest in management; Farmers who are difficult to apply for cutting indicators have low enthusiasm for forestry production, and their forestry investment behavior will also be greatly negatively affected. The long forestry production cycle, large initial investment and lack of funds are one of the important factors restricting forestry development. To solve the above problems, the "opinions" pointed out that we should promote the reform of forestry investment and financing, and all regions have also issued relevant policies to steadily promote forest property mortgage loans. To obtain more funds by mortgaging the forest land, the farmers who have applied for the forest right mortgage loan are more willing to produce and operate the forestry and have higher expected income

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for forestry, so they are more inclined to invest more funds in forestry production. Farmers' participation in the forestry cooperation organization can enhance the ability to develop forestry economies of scale and will increase farmers' enthusiasm for forestry production and their opportunities for forestry investment. Based on this, this paper makes the following research assumptions about the impact of collective forest right system reform on farmers' forestry operational investment:

*H1.* Collective forest tenure reform-related policies have a positive incentive effect on farmers' forestry operational investment.

The property right is the cornerstone of the system. The opinions of the CPC Central Committee and the State Council on comprehensively promoting the reform of the collective forest right system pointed out that the main tasks of the collective forest reform are to clarify property rights, delimit and issue certificates and fire prevention forest rights. The forestry production cycle is long, and farmers' investment in forest land largely depends on their future income expectations. The improvement of the security of forest land property rights will make farmers believe that they can own forest land for a long time and stably, and have higher expectations for the benefits brought by forest land in the future. Therefore, they will manage and protect forest land more actively, and the forestry operational investment will increase; at the same time, clarifying property rights will reduce transaction costs by expanding transaction opportunities and the ability to use transaction proceeds. The security and stability of forest land tenure increase the possibility of forest land transaction and greatly improve the transaction price of forest land, that is, farmers' income from managing and protecting forest land is higher, which will improve farmers' enthusiasm for production and management to a certain extent. Clear property rights can ensure that the decision-making of production factors input is almost free from external influence. The transaction costs incurred in the process of executing the contract are relatively small. Low transaction costs correspond to low production costs. Farmers have more room to benefit from forestry management, and forest land production investment is more active. Therefore, the following research assumptions are obtained:

*H2.* The security and stability of forest land tenure have a positive incentive effect on farmers' forestry operational investment.

As an economic decision, the investment behavior of farmers' forestry operational investment is not only affected by relevant policies but also affected by farmers' previous forestry operations, forest land characteristics as well as farmers' personal and family characteristics.

Relevant research shows that farmers' past forestry operation income will affect farmers' forestry investment behavior by affecting farmers' expectations of future income. The higher the income of farmers in the past forestry operation the higher the farmers' expectation of future income and production enthusiasm. In the subsequent forestry operation, farmers tend to invest more funds to obtain higher income. Therefore, this paper believes that farmers with higher income in previous forestry operations have a stronger willingness to invest in forestry, that is:

*H3.* The family's past forestry operation income has a positive impact on its forestry operation investment.

The characteristics of forest land include the area of forest land, the number of plots, the area of newly increased forest land, the proportion of commercial forests, special forests and bamboo forests. According to the above theoretical analysis, the characteristics of forest land will affect the forestry operation income of farmers by affecting the output and price of wood and other products, and then affect their forestry operation investment. Therefore, this paper assumes that the characteristics of forest land management in India will help affect farmers' forestry operational investment, namely:

H4. Forest land management characteristics have a significant impact on farmers' forestry operational investment.

Theoretical and empirical studies on farmers' investment behavior have found that due to the differences in farmers' characteristics and family resource endowments, farmers' forestry investment behavior decisions also have obvious individual heterogeneity. The individual and family characteristics of farmers' families also affect family decision-making. Accordingly, this paper assumes that the individual characteristics of farmers will also affect their forestry operational investment.

H5. Households' forestry operational investment has heterogeneity related to individual characteristics.

### 3. Methods and data

#### 3.1 Data recourses

Our data are received from a program that keeps monitoring the collective forest tenure reform since 2010. The program was led by the State Administration of Forestry Economic Development Research Center and Grassland and carried out together with Beijing Forestry University and North West Agriculture and Forestry University. By random stratified sampling and investigation regularly, 3,500 samples of rural households in 350 sampled villages, 70 sampled counties and 7 sampled provinces were selected for annual questionnaire survey from 2010 to 2015. After deducting households of death, migration and other abnormal conditions, the number of valid household data was 20,067 over six years, forming unbalanced panel data.

#### 3.2 Descriptive statistics

3.2.1 Annual average household forestry investment changes. As shown in Figure 1, taking 2010 as the base period, the forest management investment level of sample households from 2011 to 2015 is consistent with the GDP (gross domestic product) price deflator. The investment continued to fluctuate during the survey period. From 2010 to 2012, the investment continued to increase and decreased slightly after 2012. According to the interview with farmers, the forest land allocated to households in 2010 was mainly woodland. In the early stage, tending, cutting and other business activities were carried out with high frequency and input intensity. Therefore, from 2010 to 2012, farmers' forestry operational investment showed an upward trend and was relatively high; however, due to the discontinuity of forestry production, the intensity of farmers' tending and cutting has decreased since 2012. The main business behavior is the management and protection of cash crops. Its cost is relatively low and fluctuates with the market. Therefore, the fluctuation of farmers' forestry operational input has decreased since 2012.

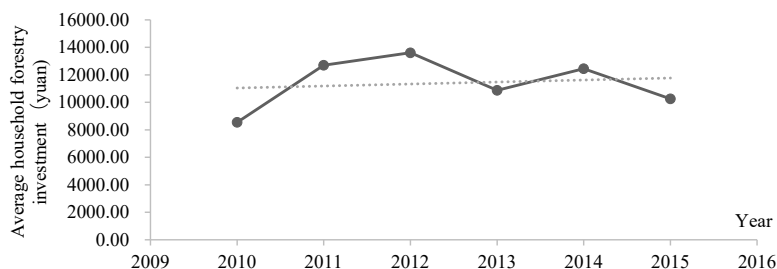
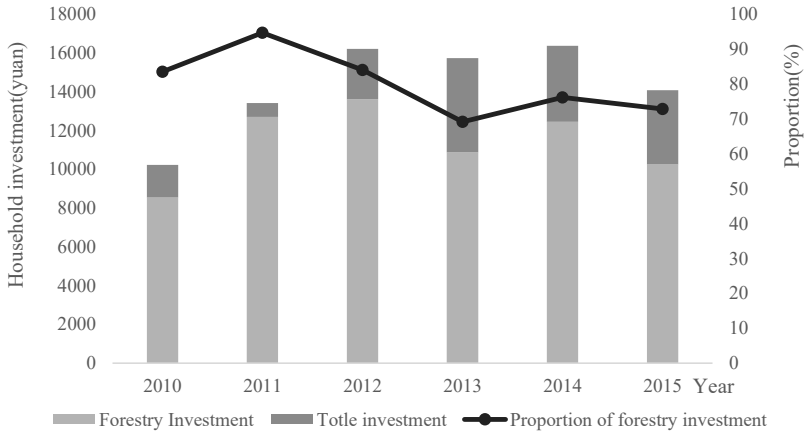


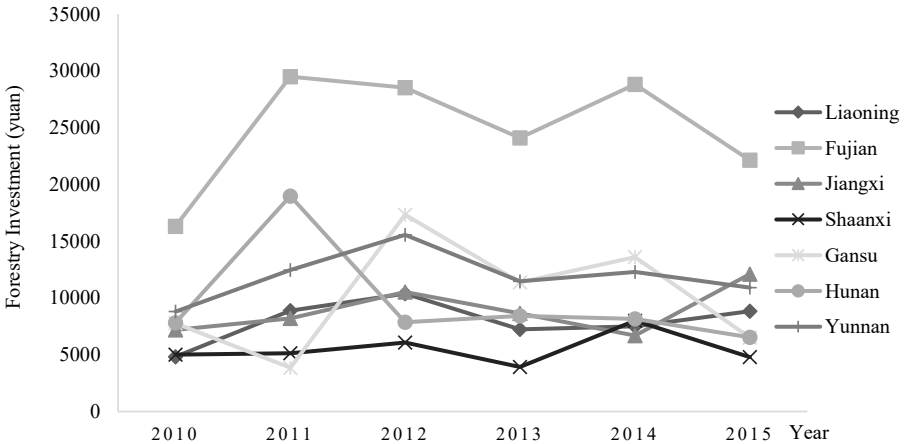
Figure 1. Average household forestry investment change annually

3.2.2 *The proportion of forestry investment in total production investment.* For example, from 2010 to 2015, the forestry investment of the sample households accounted for more than 60% of the total household production investment (see Figure 2), which was the highest in 2011, reaching 94.67%, and the lowest in 2013, also close to 70%. In the study area, forestry investment is an important part of household investment, and the total amount of household investment is relatively stable, so the proportion of forestry investment is roughly the same as the change trend of forestry investment level.

3.2.3 *Provincial farmers' forestry investment.* As shown in Figure 3, during the study period, there was a large gap in the level of household forestry investment in different provinces. The forestry investment in Fujian, Hunan, Gansu and Yunnan fluctuates greatly, while that in Shaanxi, Jiangxi and Liaoning is relatively stable. At the same time, the forestry investment level of Fujian Province is significantly higher than that of other research provinces. The survey data shows that the transfer of forest rights in Fujian Province is more active than that in other provinces. In 2015, the transferred forest land area of sample farmers in Fujian Province accounted for 32.23% of the total sample farmers' forest land management area, which led to the sample farmers' forestry investment level significantly higher than that in other provinces to some extent. In addition, the forest composition and historical



**Figure 2.**  
Proportion of sample family forestry investment



**Figure 3.**  
Annual household forestry investment on average in seven provinces



characteristics of forestry management among provinces will also affect the forestry investment level of farmers. Fujian Province is rich in forest resources and has a large area of forest land. The forestry industry plays an important role in social and economic development. In addition, the bamboo forest accounts for a high proportion, and the management intensity and investment are high, so the income is high, which also stimulates farmers' forestry investment to a certain extent.

### 3.3 Research variables

Based on previous studies, theoretical analysis and data collection, this paper selects 16 variables in four categories as explanatory variables to measure the impact of the reform. As shown in Table 1, it includes family characteristic variables (age of the head of household, education level of the head of household, family members are village cadres and labor force), forest land management characteristic variables (forest income, forest land area, new forest land area, number of forest land plots, the proportion of commercial forests, proportion of timber forests, special forests and bamboo forests, whether to plant other commercial plants) Security of property rights (number of disputed forest land plots) and supporting policies related to forest reform (difficulty in obtaining logging quotas, forestry subsidies, whether to participate in forest right mortgage loans and whether to join forestry cooperatives). Considering the previous forestry operation, including the income from forest land operation in the early stage and the number of forestry subsidies obtained will affect the expectation of farmers on forestry operation income, and then affect the level of forestry investment in the later stage, this paper selects the forestry subsidies and forestry income that lag one period when selecting explanatory variables. (See Table 2).

### 3.4 Logistic regression model

This study obtained unbalanced panel data in different years and used logistic regression to deal with the unbalanced data to analyze the factors affecting family forestry management investment. The baseline unbalanced panel data set is as follows:

$$y_{it} = a_i + X'_{it}\beta + \varepsilon_{it}, i = 1, \dots, N; t = 1, \dots, 6 \quad (5)$$

where  $i$  and  $t$  represent the sample family number and year, respectively, and  $y_{it}$  refers to farmers' forestry operational investment from 2010 to 2015,  $\beta$  represents explanatory variables  $(16-1) \times 1$ ,  $X'_{it}$  represents the observed value of a variable in the  $i$ th family in year  $t$ ,  $a_i$  represents a potential effect that cannot be observed in individual  $i$ ,  $\varepsilon_{it}$  denotes a random disturbance term.

To determine whether to choose the fixed effect model or the random effect model, the nonequilibrium panel data set was tested by the Hausman test. When the unobservable individual effect  $a_i$  is related to explanatory variables, a fixed effect model should be

Province/Year	2010	2011	2012	2013	2014	2015	Total
Liaoning	483	479	502	497	498	500	2,959
Fujian	490	473	489	500	499	496	2,947
Jiangxi	491	498	498	500	500	502	2,989
Shaanxi	500	500	500	500	500	500	3,000
Gansu	100	500	500	500	500	500	2,600
Hunan	150	443	490	499	500	500	2,582
Yunnan	499	490	500	499	500	501	2,989
Total	2,713	3,383	3,480	3,495	3,497	3,499	20,067

**Table 1.**  
Sample source

First level indicators	Second level indicators	Definition (unit)	Average	Standard deviation
Household characteristics	Age of householder	Year old	51.96	11.79
	Education level of the householder	Primary school and below = 1; Junior high school = 2; Technical secondary school or high school = 3; College or above = 4	1.76	0.76
Forestland management characteristics	Family members being village cadre	Yes = 1; No = 0	0.22	0.41
	Number of the labor force	Person	2.58	1.33
	Forestry income(lagging)	Yuan	-288.77	49,377.3
	Forestry area	Mu	85.65	214.38
	Increased forestry area	Mu	5.33	97.13
	Number of forestland plots	Plot	3.46	2.56
	Commercial forest to total forestry area ratio	Commercial forest area/Total forest land area	0.55	0.46
	Forest for timber production, special products plus bamboo forest to total forestry area ratio	Total area of timber forest, special forest and bamboo forest/total forest land area	0.55	0.49
	Whether cultivating other commercial plants	Yes = 1; No = 0	0.27	0.44
	Completeness and stability of land tenure	Number of disputed forestland plots	Plot	0.01
Supporting policies in the reform	The difficulty of getting lumbering quota	Did not apply = 2; have difficulty = 1; No difficulty = 2	0.07	0.26
	Forestry subsidies (lagging)	Yuan	170.00	4020.75
	Whether having forest tenure mortgages to pay	Yes = 1; No = 0	0.02	0.15
	Whether joining forestry cooperatives	Yes = 1; No = 0	0.08	0.27

**Table 2.**  
Information on variable indicators

established, otherwise, a random effect model should be selected. The following Hausman test was performed under the null hypothesis and the alternative hypothesis:

$$H_0 : E(\varepsilon_{it}\alpha_i) = 0 \quad H_1 : E(\varepsilon_{it}\alpha_i) \neq 0$$

The statistical value of the Hausman test is:

$$H = (\hat{\delta}RE - \hat{\delta}FE)' [\text{Var}(\hat{\delta}FE) - \text{Var}(\hat{\delta}RE)]^{-1} (\hat{\delta}RE - \hat{\delta}FE) \rightarrow \chi^2_M \quad (6)$$

The value of H conforms to the asymptotic chi-square distribution, where M = k – non-time variable – time variable.

The calculated H value is 287.3. The Hausman test rejected the original hypothesis, so the fixed effect model was selected in this study.

## 4. Results and discussion

### 4.1 Regression results

This paper uses stata16.0 to conduct logistic regression on the nonequilibrium panel data with a span of 6 years and a total of 20,067 valid data. The model estimation results are shown in Table 3.

Variable type	Variable	Coefficient and significance	Standard deviation
Household characteristics	Age of householder	56.15**	(26.10)
	Education level of the householder	134.60	(412.04)
	Family members being village cadre	-367.11	(703.32)
	Number of the labor force	483.10**	(223.26)
Forestland management characteristics	Forestry income(lagging)	0.09***	(0.00)
	Forestry area	9.08**	(3.53)
	Increased forestry area	246.83	(326.21)
	Number of forestland plots	40.33***	(5.06)
	Commercial forest to total forestry area ratio	286.10	(1143.69)
	Forest for timber production, special products plus bamboo forest to total forestry area ratio	308.51	(468.97)
	Whether cultivating other commercial plants	1512.95**	(606.96)
	Number of disputed forestland plots	-2957.38	(3136.55)
Completeness and stability of land tenure Supporting policies in the reform	The difficulty of getting lumbering quota	-1154.50	(1062.22)
	Forestry subsidies (lagging)	0.61***	(0.05)
	Whether having a forest tenure mortgage to pay	4122.57**	(1741.79)
	Whether joining forestry cooperatives	4359.80***	(1110.37)
	Constant	256.35	(2181.64)
	$R^2$	0.08	

**Note(s):** “\*, \*\*, \*\*\*” denote that the variable has a significance level of 10%, 5% and 1% respectively. The figures in the last volume stand for standard error

**Table 3.** Regression result

The results of the econometric analysis show that 9 variables have a significant impact on farmers’ forestry management investment, among which forestry income, new forest land area, forestry subsidies and whether to join the forestry cooperation organization are significant at the level of 1%; The age of the head of household, the number of household labor, the area of forest land, whether to plant other commercial crops and whether to participate in the forest right mortgage loan are significant at the level of 5%. The results show that the farmers’ forestry operational investment will increase with the increase of forest land area, new forest land area, previous forestry income and other commercial crops; relevant forestry policies, including obtaining forestry subsidies, participating in forest right mortgage loans and joining the forestry cooperation organization, will significantly stimulate farmers to increase their investment in forestry management; At the same time, with the increase of the age of the head of household and the number of household labor, farmers are more inclined to increase the investment in forestry management; the education level of the head of household, whether he is a village cadre, the number of forest land plots, the proportion of different types of forest land, and the difficulty of obtaining harvesting indicators have no significant impact on the forestry management investment of farmers.

#### 4.2 Discussion

**4.2.1 The impact of forest reform-related support policies on farmers’ forestry investment.** The empirical results show that: forestry subsidies, mortgage loans with forest rights need to be paid and joining the forestry cooperative society significantly promotes farmers to increase forestry operational investment. Among them, the number of forestry subsidies and whether to join the forestry cooperation organization is positively significant at the level of 1%, and

whether to participate in the forest right mortgage loan is positively significant at the level of 5%. The difficulty in obtaining harvesting indicators harms farmers' forestry operational investment, but the impact is not significant. To sum up, the supporting policies related to forest reform, especially the policy changes directly related to profits, have stimulated the family's investment in forest management and verified the research hypothesis H1 proposed above.

Specifically, in terms of forestry-related subsidy policies, to further deepen the collective forest reform, consolidate and share the dividends of the reform achievements and mobilize the enthusiasm of farmers for the management and protection of collective forests, the CPC Central Committee and the State Council explicitly proposed to establish a forestry financial subsidy system in 2008, including forest fire prevention, improved forest varieties, pest prevention and biogas construction into the scope of subsidies, and supporting forest tending, precious tree species and large-diameter timber cultivation. Since 2009, China has successively launched a series of forestry financial subsidy policies such as afforestation subsidy policy, forest tending subsidy policy and forest insurance subsidy policy, which have reduced the forestry production cost of farmers to a certain extent. The empirical results of this paper show that the relevant policies of forestry subsidies have played a certain policy effect. The farmers who receive forestry subsidies have a higher enthusiasm for forestry production and management and are more willing to invest in forestry production, which is of great significance to the income increase of forest farmers and the sustainable development of forestry.

In terms of policies related to forest rights mortgage loans, to revitalize forest land assets, solve fund problems and improve farmers' income, in 2003, the CPC Central Committee and the State Council issued the decision on accelerating forestry development, which stipulates that forestry operators can apply for bank loans with forest mortgage according to law, which is the beginning of China's forest right mortgage loan policy. In 2008, the opinions on comprehensively promoting the reform of the collective forest right system issued by the CPC Central Committee and the State Council expanded the scope of forest rights guarantee to forest land management rights and forest ownership. With the proposal and implementation of the "Three Rights Separation" of rural land property rights, the new round of collective forest right system reform is further deepened, and the forest right mortgage loan policy is also constantly improved. The opinions of the general office of the State Council on improving the collective forest right system in 2016 and the notice of the China Banking Regulatory Commission and the Ministry of land and resources of the State Forestry Administration on promoting the work related to forest rights mortgage loans in 2017 have made detailed provisions on forest right mortgage loans. The regression results show that the farmers who obtain the forest right mortgage loan are more willing to make forestry operational investments. It may be because the forest right mortgage loan has solved the problem of the shortage of funds for farmers to a certain extent. At the same time, after enjoying the policy dividend, the farmers have a higher income expectation for the forest land that is not mortgaged, so they are more willing to invest the corresponding funds for management and protection.

Joining the forestry cooperative organization can effectively organize the cooperative management of farmers and give play to the effect of scale economy. In terms of relevant production decision-making, the more professional personnel in the cooperative organization can guide the production decision-making of forest farmers within the organization and even the region, which is more conducive to the scientific decision-making and management of farmers, and improve the income of farmers and the ability to resist risks. The empirical results show that the farmers who join the forestry cooperatives are more willing to invest in forestry, which indicates that the forestry cooperative organization can drive the farmers to increase forestry investment and actively engage in forestry production activities to a certain extent.

4.2.2 *The impact of property right security on farmers' forestry investment.* The empirical results show that the number of disputed forest land plots has no significant impact on farmers' forestry operational investment, which is inconsistent with the research hypothesis H2 proposed above. It is possible that since the implementation of the relevant policies of collective forest reform, the forest land ownership confirmation work has achieved remarkable results. Most of the forest land has been confirmed and the forest right certificate has been issued. Only a small part of the forest land has the ownership dispute, accounting for a small proportion of the family forest land area, and has no significant impact on the investment of farmers in forestry management.

4.2.3 *The impact of the family's previous forestry operation income on the farmers' forestry investment.* The empirical results show that the forestry income promotes families to invest in forestry operation and management at the significance level of 1%, which indicates that under other fixed conditions, families with higher income in the previous period are more likely to increase investment in the current period, which is consistent with the above research hypothesis H3. This can be explained by the fact that household investment depends on their expectation of income. Therefore, when the current forestry income is relatively high, farmers will have higher expectations for the future forestry income, and to a certain extent, it will affect the investment behavior decision of farmers, which may make farmers decide to increase their investment in collective forestry management.

4.2.4 *The influence of forest land characteristics on farmers' forestry investment.* The empirical results show that the forest land area managed by farmers has a significant positive impact on their investment. The forest land area is significant at the level of 5% respectively, that is, the larger the forest land area owned by farmers, the stronger their investment intention. At the same time, planting other commercial crops has significantly promoted farmers to increase forestry operational investment at a significant level of 5%. The number of forest land plots and the proportion of different types of forest land have no significant impact on farmers' forestry management investment. This shows that the forest land area owned by farmers and the scale of forest right reform are the key factors for farmers to make investment decisions, which is consistent with the above research hypothesis H4. At the same time, the planting of commercial crops may bring more profit space to farmers' families and increase the contribution of forestry income to family income. Therefore, the planting of commercial crops will enhance the enthusiasm of farmers for the management and protection of collective forest land and increase relevant investment.

4.2.5 *The influence of family characteristics on farmers' forestry investment.* The empirical results show that the age of the head of household and the number of the labor force has a significant positive impact on the forestry management investment of farmers at the level of 5%. This shows that under the control of other factors, the more the family labor force and the older the head of the household, the higher the level of forestry management. Farmers with different education levels and whether they are village cadres have no significant impact on family forestry operational investment. This reflects that with the outflow of rural labor, the middle-aged and old people shoulder the main responsibility of China's forestry management. In most of the sample families, the laborers also make great contributions to forestry management. More laborers in the family are engaged in forestry production activities, and the stronger their ability to manage and protect the forest land, the more willing they are to invest relevant funds to obtain higher forestry income. Farmers with different education levels and whether they are village cadres have no distinction on investment. Perhaps, with the popularization of compulsory education, the education level of farmers generally rises and the heterogeneity among farmers is small, so there is no significant impact.

## 5. Conclusions and suggestions

### 5.1 Conclusions

The investment level of farmers in forestry management determines whether the quality and productivity of collective forests can be improved. The purpose of farmers' investment is to make profits, but investment behavior is also affected by many factors such as forestry policy, forest land characteristics, farmers' characteristics, natural resources and social economy. The empirical results of this paper are basically consistent with the above theoretical analysis.

*5.1.1 In general, the relevant policies of forest reform have achieved certain results.* Most of the policies can effectively stimulate farmers to increase investment in forest land management and protection. In particular, support policies related to forest land transfer, forestry subsidies, forest right mortgages, cooperatives and commercial crop planting have played a key role in stimulating farmers' forestry investment.

*5.1.2 The aging of the rural labor force limits the long-term sustainable development of the forestry industry to a certain extent.* This study finds that due to the outflow of a large number of rural laborers, the aging of rural labor is serious, and most of the family members who make significant contributions to the investment are the elderly, which poses a threat to the long-term sustainability of the collective forestry industry. Therefore, to promote forest tenure and maintain its long-term development, it is necessary to promote reform by expanding the scope of forest transformation, increasing transformation methods and reducing transformation constraints. At the same time, the private sector can participate in the forest tenure market. It is suggested that forest land should be managed on a large scale and organized; innovative modern management methods should be developed. In addition, professional forestry cooperatives, financial services and supporting policies should be further developed. By improving the family management skills, we can solve the financing problems and share some costs to make the investment more efficient and lasting.

### 5.2 Suggestions

*5.2.1 In terms of sustainable investment in collective forestry management, as mentioned above, the major investors are relatively older people.* In addition, their education level has no significant impact on investment. The old age and low education of the labor force may hinder the modernization of forestry, which requires forestry practitioners to have strong abilities. Forestry human resources are one of the most important factors to help the sustainable development of the forestry economy (Wei et al., 2019). Therefore, it is necessary to consider how to improve the capacity of practitioners and attract professionals to participate in forestry.

*5.2.2 In terms of forest right transfer and scale management, scale economy plays an important role in achieving sustainable development of the forestry economy (Huang et al., 2009) the empirical analysis of this paper further confirms that the forest area has significant significance in stimulating investment.* Under the household contract responsibility system, the transfer of forest rights is the way to realize the scale management of collective forests. Realizing scale management is one of the important tasks of the reform of the collective forest right system. We need to pay more attention to the impact of forest right transfer on the realization of scale management. As economies of scale are the basis for increasing output with the increase of production factors, the relationship between land use right transfer policy and household investment (including capital and labor investment) and production should be further studied to help promote the implementation of the policy.

*5.2.3 As for the promotion of the forest right system, at present, a series of support policies have had a positive impact on the investment of farmers' collective forest land through financial support.* However, there is still a problem that the stability of financial support is not strong. Once the state reduces the corresponding financial support funds, the collective forestry

management level is likely to decline. Therefore, we need to further study how to maximize the effect of the policy, improve the forestry management ability of farmers and promote sustainable forestry management.

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