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The Impact of Collective Forestland Tenure Reform on Rural Households' Inputs: Moderating Effects Based on Off-Farm Employment

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Abstract: Collective Forestland Tenure Reform has confirmed the forestland tenure of rural households and made forestland property rights clearer. In order to explain whether this policy is effective in improving rural households' expected returns and sense of forestland tenure security, we built models to study the impact of off-farm employment on forestland input in the context of labor migration to urban areas. We used data from the rural household tracking survey conducted by the Development Research Center of the National Forestry and Grassland Bureau from 2003–2016, which includes nine provinces (districts) and 1227 sample rural households in China. Regression models with the forestland titling program as the key influencing factor were constructed, controlling for household characteristics, household head characteristics, forestland characteristics, village level characteristics, market characteristics, and policy factors. Forestland leases had no significant on cash outlays and labor inputs. Forest tenure mortgage loans had a significant positive effect on cash outlays and labor inputs. For households' off-farm employment, the moderating effects of labor migration on labor inputs and cash outlays are modeled separately. The study indicated that the forestland tenure titling certificates increase households' enthusiasm in forestland production and promote cash outlays and labor inputs in forestland management. The results regarding the moderating effect indicated that labor migration has a positive moderating effect on rural households' forestland inputs including labor inputs and cash outlays.

Keywords: Collective Forestland Tenure Reform; rural household input; off-farm employment; moderating effect



Citation: Xiao, H.; Xie, Y.; Hou, F.; Li, X. The Impact of Collective Forestland Tenure Reform on Rural Households' Inputs: Moderating Effects Based on Off-Farm Employment. *Forests* **2022**, *13*, 1753. <https://doi.org/10.3390/f13111753>

Academic Editor: Guang-Yu Wang

Received: 8 September 2022

Accepted: 19 October 2022

Published: 24 October 2022

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1. Introduction

Collective forests refer to those forests whose right of ownership belongs to a collective. A collective has the right to own, use, benefit from, and dispose of its own forests, trees, and woodlands [1,2]. The area of collective forests in China accounts for about 60% of the total forest area in China, and most of the total forestry output value comes from collective forests. The development of collective forests has a great impact on China's ecosystem and forestry economy. Since the reform and opening up, China has attached great importance to the construction of collective forests. In 1981, Collective Forestland Tenure Reform was carried out for the first time. The development policy of “three-fixes” for forestry was implemented, and the collective forestland was divided into rural households. The collective forestland reform largely promotes forestland security in rural areas, which should have a prominent influence on rural households' forestland behavior. However, the situation of rural households cutting down forests has not changed. On the basis of successful pilot projects in Fujian, Jiangxi, Zhejiang, and other provinces, China promoted a new round of Collective Forestland Tenure Reform at the national level in 2008 and successively introduced a series of supporting reform measures, such as forest insurance, timber cutting quotas, the reduction of forestry taxes, and forest right mortgage

loans, aiming to give forest farmers more independent management rights by dividing forestland among households, so as to stimulate their enthusiasm for forest management. Without the institutional change of collective forestland reform in China, forestland tenure was uncompleted and ambiguous, which caused a large amount of forestland-related disputes. The new round of Collective Forestland Tenure Reform has adjusted the original property right arrangement and further clarified property rights by issuing forestland titling certificates with clearly defined forestland boundaries and forestland use rights [3].

The adjustment of the collective forestland tenure system is the core of the reform of the collective forest rights system. Property rights can evolve in the direction of improving economic efficiency [4]. In general, economic development also requires an effective and inclusive legal system with clarifying rules to protect property rights [5]. However, defining property rights is not free; adverse selection and free-rider behavior will lead to an unsatisfactory property rights system [6], and these unsatisfactory impacts will only be avoided when property rights are strengthened on a broad basis and constrained property rights appear. Some studies have discussed the negative impact of land tenure instability and restrictions on land productivity [7]. Furthermore, clarified and stable property rights to land are essential for production [8]. In order to clarify property rights [9,10], the government plays a crucial role in the definition and protection of forestland property rights [11]. Numerous studies by scholars worldwide have shown that the government's clarification of forestland property rights has brought positive effects. First, the reform promotes the development of forestry. It can increase the quantity and improves the quality of forest resources [12], and it optimizes the structure of forestry production [13]. One study found that clarified land property rights play a decisive role in protecting forests as an important means of halting deforestation [14]. In terms of investment, the reform is conducive to stimulating farmers' willingness to engage in afforestation management and can help to increase the labor and capital inputs of pure farmers [15]. Further analysis of timeliness found that the reform of the collective forest tenure system can promote the long-term investment of farmers in the short term [16]. In the context of off-farm labor mobility, increased stability of land tenure will promote long-term time investment by farmers [17]. Scholars also believe that this positive impact comes from issuing forest tenure titling certificates, which could make farmers perceive policy security. Clearly defined property rights to forestland can keep farmers from facing the risk of losing the expected returns from forestland and increase their incentive to invest [18].

According to the statistical data of the China Rural Statistical Yearbook 2021, the proportion of rural population in the national population declined from 82.1% in 1978 to 36.1% in 2020. The proportion of rural labor engaged in primary industry has also decreased. In 1978, rural labor engaged in primary industry accounted for 92.42% of all rural labor. Between 2010 and 2020, the proportion fell from 67.43% to 61.52%. It can be seen that engaging in off-farm employment has gradually become one of the prominent livelihood strategies for rural households.

Scholars believe that off-farm employment can effectively improve forestland leases, increasing investment in forestry management [19]. The increase of cash outlays is due to the return of funds after labor migration, which increases the cash outlay investments of rural households [20]. Some scholars believe that households' off-farm employment is not conducive to farmers' increasing investment in forestland [21]. The funds returned to small-scale rural households have not been effectively invested in forestland management [20]. Against the background of the large-scale influx of rural population into modern cities and the continuous rural labor migration to off-farm employment, there are still some differences in the research on the impact of rural labor migration on labor inputs and capital investment. The impact of forestland tenure titling certificates on rural households' forestland inputs has practical significance. Therefore, we studied the impact of forestland tenure titling certificates on rural households' forestland inputs against the background of labor migration.

In what follows, we discuss the theoretical mechanisms in Section 2, which includes the impact of Collective Forestland Tenure Reform on rural households' inputs and the moderating effects of labor migration on labor inputs and capital inputs. In the Section 3, we introduce the sample source and build the model. Section 4 conducts an empirical analysis of the assumptions and presents the results. In Section 5, we summarize the research findings and put forward some suggestions for forestland investment.

2. Theoretical Mechanisms

2.1. The Impact of Collective Forestland Tenure Reform on Rural Households' Inputs

It is assumed that all rural households are composed of rational people, i.e., whether to increase forestry inputs depends on whether they can obtain benefits from them solely. The inputs can be divided into two main categories: cash outlays and labor inputs, including forestry and off-farm employment, i.e., clear title effects k and l . The derivation is as follows:

Assuming that in year i rural households' cash outlay for forestland is K_i , the labor input for forestland is L_{1i} , the off-farm employment input is L_{2i} , and the tenure in year $i + 1$ is recorded as FR_{i+1} , the net present value of the forestry income of the forest households in year $i+1$ can be expressed as $PV(K_i, L_{1i}, FR_{i+1})$, the net present value of cash outlays and labor inputs of rural households for forestry is $PC(K_i, L_{1i}, FR_{i+1})$, the net present value of income for off-farm employment is $PV(L_{2i})$, and the net present value of inputs is $PC(L_{2i})$. For subsequent analysis, it is assumed here that $PV(K_i, L_{1i}, FR_{i+1})$ has an inflection point at K_i and is a concave function, and $PV(K_i, L_{1i}, FR_{i+1})$ and $PV(L_{2i})$ are both increasing functions. When rural households seek to maximize their long-term returns, they should follow such an investment function, referring to Besley (1995) [22]:

$$\max[\pi(K_i, L_{1i}, L_{2i}, FR_{i+1})] = PV(K_i, L_{1i}, FR_{i+1}) - PC(K_i, L_{1i}, FR_{i+1}) + PV(L_{2i}, FR_{i+1}) - PC(L_{2i}, FR_{i+1}) \quad (1)$$

Then, from Equation (1) we have

$$\frac{\partial K_i}{\partial FR_{i+1}} = -\frac{\pi_{13}(K_i, L_{1i}, FR_{i+1})}{\pi_{11}(K_i, L_{1i}, FR_{i+1})} \quad (2)$$

$$\frac{\partial L_{1i}}{\partial FR_{i+1}} = -\frac{\pi_{23}(K_i, L_{1i}, FR_{i+1})}{\pi_{22}(K_i, L_{1i}, FR_{i+1})} \quad (3)$$

$$\frac{\partial L_{2i}}{\partial FR_{i+1}} = -\frac{\pi_{33}(L_{2i}, FR_{i+1})}{\pi_{34}(L_{2i}, FR_{i+1})} \quad (4)$$

Because $\pi_{11}(K_i, L_{1i}, FR_{i+1})$, $\pi_{22}(K_i, L_{1i}, FR_{i+1})$, $\pi_{34}(L_{2i}, FR_{i+1})$ are less than zero, if $\pi_{13}(K_i, L_{1i}, FR_{i+1})$, $\pi_{23}(K_i, L_{1i}, FR_{i+1})$, $\pi_{33}(L_{2i}, FR_{i+1})$ are greater than zero, then $\frac{\partial K_i}{\partial FR_{i+1}}$, $\frac{\partial L_{1i}}{\partial FR_{i+1}}$, $\frac{\partial L_{2i}}{\partial FR_{i+1}}$ are greater than zero. It can then be assumed that when tenure is enhanced, forestry long-term cash outlays, forestry labor inputs, and off-farm employment labor inputs will also increase; meanwhile, labor inputs will also increase.

When the new round of Collective Forestland Tenure Reform is confirmed, rural households will have higher motivation to carry out meticulous transformation of their forestland, thus promoting higher returns for them. If the rural households' forestland tenure is insecure when rural households are assumed to have p possibility of losing their management rights, the probability of losing in year $i + 1$ is $(1 - p)^{i+1}$, and the rural households' income in this year should be

$$PV(K_i, L_{1i}, L_{2i}, FR_{i+1}) = [1 - p(FR_{i+1})]F(L_{1i}, L_{2i}, FR_{i+1}) \quad (5)$$

In Equation (4), $F(K_i, L_{1i})$ and $F(L_{2i})$ are the in-kind returns of households' inputs including cash outlays and labor inputs. Here, we are assuming that rural households lose

their forestland tenure and lose all their returns and that their input costs are independent of R_{i+1} ; the corresponding NPVs should be, respectively,

$$PV_{13} = -p(R_{i+1})F'(K, L_{1i}, L_{2i}) \quad (6)$$

$$PV_{23} = -p(R_{i+1})F'(K, L_{1i}, L_{2i}) \quad (7)$$

$$PV_{33} = -p(R_{i+1})F'(K, L_{1i}, L_{2i}) \quad (8)$$

Because Equations (6)–(8) should be greater than zero, the corresponding $\pi_{13}(K_i, L_i, FR_{i+1})$, $\pi_{23}(K_i, L_i, FR_{i+1})$, $\pi_{33}(K_i, L_i, FR_{i+1})$ are greater than zero. That is, $\frac{\partial K_i}{\partial FR_{i+1}}, \frac{\partial L_i}{\partial FR_{i+1}}, \frac{\partial L_{2i}}{\partial FR_{i+1}}$ is greater than zero; it can then be assumed that the long-term cash outlays, forestry labor inputs, and off-farm employment labor inputs of rural households in forestry will increase when the New Round of Collective Forestland Tenure Reform is enhanced with forestland tenure confirmation.

Secondly, according to the theory of tenure economics, land tenure contains bundles of rights such as ownership, use rights, revenue rights, and disposal rights as well as the stability or security of each bundle of rights. In addition, from the structure of forest rights, forestland tenure can be divided into forestland use rights, forestland revenue rights, forestland mortgage rights, forestland transfer rights, and so on [23]. The interrelated forestland tenure elements systematically affect the enthusiasm and initiative of the labor force, the most dynamic production element, to engage in production, and thus affect income expectations and behavioral decisions, which are finally reflected in the status of forest resources [24,25]. By giving rural households complete and clear collective forestland tenure, the policy can produce the “income effect”, “property rights stability effect”, “collateral effect”, and “realization effect” [26,27].

For forestland use tenure, the larger the area of forestland owned by rural households and the longer they have owned it, the more beneficial to them. For example, more stable the forestland tenure will promote more rural households realizing the market value of their current investments in the future, thus stimulating rural households to increase their forestry investments and extend the cutting time; such processes produce the stabilization effect of forest rights. For the forestland income right, rural households can directly bring about direct income effects through forestland income, farmland income, off-farm employment income, government subsidies, and so on. On the other hand, the part of income obtained through production factor allocation will reverse the incentive to invest and thus produce an indirect income effect brought by investment incentive. For the mortgage right, the complete forestland mortgage right forms a guarantee for rural households to obtain more mortgage money, satisfies rural households’ capital demands, stimulates them to increase forestation management investment, and thus generates the effect of forest mortgage rights. For forestland lease rights, rural households can lease in or lease out forestland and trees as asset resources, which reduces investment risks and uncertainties, lowers tenure transaction costs, stimulates rural households to invest in forestland and reduce damage to forest resources, and thus generates the effect of forest tenure realization.

To sum up, once rural households have a certain perception of the stability and security of tenure, they will obtain forest revenue through the income effect and guarantee effect, reduce forest risk through the collateral effect, delay forest harvesting decisions through the realization effect, and then increase their forest management, reduce their willingness to deforest and abandon their forestland, and increase their production costs and labor inputs on forestland.

Meanwhile, during the implementation of the new round of Collective Forestland Tenure Reform, governments nationwide have successively implemented a series of supporting reform policy measures such as forest insurance, forestry subsidies, and forest tenure mortgage loans [20,28], which create conditions for rural households to optimize their resource endowments and reconfigure their production factors. In addition, complete and secure collective forest

tenure can effectively reduce the probability of land encroachment, reduce rural households' supervision time over forestland, stimulate them to engage in off-farm employment, and thus promote the growth of rural households' off-employment income [29].

2.2. Moderating Effects of Labor Migration on Labor Inputs and Capital Inputs

Figure 1 showed the the impact mechanism of Collective Forestland Tenure Reform on rural households' inputs. Due to the gap between urban and rural income levels and expectations of future work, the migration of rural laborers to cities has become a common phenomenon [30]. In terms of labor migration distance, current off-farm employment is divided into local and out-of-home employment, among which out-of-home employment takes longer and is farther away compared to local employment, which leads to farmers' inability to nurture forestland and affects labor inputs in forestry negatively. Because forestland management is seasonal and does not require continuous labor inputs, local off-farm employment laborers can still effectively manage forestland [25]. From the gender perspective of labor migration, after the migration of male labor, surplus laborers such as women and the elderly will replace men as the main labor supply for tending to forestland [31]. Most rural households manage both farmland and forestland, and compared to farmland operation, surplus laborers prefer to manage forestland, which requires less labor inputs and cash outlays, thus increasing the labor inputs to forestland. Therefore, the relationship between labor migration and labor inputs on forestland remains to be tested. The migration of labor to industries with higher marginal returns increases the household income of farmers, and more funds are allocated to woodland operations, creating a pattern of capital return [26]. If the income from off-farm employment is not used for woodland production and operation but for non-productive consumption and so on, labor migration will not affect forestland capital investment [32].

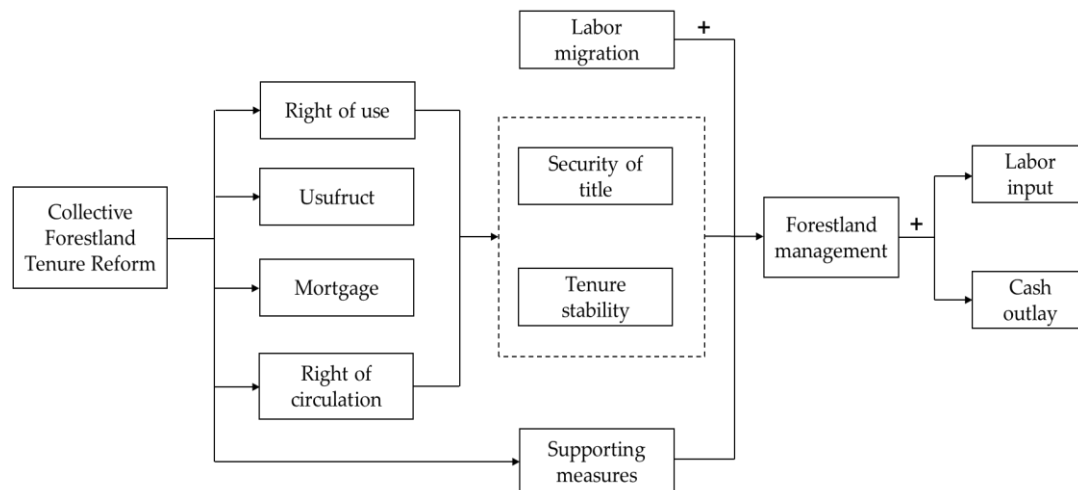


Figure 1. The impact mechanism of Collective Forestland Tenure Reform on rural households' inputs. Note: + implies a positive direction of impacts in hypothesis.

Synthesizing the above analysis, this section proposes two research hypotheses.

H1 . *The reform of the Collective Forestland Tenure Reform system promotes labor inputs and cash outlays in rural households' forestland management.*

H2 . *Labor migration has a moderating effect on labor inputs and cash outlays in the forestry management of rural households.*

3. Methods

3.1. Data Collection

The data used in this paper come from a survey conducted by the research team of the Center for Development of the State Forestry and Grassland Administration for the program “Policy Issues Related to the Reform of Collective Forest Tenure System in China” in 18 counties in 9 provinces across China. Rural households were selected using a stratified random sampling method. Taking into account the characteristics of geographical distribution, economic development, forest resources distribution, and the Collective Forestland Tenure Reform, Liaoning, Henan, Shandong, Sichuan, Guangxi, Hunan, Jiangxi and Fujian provinces—with different natural conditions and economic development levels—were selected as the survey areas. Three townships were selected randomly in each province, three villages were selected randomly in each township, and 15 households were selected randomly in each administrative village, which is representative of the whole country. Thus, the sample contains 1276 rural households from 90 villages in 12 counties and 6 provinces.

Our research survey was conducted in 5 rounds, with the first round conducted in 2010 to obtain data for 2003 (before forest tenure reform) and 2007–2009 (during forest tenure reform), and the next 4 rounds conducted in alternate years from 2012–2018 to obtain data for 2010–2016 (after forest tenure reform). We ensured the basic stability of the quantitative questionnaire and qualitative questionnaire research framework at the county, township, village, and rural household levels during the follow-up research. In the research process, we not only recorded the production and living information of rural households in the current year, but also asked sample rural households to recall the relevant data from last year. In order to account for possible deviations in some sample rural households’ data in previous years, we recorded the changes in land use, cultivation structure, and off-farm employment of the sample rural households in detail during the research process and further corroborated the data obtained through various channels such as village committees’ access to relevant rural households’ files, villagers’ groups’ recollection of relevant information, some rural households’ diaries, and so on. We compared the questionnaires filled out by rural households with the information from the channels and eliminated those with large deviations. For the sake of comparability across periods, sample rural households with incomplete observations and inconsistent questionnaire information were excluded, and the final sample size of 1276 rural households was obtained after data collation. We collated the data to form a total of 1276 rural household survey data for 10 time points from 2003 and 2007–2015.

The survey information of rural households included basic demographics and characteristics, land structure, land production and marketing, labor allocation, household income and consumption, social security and insurance, credit situation, and subjective attitudes about forestry policies. The data were collated to form a total of 1276 rural household survey data for 10 time points from 2003 and 2007–2015. Using the price index of rural production materials and the consumer price index of rural households, the data information of relevant variables was converted to constant 2003 prices. The research team used face-to-face questionnaire interviews with rural households in each of the randomly selected sample villages. The data reflect the production and management activities of rural households and family members in collective forest areas in China.

3.2. Selection and Definition of the Model’s Variables

Referring to the method in Yu et al. (2021) [23] on the study of the effect of Collective Forestland Tenure Reform on rural households’ enthusiasm to manage forestland, variables in four dimensions of the head of a rural household’s characteristics, household characteristics, forestland characteristics, village characteristics, and market characteristics were selected as control variables [23]. Wei et al. (2022) showed that forestry subsidy policy could help to improve the labor inputs and financial inputs of rural households in afforestation, so a political factor was added to the control variables [33].

With reference to relevant research literature, the characteristics of the rural household heads in this study include four indicators: age, gender, whether the household head is a cadre, and years of education; household characteristics include three indicators: number of household members, number of household laborers, and total household income; forestland characteristics include three indicators: area of forestland, area of commercial forestland, and number of forestland plots; village characteristics include three indicators: whether the road is hardened, whether the area is mountainous, and distance from the market. The market characteristics include three indicators: agricultural price index, timber price index, and labor price index with 2003 as the base period; policy factors include two indicators: forestry subsidies and other engineering subsidies. In addition, the amount of forestry subsidies in the previous year is used as an indicator because of the lag in the perception and response of rural households to forestry policy subsidies. The definitions of the variables involved in the model are shown in Table 1.

Table 1. The definitions of the variables involved in the model.

Variable	Definition
Dependent Variables	
C_{forest}	Household's cash outlays in forest management (yuan)
L_{forest}	Household's labor inputs in forest management (person-days)
Independent Variables	
Tenure Titling	Whether or not there is a Forestland Tenure Titling certificate in a household (1 = yes, 0 = otherwise)
Lease	Whether or not there is a Forestland Lease in a household (1 = yes, 0 = otherwise)
Loan	Whether or not there are forest tenure mortgage loans in a household (1 = yes, 0 = otherwise)
Moderating Variables	
Labor Migration	The ratio of migrant laborers to total household laborers
Control Variable	
Characteristics of the Head of Household	
Age	Age of the household head
Gender	Gender of the household head
Cadre	Whether the head of the household is a cadre of the village or above (Yes = 1; 0 = otherwise)
Edu	The education year of the household head
Household Characteristics	
Family Members	Total number of family members in the rural household
Labor _{number}	Total number of laborers in the rural household
Income	Total income of rural households (yuan)
Forestland Characteristics	
Area _{forest}	The total area of forestland (ha)
C-Area	The area of household commercial forest (ha)
Tract	Total number of family forest tracts (tract)
Logging	Whether or not they are satisfied with the logging quota system (1 = yes, 0 = otherwise)
Village Characteristics	
Road	Whether or not the village has hardened roads (1 = yes, 0 = otherwise)
Location	Whether or not the village is located in a mountainous area
Distance	Distance of the village from the county town (km)
Market Characteristics	
API	Agricultural Products Price Index
FPI	Forest Products Price Index
LPI	Labor Price Index
WPI	Wood Price Index
Policy Factors	
Forestry Subsidies	Amount of relevant forestry subsidies for the household (yuan)
Other Subsidies	Other subsidies for the household (yuan)

3.3. Econometric Model

For the individual effect α_i , there are two different treatments, deriving two different types of model: fixed-effects models and random-effects models. Referring to Wooldridge (2010) [34], the fixed effects model incorporates α_i into the fixed part of the model, and this approach treats α_i as the parameter to be estimated in the model, i.e., the independent variable of the model. The advantage of this setup is that the time-varying variable X_{it} can be correlated with α_i . The fixed-effects model controls for all individual characteristics that do not vary over time when estimating β . Therefore, the fixed-effects model is chosen in this paper. Based on the above theoretical mechanisms, we first construct benchmark regression models for labor inputs and capital inputs, respectively, to test the effects of Collective Forestland Tenure Reform on rural households' inputs. Then, we construct a moderating-effect model to test the moderating effect of labor migration on rural households' investments, including cash outlays and labor inputs. The benchmark regression model is as follows:

$$Y_{it} = a + \beta_1 X_{it} + \beta_2 \sum X'_{it} + \mu_{it} \quad (9)$$

Y_{it} indicates the input of rural households in period t , which is divided into forestry labor inputs and cash outlays; X_{it} is the key variable to observe the effectiveness of Collective Forestland Tenure Reform, which is 1 if the forestland tenure titling certificate is confirmed and 0 otherwise. x' is the control variable, a is the intercept term, and u is the random error term.

To test whether labor migration has moderating effects on rural households' cash outlays and labor inputs, we construct the following moderating-effect model:

$$Y_{it} = a + \beta_1 X_{it} + \beta_2 X_{it} * LT_{it} + \beta_3 LT_{it} + \beta_4 \sum X'_{it} + \mu_{it} \quad (10)$$

X_{it} represents the main effect of the model with the forestland tenure titling certificate confirmed, and the interaction term $X_{it} * LT_{it}$ is used to measure the moderating effect of labor migration, where LT_{it} indicates the rural households' labor migration in period t . The number of off-farm employees of a rural household i in period t is selected. In the case that the coefficient of X_{it} is significantly positive and the coefficient of $X_{it} * LT_{it}$ is significantly positive, it is indicated that labor migration has a positive moderating effect on rural households' labor inputs and cash outlays. If the coefficient before $X_{it} * LT_{it}$ is significantly negative, off-farm employment weakens the effect of forestland tenure titling certificates on rural households' forest investment. In the case that the X_{it} coefficient is significantly negative and the $X_{it} * LT_{it}$ coefficient is significantly negative, off-farm employment has a negative moderating effect on rural households' forest investment. If the $X_{it} * LT_{it}$ coefficient is significantly negative, then the off-farm employment of rural households weakens the negative effect of forestland tenure titling certificates on rural households' investments.

4. Empirical Findings

4.1. The Estimated Results of Household Cash Outlays

Table 2 reports the estimated results for the factors that influenced the amount of rural households' cash outlays. Specifically, Models 1–6 summarize the results from the OLS regressions where the variables were added progressively.

It can be seen from test statistics that all the models are significant at the 1% level, indicating that at least one of the independent variables had a significant relationship with the dependent variable. Meanwhile, the Wald statistics (χ^2) of Models 4, 5, and 6 are significant at the 1% level, revealing that the key independent variables involving migrant status in these models are endogenous, and it is thus appropriate to use the instrumental variable in estimation.

Table 2. Estimated results of household cash outlays.

Variable Name	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Tenure Titling	0.565 ** (0.257)	0.573 ** (0.256)	0.528 ** (0.256)	0.547 ** (0.256)	0.371 ** (0.223)	0.299 ** (0.171)
Lease	0.075 (0.511)	0.072 (0.510)	0.082 (0.507)	0.132 (0.507)	0.394 (0.481)	0.348 (0.479)
Loan	3.151 *** (0.853)	3.149 *** (0.854)	3.175 *** (0.849)	3.043 *** (0.827)	1.578 ** (0.735)	1.595 ** (0.719)
Age		0.004 (0.021)	0.004 (0.021)	0.008 (0.021)	0.007 (0.021)	0.007 (0.021)
Gender		−0.665 (1.147)	−0.600 (1.136)	−0.581 (1.135)	−0.252 (0.929)	−0.229 (0.924)
cadre		−0.331 *** (0.102)	−0.334 ** (0.102)	−0.311 ** (0.101)	−0.352 ** (0.180)	−0.357 ** (0.179)
Edu		0.022 (0.047)	0.025 (0.047)	0.035 (0.048)	0.097 (0.044)	0.093 (0.044)
Family members			−0.081 ** (0.015)	−0.053 ** (0.019)	−0.046 ** (0.015)	−0.046 ** (0.014)
Labor number			0.225 ** (0.111)	0.259 ** (0.128)	0.142 (0.123)	0.151 (0.123)
Income			3.66×10^{-6} ** (2.24×10^{-6})	3.53×10^{-6} ** (2.21×10^{-6})	7.44×10^{-6} ** (2.31×10^{-6})	$−7.44 \times 10^{-6}$ ** (2.28×10^{-6})
Area forest				0.004 (0.002)	0.000 (0.002)	0.000 (0.002)
C-Area				0.001 (0.002)	0.002 (0.002)	0.002 (0.002)
Tract				0.006 (0.029)	0.012 (0.025)	0.013 (0.025)
Logging				0.431 * (0.381)	0.096 * (0.036)	0.105 * (0.032)
Road					0.015 (0.001)	0.015 * (0.009)
Location					0.415 (0.458)	0.399 (0.459)
Distance					3.380 *** 1.084	3.217 *** (1.068)
API						−0.086 * (0.021)
FPI						0.880 ** (0.388)
LPI						−0.175 (0.241)
WPI						−0.585 (0.534)
Forestry Subsidies						0.0001 * (0.000)
Other Subsidies						−0.000 (0.000)
Cons	−4.893 ** (0.145)	−4.261 ** (1.631)	−4.657 ** (1.650)	−5.293 ** (1.733)	−7.984 *** (1.567)	5.158 (3.806)
Individual Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
N	12,760	12,760	12,760	12,760	12,760	12,760
R ²	0.0236	0.0240	0.0258	0.0280	0.1256	0.1281

Note: ***, **, and * are significant at the level of 1%, 5%, and 10%, respectively, and the values in brackets are standard errors.

Model 1 in Table 2 analyses the effect of the core explanatory variable, i.e., whether forestland tenure has an impact on capital inputs. Model 2 to Model 6 gradually add control variables such as the household head characteristics, household characteristics, forestland

characteristics, village characteristics, market characteristics, and policy factors. The coefficient of forestland tenure titling certificates in Model 1 is 0.565 and is significant at the 10% significance level, indicating that forestland tenure titling certificates promote households' cash outlays positively. The coefficients of Model 2 and Model 4 fluctuate with the addition of control variables, but the changes are small and still significant at the 10% level of significance. Forestland leases (*Lease*) had no significant on cash outlays. Forest tenure mortgage loans (*Loan*) had a significant positive effect on cash outlays, which was significant at the 1% statistical level. Satisfaction with the logging quota system of rural households (*Logging*) had a positive influence on cash outlays. The Wood Price Index (*WPI*) had no significant influence on cash outlays in the rural households' forestland management.

4.2. The Estimated Results of Household Labor Inputs

Table 3 reports the estimated results for the factors that influenced the amount of rural households' labor inputs. Specifically, Models 7–12 summarize the results from the OLS regressions where the variables were added progressively. Models 7–12 examine the effect of forestland tenure titling certificates on households' labor inputs. The coefficient of the core explanatory variable of Model 7 is 0.026 with positive significance, indicating that forestland tenure titling certificates have a significant promoting effect on households' labor inputs. Model 8 to Model 12 include the control variables in turn, and forestland tenure titling certificates still significantly promote labor inputs, indicating that the results pass the robustness test, and Hypothesis 1 is authenticated.

Table 3. Estimated results of household labor inputs.

Variable Name	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12
Tenure Titling	0.026 ** (0.014)	0.023 ** (0.159)	0.025 ** (0.167)	0.037 * (0.258)	0.035 * (0.157)	0.025 * (0.012)
Lease	−0.090 (0.328)	−0.088 (0.329)	−0.089 (0.331)	−0.130 (0.333)	−0.137 (0.354)	−0.264 (0.322)
Loan	0.772 * (0.537)	0.769 * (0.541)	0.785 * (0.542)	0.797 * (0.534)	0.821 ** (0.474)	0.791 * (0.480)
Age		0.008 (0.016)	0.003 (0.015)	0.006 (0.015)	0.006 (0.011)	0.006 (0.016)
Gender		−1.683 * (0.947)	−1.654 * (0.931)	−1.644 * (0.917)	−1.649 * (0.565)	−1.506 * (0.896)
Cadre		0.458 ** (0.255)	0.454 ** (0.256)	0.427 ** (0.256)	0.420 ** (0.191)	0.435 ** (0.258)
Edu		−0.037 * (0.037)	−0.037 * (0.037)	−0.032 * (0.037)	−0.034 * (0.024)	−0.060 * (0.037)
Family Members			−0.125 * (0.086)	−0.169 * (0.092)	−0.173 * (0.055)	−0.171 * (0.091)
Labor number			0.178 *** (0.091)	0.245 *** (0.103)	0.242 (0.066)	0.241 *** (0.102)
Income			-8.66×10^{-7} (1.99×10^{-6})	-1.02×10^{-6} (1.96×10^{-6})	9.54×10^{-7} (1.33×10^{-6})	-6.11×10^{-6} (1.80×10^{-6})
Area forest				−0.002 (0.001)	−0.001 (0.001)	−0.003 (0.002)
C-Area				0.005 *** (0.001)	0.004 *** (0.001)	0.005 *** (0.002)
Tract				0.014 (0.013)	0.013 (0.007)	0.011 (0.012)
Logging				−0.373 (0.324)	−0.372 (0.200)	−0.547 (0.324)
Road					0.282 ** (0.131)	0.006 *** (0.000)

Table 3. Cont.

Variable Name	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12
Location					0.055 (0.247)	0.396 (0.309)
Distance					0.195 (0.537)	0.212 (0.520)
API						−0.012 * (0.020)
FPI						0.015 (0.347)
LPI						0.063 (0.212)
WPI						0.613 (0.590)
Forestry Subsidies						−0.001 (0.000)
Other Subsidies						0.000 (0.000)
Individual Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Cons	3.320 ** (0.130)	1.285 (1.317)	−1.306 (1.325)	−0.922 (1.383)	−0.687 (0.890)	−4.384 * (3.727)
N	12,760	12,760	12,760	12,760	12,760	12,760
R ²	0.0526	0.0543	0.0553	0.0577	0.0582	0.0876

Note: ***, **, and * are significant at the level of 1%, 5%, and 10%, respectively, and the values in brackets are standard errors.

The increase in household labor inputs and cash outlays is mainly due to the security of property rights brought by Collective Forestland Tenure Reform, which improves households' motivation to nurture their forestlands and increases their willingness to manage forests by stabilizing their income expectations and reducing the risk of holding forestland, and this further increases households' motivation to invest in capital and labor. Concerning the other policy variables, forestland leases (Lease) had no significant on the labor inputs, and forest tenure mortgage loans (Loan) had a significant positive effect on labor inputs that was significant at the 10% statistical level. Satisfaction with the logging quota system of rural households (Logging) had no significant impact on labor inputs. The Wood Price Index (WPI) had no significant influence on labor inputs in rural households' forestland management.

As shown in the results in Tables 2 and 3, it can be seen that the coefficients of agricultural prices negatively affected rural households' labor inputs at the 1% significance level, which is due to rural households owning both farmland and forestland. When the prices of agricultural products increase, rural households tend to invest their cash outlays and labor inputs in farmland, which has a shorter operating cycle and faster returns. Regarding the household head characteristics, when the head of household is a cadre, it significantly reduces a rural household's investment in cash outlays but significantly increases that rural household's investment in labor inputs. Increasing the number of education years significantly reduced rural households' investments in forestland because when a rural household was more educated, it often chose not to engage in forestry production but in other industries with higher marginal returns. Although years of education can promote rural households' cash outlays in forestland, the results are not significant.

Among the household characteristics, the number of household members significantly affected rural households' labor inputs. Laborer count had a significant positive impact on labor inputs. When the number of household members increased but that household did not correspondingly invest in forestland management, it would disperse the labor that would otherwise be invested in forestland. The number of household members also had a negative effect on cash outlays, but the total number of household laborers had a positive effect on forestry cash outlays, which indicates that when the number of household members is higher,

the household's cash outlays will be used more for unproductive consumption, crowding out forestry capital investment. However, when household labor is invested more in forestland management, this will correspondingly increase households' investment in cash outlays. Increases in forestland area will significantly reduce labor inputs, which is due to the fact that large-scale operation helps to improve mechanization, and the machinery replaces manual labor to reduce rural households' average labor inputs on forestland. Forestry subsidies given by the state improve the capital status of rural households and furthermore significantly increase their capital investment in forestry operations.

4.3. The Estimated Results of the Moderating Effect of Labor Migration on Cash Outlays

Table 4 reports the estimated results for the moderating effect of labor migration and forestland tenure titling certificates that influenced the amount of rural households' cash outlays.

Table 4. Estimated results of the moderating role of labor migration for cash outlays.

Variable Name	Model 13	Model 14	Model 15	Model 16	Model 17	Model 18	Model 19
Tenure Titling	0.596 ** (0.258)		0.785 ** (0.299)				
Labor Migration		−0.476 ** (0.218)	−0.623 * (0.493)		−0.253 * (0.171)		−0.225 * (0.154)
Tenure Titling * Labor Migration			−0.576 * (0.291)				
Lease				−0.083 (0.521)	0.355 (0.658)		
Lease * Labor Migration					−1.192 (1.788)		
Loan						3.202 ** (0.859)	2.199 ** (1.035)
Loan * Labor Migration							4.396 ** (2.048)
Control Variable	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Individual Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cons	−4.897 ** (0.144)	−4.738 ** (0.164)	−4.596 ** (0.207)	−4.905 ** (0.145)	−4.741 ** (0.165)	−4.901 ** (0.145)	−4.721 ** (0.163)
N	12,760	12,760	12,760	12,760	12,760	12,760	12,760
R ²	0.0206	0.0193	0.0206	0.0196	0.0194	0.0227	0.0231

Note: **, and * are significant at the level of 5%, and 10%, respectively, and the values in brackets are standard errors.

As shown in the Table 4, the coefficient of forestland tenure titling certificates as the main effect in Model 15 is negative at the 10% significance level, and the coefficient of the interaction term of forestland tenure titling certificates and labor migration is significantly positive, which indicates that labor migration has a positive moderating effect on rural households' cash outlays. Under the background of Collective Forestland Tenure Reform, rural labor migration helps to promote rural households' cash investment. However, labor migration to some extent weakens the promoting effect of forestland tenure titling certificates on rural households' cash investment. This conclusion confirms the substitution relationship between cash outlays and labor inputs proposed in the study of Xie et al. (2019) [21]. That is, the migration process of rural labor to more profitable sectors helps rural households to obtain more income, forming a return flow of capital to forestry management. When a rural household invests the cash outlays obtained from off-farm employment income in forestland management, this will increase the amount of cash outlays in forestland. This further shows that when a rural household has a surplus cash outlay, they will not invest all of it in daily consumption, and thus labor migration promotes rural households investing cash in household forestry production.

As shown in Table 4, Model 16 is the main effect of the influence of forestland leases on cash outlays, and Model 17 is the model of the interaction effect of forestland leases and

labor migration. Model 16 indicates that forestland leases do not have a significant effect on cash outlays, and Model 17 indicates that the interaction term between forestland leases and labor migration also does not have a significant effect on cash outlays. This indicates that there is no moderating effect of labor migration on forestland leases. In Model 18, as a main-effect model of the impact of forest tenure mortgage loans on cash outlays, forest tenure mortgage loans were positive and had a significant effect on rural households' cash outlays at the 5% statistical level, indicating that if a rural household received more forest tenure mortgage loans, they would be more likely to increase cash outlays in forestland management. In Model 19, the coefficient of the interaction term of forest tenure mortgage loans and labor migration was positively related to cash outlays at the 5% statistical level. This indicates that labor migration has a positive moderating effect on cash outlays. That is, labor migration helps to promote rural households' cash outlays in the context of the comprehensive promotion of forest tenure mortgage loan policy.

4.4. The Estimated Results of the Moderating Effect of Labor Migration on Labor Inputs

Table 5 reports the estimated results for the moderating effect of labor migration and forestland tenure reforms—including forestland tenure titling certificates, forestland leases, and forest tenure mortgage loans—that influenced the amount of rural households' labor inputs. Model 18 showed that the coefficients of forestland tenure titling certificates and their interaction term with labor migration are significantly positive at the 5% significance level, indicating that rural labor migration does not bring about a decrease in labor inputs on forestland, but rather increases rural households' labor inputs. The reason for this can be drawn from the findings of Xie et al. (2019) [21]: when the main household laborer, such as the male head of a rural household, migrates out to work, the remaining laborers within the rural household will replace them as the main laborer in forestland management. The other side of the coin is that as labor migration prompts rural households to run off their forestland, the inflow to the forestland is concentrated under the name of a certain person or organization, which not only helps to improve the problem of forestland fragmentation brought about by Collective Forestland Tenure Reform due to the subdivision of forests to rural households, but also allows the forestland to receive more professional and sustained labor inputs.

Table 5. Estimated results of the moderating role of labor migration on labor inputs.

Variable Name	Model 20	Model 21	Model 22	Model 23	Model 24	Model 25	Model 26
Forestland Tenure	0.021 * (0.161)		0.188 * (0.013)				
Labor Migration		−0.476 ** (0.218)	−1.153 ** (0.515)		−0.468 ** (0.219)		−0.506 ** (0.311)
Forestland Tenure * Labor Migration			0.809 * (0.499)				
Lease				−0.095 (0.330)	0.190 (0.394)		
Lease * Labor Migration					−0.790 (1.141)		
Loan						0.775 * (0.537)	0.004 (0.567)
Loan * Labor Migration							3.468 ** (1.391)
Control Variable	Yes	yes	yes	Yes	yes	yes	yes
Cons	−3.322 (0.130)	−4.738 ** (0.164)	−2.767 ** (0.202)	−3.321 * (0.129)	−2.971 * (0.145)	−3.321 * (0.129)	−2.959 (0.145)
N	12,760	12,760	12,760	12,760	12,760	12,760	12,760
R ²	0.0523	0.0193	0.0472	0.0523	0.0464	0.0526	0.0473

Note: **, and * are significant at the level of 5%, and 10%, respectively, and the values in brackets are standard errors.

As shown in Model 23 and Model 24, Model 23 involves the main effect of the influence of forestland leases on labor inputs, and Model 24 is the model of the interaction effect of forestland leases and labor migration. Model 23 indicates that forestland leases do not

have a significant effect on labor inputs, and Model 24 indicates that the interaction term between forestland leases and labor migration also does not have a significant effect on labor inputs. In Model 25, forest tenure mortgage loans had a significantly positive effect on labor inputs at the 5% statistical level. In Model 26, the coefficient of the interaction term of forest tenure mortgage loans and labor migration positively affected labor inputs at the 5% statistical level.

4.5. The Robustness Tests

Table 6 reports the estimated results of the robustness tests of cash outlays and labor inputs. Model 27, Model 28, and Model 29 are the robustness tests of the impact of forestland tenure reform on rural households' cash outlays in forestland management. Furthermore, Model 27, Model 28, and Model 29 are the robustness tests of the impact of the forestland tenure reform on rural households' labor inputs. The robustness tests of this paper are conducted by the replacement model method to test the conclusions drawn from the relevant empirical part, and the specific model is divided into the following ideas for testing. We transformed the forestry cash outlays and forestry labor inputs of rural households into dichotomous variables, i.e., set to 1 if a rural household made forestry cash outlays and labor inputs, respectively, and 0 otherwise. Model 27 is a binary logit model robust regression of the forestland titling program (*Tenure Titling*) on household cash outlays. Model 27, Model 28, and Model 30 show that forestland leases (*Lease*) had no significant influence on rural households' cash outlays and labor inputs. Model 27 and Model 30 show that forestland titling programs (*Tenure Titling*) had a significant positive influence on rural households' cash outlays and labor inputs. As shown in Model 29 and Model 32, forest tenure mortgage loans (*Loan*) had a significant positive impact on rural households' cash outlays and labor inputs, promoting rural households' forest management. The results show that the significance levels of the regression coefficients of the core independent variables at the three levels do not change and tend to be consistent with the baseline regression results, indicating good robustness. Once again, it is confirmed that forest land titling has a significant positive impact on the forest land management behavior of households.

Table 6. Estimated results of the robustness tests of cash outlays and labor inputs.

Variable Name	Model 27	Model 28	Model 29	Model 30	Model 31	Model 32
Tenure Titling	0.768 *** (0.059)			0.582 * (0.211)		
Lease		−0.561 (0.247)			0.489 (0.081)	
Loan			1.292 ** (0.478)			0.819 ** (0.065)
Control Variable	Yes	Yes	Yes	Yes	Yes	Yes
Cons	0.464 ** (0.088)	−0.110 ** (0.075)	−0.110 (0.075)	0.255 * (0.211)	0.653 * (0.014)	0.484(0.081)
Individual Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
N	12,760	12,760	12,760	12,760	12,760	12,760
Prob	0.0000	0.0231	0.0069	0.0000	0.0000	0.0000

Note: ***, **, and * are significant at the level of 1%, 5%, and 10%, respectively, and the values in brackets are standard errors.

5. Conclusions and Discussion

The Collective Forestland Tenure Reform program has further clarified rural households' forestland tenure by issuing forestland tenure certificates officially, which has improved rural households' perceptions of forestland tenure security and is conducive to increasing rural households' enthusiasm to manage forestland. This increases cash outlay and labor input investment in forestland. We constructed the theoretical analysis framework of "Collective Forestland Tenure Reform -cash outlay" and "collective forestland

tenure reform-labor input". We used data from 1227 rural households in 18 counties and cities in nine provinces (districts) in the Northeast, Southwest, Plain, and South regions of China, drawing from eight years of panel data. It is revealed that Collective Forestland Tenure Reform has had a significant positive effect on rural households' cash outlays and labor inputs. Forestland leases had no significant impact on cash outlays and labor inputs. Forest tenure mortgage loans had a significant positive effect on cash outlays and labor inputs. The market price level of agricultural products had a negative impact on both cash outlays and labor inputs. Because it is a common phenomenon that rural laborers migrate to urban areas, we studied the impact of rural households' off-farm employment on households' investment in forestry operations. We also constructed the framework of the "Collective Forestland Tenure Reform -labor migration-cash outlay" and "Collective Forestland Tenure Reform -labor migration-labor input". The analysis found that labor migration has a positive moderating effect on forestry inputs, rural households' labor inputs do not decrease after labor migration, and off-farm employment makes rural households obtain higher marginal income, which forms capital returns and promotes households' cash outlays in forestry.

The contributions of this study are primarily reflected in the following three dimensions. First, unlike most of the previous studies [31,33], we examined the effects of forestland tenure titling certificates on cash outlays and labor inputs. Whether there are cash outlays in rural households' forestland management was used to capture the overall effect; rural households' labor inputs were also selected to represent forestland management [35,36]. We also examined the moderating effect of labor migration and forestland tenure titling certificates from multiple aspects, which provided more new insights to explore forestland management, compared to many other studies that only focused on the policy factor [37]. It is generally found that policy factors such as Collective Forestland Tenure Reform and forestland tenure titling certificates had a significant positive effect on forest management in terms of cash outlays and labor inputs. This is consistent with previous studies, and the results confirm both the research hypotheses and previous studies [29,38]; collective forestland tenure promotes rural households' forest management. However, this study's results differ from others [28,39], which do not consider the moderating effect of policy factors and labor migration. Those studies report that labor migration has a positive moderating effect on forestry inputs and mainly analyze the influences on forestland management from the dimension of labor inputs and cash outlays. By taking into account the different enumerations of forestland management, we have also verified the robustness of our findings. However, it is difficult to reflect the moderating effects of labor migration.

Second, previous research and analysis failed to consider the impact of rural labor migration changes under certain socio-economic conditions on current rural households' forestland management [1], so the moderating effects of rural households' labor migration have been added. Presently, labor migration is one of the most important livelihood strategies of rural households in China, and thus it is crucial to consider this factor to analyze the effects of forestland management.

Third, these results provide new insights into how policy factors such as Collective Forestland Tenure Reform and forestland tenure titling certificates affect rural household forestland management, and therefore complement previous conclusions that Collective Forestland Tenure Reform affects rural households' forestry management behavior [26,40]. This study contributes to the literature by improving our understanding of the influence of the moderating effect of rural areas' policy implementation and rural labor migration on rural households' behavior. On the basis of the new economics of labor migration (NELM) framework, combined with the data from a nationwide sample survey, this research enriches and supplements the analysis framework, discusses prominent phenomena such as labor migration, and adds the trend analysis of rural households' forestland management behavior. This research systematically analyzes the moderating effects of labor migration

and Collective Forestland Tenure Reform and the main reasons for rural households planning to manage forestland.

Even though this research has contributed to an improved understanding of the relationship between Collective Forestland Tenure Reform and rural households' forestland management, there still exist some deficiencies that need further research. First, our findings need to be interpreted with caution. More efforts should be made to examine variations in forestland management between regions with different aspects, as well as different socioeconomic characteristics. Also, labor is a broad concept, which has many facets, such as gender differences and location differences. In order to fully capture the impacts of the moderating effects of Collective Forestland Tenure Reform and labor migration on rural households' forestland management, it would be worthwhile for future research to further explore the impact of these and other elements of labor migration on forestland investment. We hope that future research can be carried out from this perspective, leading to greater knowledge. Second, this study has focused on the sample area in China. Our results may be very different from those derived from other areas worldwide. Other regions in other countries have different forestland tenure institutions, and thus we recommend that other studies should extrapolate our conclusions for use in other regions where the forestry resources, environmental conditions, and demographic and institutional characteristics might be different because the question of whether the conclusions from this study can be applied to other regions needs to be further examined.

The following implications are made in response to the above results.

First, the Chinese government should continue to promote Collective Forestland Tenure Reform, not only including forestland tenure titling certificates, but also to further improve rural households' perception of forestland tenure security, such as the right to lease and income from managing forestland.

Second, the Chinese government should improve the supporting measures of Collective Forestland Tenure Reform, such as forest insurance and forestland subsidies. Forest insurance can cushion rural households from the risks caused by long forest management cycles and increase their sense of security regarding future returns. Forestry subsidies can reduce rural households' logging behavior and not only improve their investment in forestland, but also realize sustainable forestry operation.

Third, the Chinese government should encourage industries to move to small and medium-sized cities and towns, and encourage rural laborers to engage in off-farm employment nearby. On the one hand, this can ensure higher returns for rural households, and on the other hand, it can reduce the loss of the main family laborers from forestland management.

Fourth, the Chinese government should further improve the mechanism of forestland leasing, simplify the cost and process of the forestland leasing process, accelerate the construction of new forestry business entities, and promote the effective leasing of forestland to forestry enterprises. It should incentivize modernized forestry enterprises with good skill levels and family forestry farms to develop forestry economy scientifically and drive up the inputs of rural households.

Author Contributions: Conceptualization, F.H. and H.X.; methodology, Y.X.; software, H.X.; validation, H.X., F.H. and Y.X.; formal analysis, H.X.; investigation, H.X. and F.H.; resources, F.H.; data curation, H.X. and F.H.; writing—original draft preparation, F.H. and Y.X.; writing—review and editing, X.L.; visualization, X.L.; supervision, F.H.; project administration, F.H.; funding acquisition, F.H. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the key project of the basic business expenses of central universities research “Impact of Industry Clusters and Global Value Chain Reconstruction on the High-Quality Development of Forestry Industry under the Double-Cycle Perspective” (Grant Number: No. 2021SRZ02); project entrusted by the State Forestry and Grassland Administration “Evaluation of Rural Forestry Reform and Development Policy Based on the Perspective of New Management Subjects” (Grant Number: JYC-2021-00203).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

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