

Article

Evaluating the Impact of Forest Tenure Reform on Farmers' Investment in Public Welfare Forest Areas: A Case Study of Gansu Province, China

Yuge Wang ^{1,†}, Apurbo Sarkar ^{1,†} , Min Li ¹, Zehui Chen ¹, Ahmed Khairul Hasan ², Quanxing Meng ^{1,*}, Md. Shakhawat Hossain ³ and Md. Ashfikur Rahman ⁴ 

¹ College of Economics and Management, Northwest A&F University, Xianyang 712100, China; wangyuge@nwfau.edu.cn (Y.W.); apurbo@nwfau.edu.cn (A.S.); limin1983@nwfau.edu.cn (M.L.); chenzh@nwfau.edu.cn (Z.C.)

² Department of Agronomy, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh; akhasan@bau.edu.bd

³ College of Agronomy, Northwest Agriculture and Forestry University, Xianyang 712100, China; shakhawat@nwfau.edu.cn

⁴ Development Studies Discipline, Social Science School, Khulna University, Khulna 9208, Bangladesh; ashfikur@ku.ac.bd

* Correspondence: qsmeng@nwfau.edu.cn

† These authors contributed equally to the study.



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Abstract: In recent times, forest tenure reform has become one of the most discussed agendas among local and global policymakers. Forest tenure is a contract that specifies who has rights to forestry resources and depicts who should utilize, maintain, and acquire them. It can have a significant impact on whether farmers invest in their forestland. The study's primary purpose is to explore whether and how the reform of forest rights affects farmers' investment in public welfare forestry. More specifically, the study thoroughly analyzes the impact of primary and supplementary reforms on farmers' investment in public welfare forest areas. We have outlined the theoretical framework using the theory of property rights and utilized the fixed-effect model and the Difference in Differences (DID) model to achieve research objectives. However, the empirical setup of the study has comprised time series data of 500 farmers, which was collected via interviews conducted at regular time intervals (2011—before the reform; 2013, 2015, and 2017—after the reform). The collective forest land welfare areas in Gansu Province, China, have been selected as the key data collection area. The study concludes that: (i) although the principle reform of forest tenure can stimulate farmers' investment intensity in the short term, it is insufficient in the long term. (ii) The supplementary reform of forest tenure can significantly promote farmers' long-term effective investment. There is a significant difference in forest land investment between the experimental and control groups, and this difference gradually expands over time. The study suggests that the government should pay more attention to the relevance of additional reforms to encourage the growth of forest rights mortgages and circulation. Moreover, the core themes of sustainable development in forestry should be highlighted.

Keywords: collective forest rights; land tenure; reform; forestland investment; public welfare; forest land

1. Introduction

Nowadays, the present world confronts several interconnected socio-economic and ecological problems such as the climatological issue, the widespread grasp of novel pandemics, increasing social discrimination with pervasive hunger, and the threat of losing global biodiversity [1]. These issues lead to the pressing necessity of restoring and managing land and forests sustainably [2,3]. According to recent studies, land and forest tenure reforms can boost collective forest occupancy [4,5], and it has progressively been cited as an

efficient way to decrease deforestation, combat the adverse impact of climate change, retain biodiversity, and restore natural ecosystems [6–8]. Specifically, it may foster a vital boost for facilitating a smooth transition to the sustainable development of forest land within remote Chinese mountainous regions [9]. Since the Brundtland Report was released in the 1970s, also called *Our Common Future*, the publication presented by the World Commission on Environment and Development (WCED) that familiarized the notion of sustainable development and defined how it could be attained, the importance of collective forest rights has retained much appreciation towards sustainable forest management [10]. The essential element of the tenure reform was to provide farmers user rights on land collectively owned by villages [11]. Various regions have endeavored to expand formal forest ownership structures and use the potential opportunities for involving local communities. In Africa, Asia, and Latin America, around 28% of forests are officially possessed or allocated for usage by native communities [12,13].

In the early 1980s, China adopted agricultural land tenure reform, which also fostered seeds for the availing of rural forest tenure reform, and since then, the government has allowed the privatization of some collective community forestry resources [14]. Aligned with agriculture land tenure reform, China has implemented the reform of collective forest tenure reform, which is divided into two stages: (i) the primary reform stage and (ii) supplementary reform. The primary reform stage began in 2008 and was completed by the end of 2011. The purpose of the primary reform is to clarify the property rights, endow farmers with the right to use and benefit from collective forest land, enable farmers to obtain important means of production, and promote farmers' employment and income [15]. Moreover, it also ensures the active participation of associated farmers, determines the ranges of forest land, and issues forest tenure certificates for farmers to exercise their rights and supervise the completion of the reform. The supporting reform began in 2012 and is still ongoing. The purpose of the supplementary reform is to promote the improvement of forest land mortgage and circulation and so on, to realize the sustainable development of collective forest land [16]. Seemingly, it also monitors the implementation of supporting reforms through follow-up surveys. Interestingly, the collective forests cover around 58% of China's forest territory and have the potential to significantly improve livelihood opportunities [17]. China has adopted several policies to uphold the possibilities of forest land reform, which concentrates on providing local families land-use rights and forest governance in collective forest regions. This enables communities to make earnings and enhance their lifestyles by embracing communal forest lands and forests. The ongoing forestry tenancy reforms will distribute 167 million hectares of forest land to local households, with around 500 million farmers expected to benefit by 2025 [18]. Within the reform mechanism, around 35% of the overall communal forest has already been distributed to individual families [19].

Moreover, with the ever-increasing pressure of mitigating climate change and global warming, China has initiated a new phase of collective reform of the forest property rights system to enhance the poor productivity of communal forest land while restoring and protecting the ecological environment of vital water conservation regions [20]. The core aspect of the changes (such as demarcation, confirmation, and certification) was completed at the end of 2011, and farmers were given the complete rights to manage forestland and the ownership of forest trees [21]. Around 99% of the collective forest land was distributed to the local communities till then [22]. Moreover, several regions have begun additional changes by boosting the development of forest land credit and forest property rights transfers. As a result, farmers' mortgage and transaction rights are strengthened substantially, and the diversification of collective forest land development is encouraged [23,24].

Existing literature highlights that the relationship between forest property rights reform and forest land investment is primarily focused on two dimensions. The first dimension deals with farmers' interpersonal behaviors and feelings about forest tenure reform [25–27]. The second dimension fosters the impact of farmers' subjective evaluations of forest tenure reform on investment [28–30]. However, most of the existing studies

focus exclusively on the primary reform of forest tenure and overlook the impact of subsidiary reforms on forest land investment [31,32]. The development of public welfare forests may be a significant challenge for sustaining the ecological environment, as it is a continuous development process and inextricably linked to forest farmers' long-term and effective investment [33,34]. Farmers need to make a long-term and effective investments to ensure the sustainable growth of communal forests, which is one of the main objectives of new rounds of collective forest rights system reforms [35,36]. While, past studies have relied substantially on small, short-term samples and have failed to capture the dynamic influence of the new round of collective forest land usufruct confirmation on farmers' long-term investment in forest land. The research on forest land investment is also disproportionately focused on economic forest areas, while minimal attention has been paid to public welfare forest areas. Specifically, economic wellbeing and communal growth are critical aspects of investments that may foster the farmers' collective forest management and conservation [37–39]. Therefore, studying forest land investment in public welfare forest areas is necessary.

After the forest tenure reform, the trees in public welfare forest areas are protected and cannot be cut down, reducing farmers' timber income [40]. Forestry subsidies and benefits from secondary economics make up the majority of farmers' forestry revenue, causing the forestry development of public welfare forest regions to shift to other sustainable forest usage elements such as non-timber forest products on forest land [41,42]. This context impacts the method of forest rights reforms in public benefit forest regions and farmers' investments. Interestingly, some studies have found that farmers' long-term investment in forest land shows an unstable growing trend [43,44]. This notion leads to the following research questions, which need to be explored for understanding the critical impacts of forest tenure reform: (i) Whether the ongoing incentive of collective forest rights reforms affects forest land investments? (ii) What would be the possible effect of the supplementary forest tenure reforms on farmers' investments? (iii) Is there any deviation between the investment intensity within a certain period? (iv) Is there any combined effects from the primary and supplementary reform policies?

This study tracks the changes in forest farmers' forest land investment during regular intervals (2011, 2013, 2015, and 2017) using property rights theory and monitoring panel data from the forest rights system reform. The impact of the primary reform (forest land certification) and supplementary reform policies (development of forest right mortgages and forest right transfers) on farmers' forestland investment has been assessed using the fixed-effect and DID models. These are the main innovations of this study. This study's findings might help determine if the forest property rights reform's primary and supplementary reforms have long-term consequences. On the other hand, this study demonstrates a more profound knowledge of the relationship between forest property rights reform and long-term investment by farmers and a prospective for a new direction for follow-up reform.

2. Materials and Methods

2.1. Literature Review

In this part, this study discusses the theoretical background, portrays the formulation of the hypothesis, and outlines the adopted methods and methodology.

2.1.1. Background Studies and Hypothesis Development

Small farm sizes and low productivity can be ameliorated by letting farmers transfer farmland to others for agricultural production. However, private land ownership is banned in China, and therefore insecure ownership of farmland may cause a serious burden for the farmers to invest spontaneously. Under China's current Household Responsibility System (HRS), which started in the early 1980s, all rural land is owned by rural collectives, which allocate contract rights for parcels of farmland to eligible households (NPC 2017). Under

the contract rights, farmers can decide what to plant and how, keep returns from their agricultural production, and lease their land to others for agricultural production.

Currently, land transfers to firms represent 10.5 percent of all transfers (or 3.8 percent of all arable land), but their growth has been slow in recent years [45]. An important factor is that the property rights of rural land are insecure and unclear. This is manifested in inaccurate land borders and sizes, incomplete land use right certificates, and a limited HRS tenure. Therefore, a property rights system with a clear definition is essential in realizing the effective allocation of production factors [46,47]. The Chinese government just extended HRS tenure to 2057 and is in the process of issuing land use right certificates with more accurate land positions and size information. This effort is expected to boost the land rental market in the future.

The impact of forest rights reform on forest land investment is mainly divided into two aspects: the primary reform's impact and the supplementary reform's impact [48], which are shown in Figure 1. The primary reform improves farmers' expectations of stable property rights and security perceptions through issuing certificates [49,50]. Previous studies have shown that unstable property rights will make farmers lack long-term expectations for the plots they use [51] and have a negative impact on farmers' investment incentives [52–54]. After analyzing the impacts of forestland distributions among local farmers, private producers, and land-poor households of Nicaragua, Deininger and Chamorro [55] identified that the confirmation of forest land ownership can reduce the risk of the random adjustment and expropriation of forest land, increase farmers' investment enthusiasm, improve farmers' sense of security in obtaining income, and impel their investment willingness and behavior. Moreover, Ghebru and Holden [56] explored farm-level data of Ethiopian rural forestland and confirmed that through the accurate mapping of the plot, the ownership can be clarified, the unclear income ownership caused by the ambiguity of property rights can be avoided, the cost of forest land disputes and mediation can be reduced, and farmers' investment in forest land can be increased.

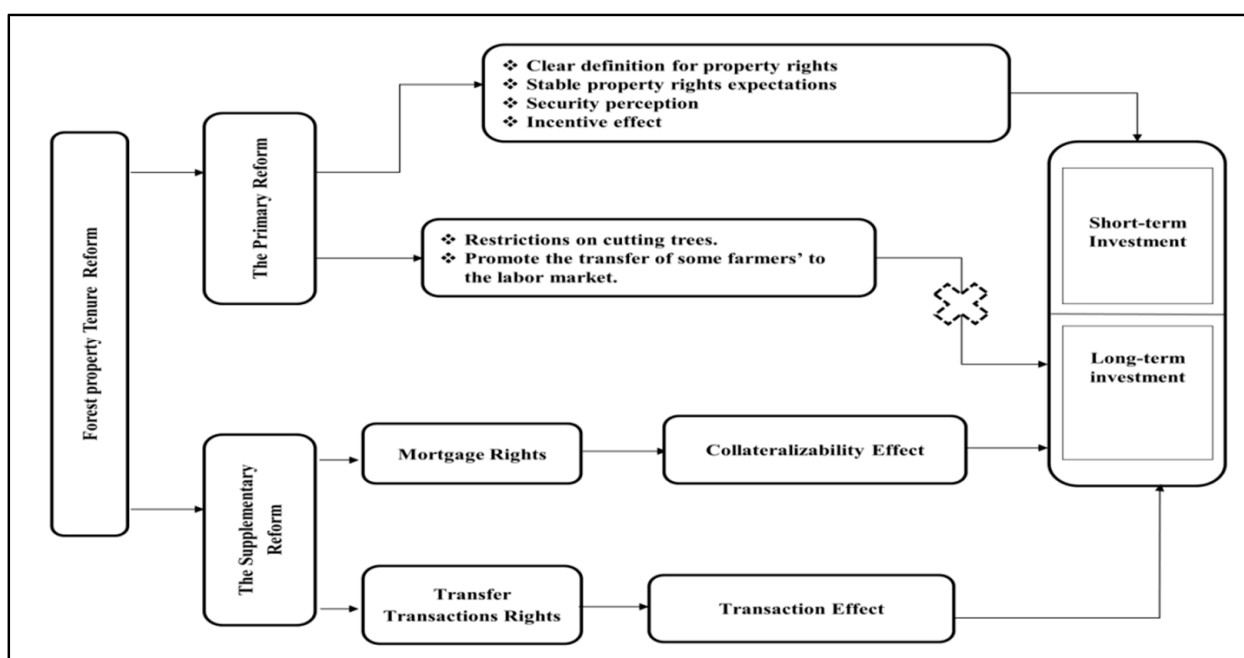


Figure 1. Effect mechanism of forest tenure reform on farmer's investment in the public welfare forest area.

Moreover, existing studies have studied the relationship between property ownership, management rights, mortgages, transaction rights, and different investments. However, there is no consensus on the relationship between property rights and land investment [55]. Some scholars have affirmed the positive incentive between rights confirmation and farmers'

investment [57–59] and believe that the stability and duration of property rights play an essential role in encouraging farmers' investment and production decisions [45,60]. Some studies have not observed the relationship between right granting and land investment (for example the study of Haley and Nelson [61] regarding crown forest tenure systems; Holden and Yohannes [62], exploring Southern Ethiopian farm households and Carter and Olinto [63], evaluating Paraguayan farmers forest tenure rights systems). Moreover, by exploring existing trends in the literature it can be found that they mostly focus on exploring the relationship between the primary reform of property rights and investment rather than supplementary reform [20,31]. Interestingly, most of the related literature rarely explored the potential impacts of the primary reform and supplementary reform in fostering short term and long-term investment behavior in public welfare forest regions. For example, in a study of African nations, Conigliani et al. [64] explored the relationship between farmers' investment behaviors and institutional contracts, but the study exclusively focused on large-scale farm dimensions with long-term investments. Lönnstedt and Sedjo [65] explored how investment in forestland is changing as per the alteration of forestland ownership changes in the United States and Sweden, and they solely focused on long-terms effects.

However, the nature of forest land in public welfare forest areas makes farmers lose their ownership of trees and only have the usufruct and management rights of forest land. This limits the incentive effect of the primary reform in public welfare forest areas on farmers' investment behavior. Low returns on investment are an important reason why farmers are unwilling to invest [16]. Borrás [66] explored the investment behavior of farmers in the public forest of the Philippines and found that farmers' investment behavior has the characteristics of short-term monetization, and the characteristics of forestry management often require long-term investment to obtain corresponding returns. Therefore, when the income cycle does not match farmers' expected cycle, they often choose to reduce forestland investment. At the same time, the reform of forest property rights promotes the transfer of some farmers to the labor market [67,68], which further reduces farmers' enthusiasm for forest investment [69,70]. Therefore, the lack of property rights may make the long-term incentive of the primary reform regarding forest land investment insufficient. The study outlines Hypothesis one (H1) and Hypothesis two (H2) as follows:

H1: *the primary reform of forest tenure doesn't have any significant effects on farmers' short-term investment.*

H2: *the primary reform of forest tenure has no positive incentive for farmers' long-term investment.*

Supplementary reforms liberalize the rights of farmers' mortgage and transfer transactions, which is necessary for forest land investment. Credit shortage is the key factor determining the production performance and development of agroforestry, and budget constraints are an important factor that limits farmers' input [71–73]. The supplementary reform of forest tenure gives farmers the right to forest land mortgages and makes varying degrees of efforts for the implementation of the mortgage (such as actively communicating with relevant banks and promoting the improvement and revision of loan treaties on forest rights). This measure makes it possible for farmers to obtain forest right credits and effectively promotes farmers' resource allocation so that the potential collateralizability effect can appear. In a study of Latin American rural and indigenous women, Bose [74] has shown that farmers' access to credit can increase the dual impact on variable and fixed inputs. Similarly, Ceddia et al. [75] explored the relationship between land rights and agricultural expansion among Latin American indigenous communities and identified that if the continuous improvement of the credit right of forest land can be ensured, farmers' long-term expectations of obtaining forest rights credits is more stable, and they tend to be more willing to make a long-term investment in forest land. Therefore, the success of the supplementary reform of forest rights mortgages has a long-term and positive impact on forest land investment.

The development of the forest land circulation market can liberalize the allocation of forest land means of production and enhance the efficiency of farmers' resource alloca-

tion [76]. Households with obtained land certification are more likely to rent out or rent in the land than the not-obtained ones [77,78]. There is evidence that leased land's input use and productivity are higher than self-owned land [79,80]. Moreover, safe trading rights can encourage farmers to invest more and grow long-term trees, which is supported by the study of the Brazilian Amazon [81]. In addition, even if the long-term investment of farmers cannot be recovered temporarily, farmers can also realize the realization effect through circulation to reduce the investment risk [82,83]. Stickler et al. [84] identified similar assumptions among community-driven forest owners of Zambia. Therefore, to maintain the circulation value of forest land, farmers are bound to maintain the management and protection of forest land or fertilizer for a long time. Therefore, this article depicts the third hypothesis as follows:

H3: *There is no association of the supplementary reform of forest tenure to promoting farmers' long-term investment in forest land.*

2.1.2. Methodology

This study uses a combination of the fixed-effect model and DID model to compare the changes in forest land investment of forest households before and after implementing the forest rights reform policy. We mainly considered the different implementations of the primary and supplementary reforms. The state predominantly initiates the primary reform, and all sample farmers have to carry out the reform to ensure that the forest rights certificate is issued in the hands of each farmer. Therefore, using the fixed-effect model can better highlight the relationship between the reform of forest property rights and farmers' long-term investment behavior, as suggested by Lu et al. [85]. The fixed-effect model set in this study is as follows:

$$y = \beta_0 + \beta_i \chi'_{it} + \delta_i z'_i + \lambda_t + \mu_i + \varepsilon_{it} \quad (1)$$

In the formula, y is the farmers' investment, χ'_{it} is the explanatory variable such as the right confirmation period, β_0 is the intercept term, β_i is the coefficient parameter corresponding to the explanatory variable. Seemingly, z'_i is the control variable, δ_i is its corresponding parameter, λ_t represents the time effect that does not change due to the individual, μ_i represents the individual effect that does not change with time, and ε_{it} is the random disturbance term.

However, the supplementary reform is carried out in an orderly manner in combination with the actual conditions [22]. Due to the different development of various regions, it is more suitable to use the DID model for analysis. The DID model is a standard method to identify the effectiveness of policies [86], which can test the average change in forest land investment in the experimental and control groups before and after implementing the forest tenure supplementary reform. Referring to Nunn and Qian [87], the model set in the article is as follows:

$$y_{it} = \alpha_0 + \alpha_1 du + \alpha_2 dt + \alpha_3 du * dt + \varepsilon_{it} \quad (2)$$

In the formula, y_{it} is the investment of farmer i in year t , and du is a grouped dummy variable. If the individual i is affected by the implementation of the policy, individual i belongs to the treatment group, and the corresponding du value is 1. If individual i is not affected by the implementation of the policy, individual i belongs to the control group, and the corresponding du value is 0. Where, dt is the dummy variable of policy implementation. Before policy implementation, dt is 0, and dt is 1 after policy implementation. While, $du*dt$ is the interaction between the grouped dummy variables and policy implementation dummy variables, and its coefficient reflects the net effect of policy implementation.

Farmers' investment has been selected as the dependent variable. The article chooses farmers' forestry production and management inputs to measure farmers' investment. It is mainly divided into the management and protection costs of forest land and inputs in understory planting. So, the investment includes the materials and labor cost for forest management and protection and the inputs of seeding, chemical fertilizers, pesticides,

machinery, and the labor force in the development of the understory planting industry and other forestry management. Regarding the primary reform of forest tenure, the study selects the certification duration as the index to verify the long-term impact of the primary reform on forest land investment.

The interaction term between dt and du has been used as independent variable two. In terms of supplementary reform, the article uses the interaction term between du (regional dummy variable) and dt (time dummy variable) as an index to measure the effectiveness of the supplementary reform. According to the different development of forest right mortgages and forest right transfers, Jingchuan County, Hui County, and Huining county, with a perfect supplementary reform, are set as the experimental group with a value of 1 ($du = 1$), and other areas are set as the control group with a value of 0 ($du = 0$). Considering the lag effect of policy implementation, the article set the dt value before 2013 as 0 and after 2013 as 1.

The study used farmers' individual characteristics, family capital, and forest land characteristics as the control variables. These variables may affect forest farmers' investment and mainly include sex, age, the number of laborers, the number of migrant workers, the forest land area, the number of forest land blocks, and total household income [88–90]. The definition and descriptive statistics of the variables are shown in Table 1.

Table 1. Variable selection and descriptive statistics.

Variable	Implication	Mean	Min	Max
Farmers' Investment	Yuan	2672.969	0	650,000
Confirmation of Tenure for Two Years	Yes = 1, No = 0	0.250	0	1
Confirmation of Tenure for Four Years	Yes = 1, No = 0	0.250	0	1
Confirmation of Tenure for Six Years	Yes = 1, No = 0	0.250	0	1
dt	After 2013 = 1, others = 0	0.750	0	1
du	After policy implement = 1, Before policy implement = 0	0.300	0	1
DID	$du*dt$	0.225	0	1
Age	age of the householder (years)	52.252	21	85
Sex	Male = 1, female = 0	0.949	0	1
Number of labors	The actual number of adult laborers in the family	2.739	0	8
Number of migrant labors	The actual number of migrant workers in the family	0.969	0	5
Forest land area	μ	35.822	0.3	940.66
Number of forest land blocks	blocks	2.892	1	20
Household total income	yuan	43,281.730	149	1,230,000

2.2. Data Resources

The data in the study has been comprised of time series data with regular time intervals of 2 years (2011, 2013, 2015, and 2017) to reflect the impact of forest land investment before and after the forest tenure reform, especially on long-term investment. The data for 2011 denotes before the reform, and 2013, 2015, and 2017 represent after the reform. The survey uses the stratified sampling method to select the peasant who participated in communal forestland. More specifically, we explored the collective public welfare forest areas, which refer to the forest, trees, and forest land owned by the collective, mainly to protect and

improve the human living environment, maintain ecological balance, encourage tourism, and foster better livelihood opportunities for local communities [25]. It can be divided into shelter forests and special-purpose forests. First, a set of 10 counties has been chosen among 86 counties using the random sampling technique (which is shown in Figure 2). Next, five sample townships were chosen randomly from those counties, and then one village was chosen from each township. A set of ten peasant farming individuals were chosen randomly from each village, which comprised 500 peasants for final interviews. The main strengths of this sampling technique were that each member of the population had an exactly equal probability of being chosen using this sampling procedure [91]. It also employs randomization; any research conducted on this sample has excellent internal and external validity [92], because randomization is the most effective strategy for reducing the impact of potential confounding variables [93]. The empirical data has been collected through face-to-face interviews, where the responses have been taken based on a structured questionnaire. Finally, the study has obtained a total of 2000 questionnaires (500 peasants multiplied by four subsequent years) which have been further analyzed to fulfill the research objectives.

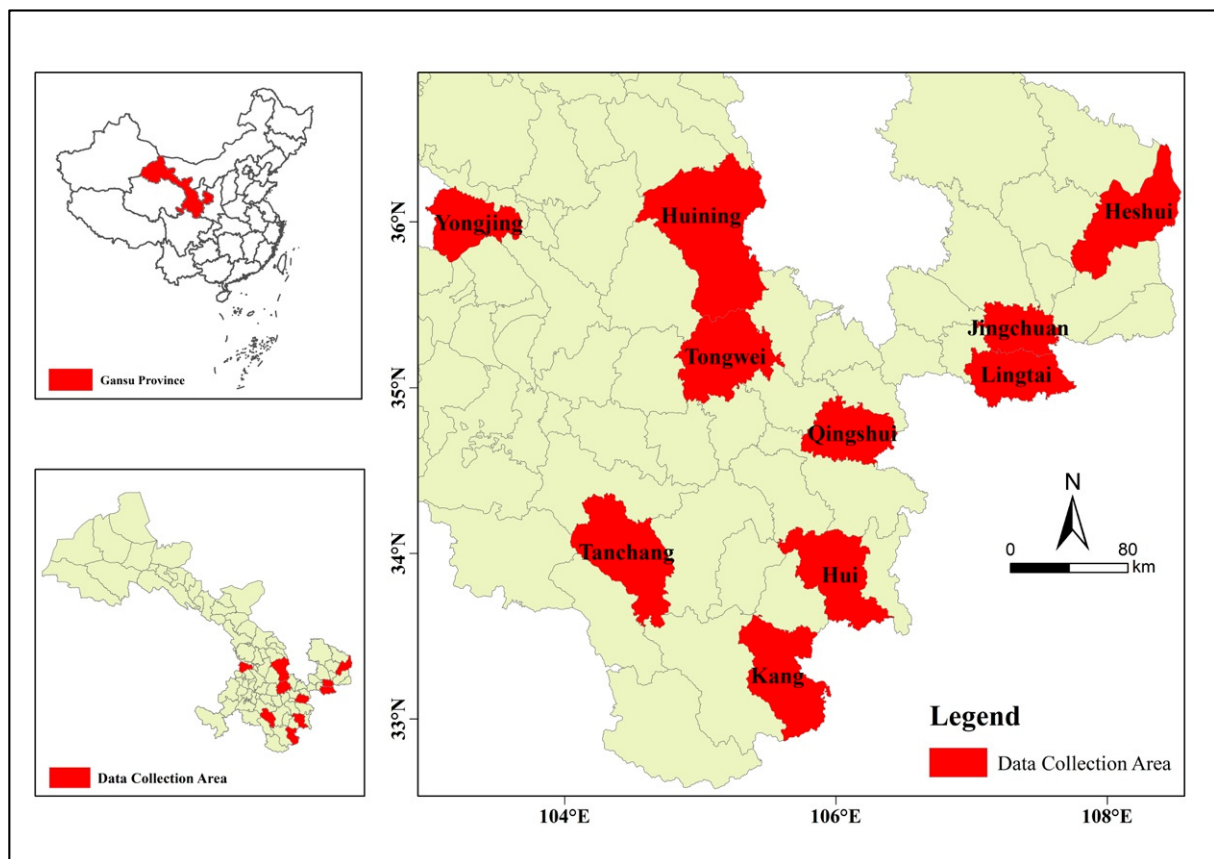


Figure 2. Study Area.

The group leader rechecked the questionnaire to identify any missing components, and a timely callback was made after each day's investigation was completed, which helped the study ensure the quality of the investigation. Before conducting the survey, the study took formal permission from the local forestry administrative authority and the local communist party. Before starting the formal interviews, each respondent was clearly informed and explained that the primary motives of the data collection were just for academic purposes, and the study would not store or share any form of the data for any business purposes. They were well aware that they can opt out anytime from answering any part of the questionnaire. Moreover, in the formal questionnaire, we have also included

questions regarding verbal permission. Therefore, strict requirements for taking formal permission from the institutional review board were used, as suggested by Josephson and Smale [94] and Yanow and Schwartz-Shea [95]. Additionally, we have obtained verbal permission from each of the villages' heads, which helps us ensure a higher response rate. The survey was conducted as a part of the research project called "Monitoring of Collective Forest Tenure Reform-Gansu province". This is known as the first initiative to continuously track and monitor large-scale farmers to assess the effectiveness of communal forest property rights reforms. The progress of clarifying the property rights of communal forest lands, deepening the reform, increasing service follow-up, farmers' evaluations of the reform, and the policy needs are part of the monitoring content.

3. Results

3.1. Effect of the Primary Forest Tenure Reform on the Farmers' Investment in Public Welfare Forest Areas

According to the research framework and techniques that are given above, the fixed-effect model is used to quantify the impact of the major collective forest tenure change on farmers' investment. The Hausman test is used to determine the applicability of the fixed-effect model before adopting it. The Hausman test p -value is significant at 1%, showing that the fixed effect model is appropriate. Table 2 shows the results of the primary reform of collective forest tenure on farmers' investment. The primary reform of collective forests can promote the short-term investment in public welfare forest areas. However, the primary reform has an insufficient incentive for long-term investment. The regression coefficient between the primary reform of collective forests and short-term investment in public welfare forest areas is positive, and the p -value is less than 0.05, which means the null hypothesis 1 is rejected. In other words, it demonstrates that the primary reform of collective forests can promote short-term investment in public welfare forest areas. The regression coefficient between the primary reform and long-term investment is insignificant (p -value for four years of confirmation is more than 0.1) or negative (coefficient for six years of confirmation is negative and the p -value is less than 0.01). Therefore, hypothesis 2 is accepted. More specifically, it proved that the primary reform doesn't have a positive incentive for long-term investment, as the confirmation period increases.

Table 2. The impact of primary reform of collective forest on farmers' investment.

	(1)	(2)	(3)	(4)
Confirmation of tenure for two years	0.006(0.002) **	-	-	0.004(0.001) ***
Confirmation of tenure for four years	-	-0.002(0.001)	-	-0.002(0.002)
Confirmation of tenure for six years	-	-	-0.005(0.001) ***	-0.004(0.002) ***
age	-0.001(0.001)	-0.001(0.001)	-0.001(0.001)	-0.001(0.001)
sex	0.002(0.003)	0.002(0.003)	0.002(0.003)	0.003(0.003)
Education	0.001(0.001)	0.005(0.001)	0.001(0.001)	0.001(0.001)
Number of labors	-0.001(0.001)	0.002(0.001)	-0.003(0.006)	-0.001(0.001)
Number of migrant labors	0.001(0.001)	0.008(0.001)	-0.005(0.007)	-0.001(0.001)
Forest land area/blocks	0.001(0.001) ***	0.001(0.001) ***	0.001(0.001) ***	0.001(0.001) ***
Household total income	0.234(0.014) ***	0.233(0.014) ***	0.236(0.136) ***	0.240(0.138) ***
Cons	-0.006(0.006)	-0.004(0.006)	-0.004(0.006)	-0.006(0.006)

Notes: **, and *** indicate significance at 5%, and 1% levels, respectively, and the standard errors are reported in parentheses.

The regression coefficient between them does not vary significantly, if at all, as the confirmation period increases. Farmers invest in public welfare forest regions for two reasons: one, to earn matching forestry subsidies by investing in forest resource management and protection, and two, to generate income through the growth of understory planting. Due to the primary change, farmers will benefit from more stable tenure and operating periods.

Farmers have higher hopes for forest land management stability and continued gains from understory planting in the early days of the significant reform. Moreover, they are eager to invest in forestry to increase their earnings [96].

However, with time, farmers discovered that they could still receive most of the payments even if they did not invest in forest management and conservation. Furthermore, the overall amount of forestry subsidies in public benefit forest regions is low (the average amount provided to families is 10 yuan/mu), which is insufficient to entice farmers to invest in long-term forest management and protection. On the other hand, under-forest planting is complex and necessitates advanced technology and capital support. However, technology and market development in the public welfare forest area are not yet mature enough, and there are risks and losses in production and operation, necessitating the use of borrowed funds to complete capital turnover. As a result, proper forest mortgages are becoming increasingly important to farmers.

The primary reform can pique forest households' interest in making a short-term investment, but it fails to address new farmer demands such as with circulation and mortgages, leaving farmers with a small motive to make long-term investments. In addition, the fragmentation of forest land has a significant negative impact on farmers' forestland investment. The smaller area per block rectifies a relatively greater degree of forest fragmentation and possesses less long-term investment of forest households. This is possible because the fragmentation of forest land increases the production loss [97,98], increases forestry production and management costs [99,100], reduces productivity, and weakens the farmer's investment. Besides, household income significantly promoted the forest land investment of forest households. It could be due to China's rural social security system [101]. Forest farmers expect that forest land resources will be one of the sources of livelihood security in the future [102,103], so they will correspondingly increase investment to ensure the sustainable development of forest land when the family income has been raised.

3.2. The Influence of Supplementary Reform on Farmers' Investment in Public Welfare Forest Areas

A parallel trend assumption test should be conducted before the DID test. The results showed that if the individuals in the treatment group did not receive intervention or impact, the changing trend of the results was the same as that in the control group. It illustrates that the premise of the double-difference method is met, and the DID model is appropriate.

Table 3 shows the impact of supplementary reform on farmers' forestry investment. Column (1) shows the results of not introducing the control variable, and column (2) shows the introduced results. The two results show that the long-term investment of forest farmers in counties with successful supplementary reform is higher than that in other counties, and the gap is more significant with time. That is to say, the coefficient between DID and farmers' investment is positive, and the *p*-value is less than 0.1, so therefore hypothesis 3 has been rejected. The effective promotion of supplementary reform can carry forward farmers' long-term input in management and protection of forest land. The whole forest land disposal right, for example, might save transaction costs and increase farmers' investment excitement. The right to mortgage and circulate forest land is crucial for the disposal tenure. The mortgage has a strong relationship with loan availability [104]. The easier it is for forest farmers to access forest management funds if the mortgage is liberalized correctly as part of the additional reform of forest tenure, the greater their investment and incentive ability. For forestry production's efficient distribution of land elements, forest land circulation is required. The seamless flow of land factors increases marginal productivity, increasing farmers' incentive to produce and invest [23].

Table 3. The impact of supplementary reform of collective forest son farmers' investment.

	(1)	(2)
DID	0.005(0.003) *	0.005(0.003) *
time	0.001(0.003) **	−0.001(0.001)
treat	0.004(0.001) ***	0.002(0.002)
Control variable	not-introduced	introduced
cons	0.001(0.001) ***	−0.046(0.021) **

Notes: *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively, and the standard errors are reported in parentheses.

3.3. Robustness Test

The study employed Propensity Score Matching (PSM) as a robustness test to verify whether households' investments before and after the forest rights reform have consistent outcomes, as suggested by Song et al. [105]. Referring to Smith and Todd [106] and Caliendo and Kopeining [107], the following model is constructed according to the general steps of PSM to calculate the average treatment effect. This study uses approximate randomization of non-random data to estimate the counterfactual probability of the treatment and control groups. The formula is set to $ATT = E(Y_{1i} + Y_{0i} | D_i = 1)$, where D_i is the treatment variable, Y_{1i} refers to the investment in the treatment group, and Y_{0i} indicates the investment in the control group.

The outcomes shown in Table 4 depict that the primary reform of forest tenure can promote farmers' investment in the short term, but the long-term incentive is insufficient. However, the supplementary reform can effectively improve farmers' long-term input. The results obtained are consistent with the above test results. Therefore, the research conclusion of this paper is relatively stable.

Table 4. Results of the treatment effect of forest tenure reform on farmers' investment.

	Treatment Effect	Treatment Group	Control Group	Gap	Standard Error	T-Value	Sig.
Confirmation of tenure for two years	Unmatched	2.906	2.252	0.655	0.188	3.48	yes
	ATT	2.885	2.162	0.723	0.222	3.25	
Confirmation of tenure for six years	Unmatched	1.126	2.845	−1.720	0.184	−9.31	yes
	ATT	1.126	2.911	−1.785	0.196	−9.12	
Supplementary reform	Unmatched	3.089	2.220	0.869	0.195	4.46	yes
	ATT	3.089	2.234	0.854	0.241	3.55	

4. Discussion

According to the tracking data, the investment of forest households in public welfare forest areas shows two distinct development trends after the reform of forest tenure. On the one hand, farmers' investments in public welfare forest areas have a pattern of increasing within the short term. However, in the long run, it shows declining trends. Farmers' investment is expected to rise in the short term once the primary reform is largely accomplished. In 2013, which is the second year after the completion of the primary reform, overall investment in forest land was 1.43 times what it was before the primary reform. Farmers' investment, on the other hand, shows a substantial drop in volatility as confirmation time increases. As a result, this study believes that the impact of the significant reform's confirmation and certification on farmers' investment has a certain amount of variability. As indicated in the literature review sections, most of the existing literature (such as Yi et al. [23], Holden et al. [29], and [84]) showed that the relationship between forest tenure and investment is one-sided (relevant or not) and that the long-term tracking of forest land investment changes is insufficient. As a result, the study explores if the long-

term evolution of forest tenure reform has an uneven impact on forest households' short and long-term investment in public benefit forest regions to build a novel reference policy.

Farmers' investment in diverse regions, on the other hand, exhibits varied development tendencies as a result of the promotion of supplementary forest tenure reform, despite the tracked samples having identical personal and family characteristics. According to the findings of the previous study (for example, Wang et al. [108] and JingWen et al. [109]), the development of forest land circulation and forest right mortgages is causally related to farmers' investment. As a result, this study explores whether the supplemental reform plays a significant role in the distinct development of the investment and whether there is any relationship between supplementary forest tenure reform and farmer investment. Therefore, this study tests the impact of forest tenure's primary and supplementary reform on farmers' investment using the fixed-effect and DID models. The results show that the primary reform of forest tenure significantly affects farmers' short-term investment, which is consistent with the research of Yi et al. [23] and Ren et al. [25].

However, the primary change provides insufficient incentives for long-term investment by farmers, which corresponds to the current state of China's public welfare forest areas. Farmers' confidence and safety perceptions of earning revenue through certification have improved due to the significant reform, which has increased farmers' investment. Seemingly, the integrity of property rights is limited due to the constraints of public welfare forests and the fact that the major reform only provides farmers the right to use and manage them. The benefits to the subject will be lessened if certain of the rights inherent in property rights are lacking or limited. Over time, farmers' imperfect rights will not consistently supply their new product needs, reducing the incentive to invest in property rights. Therefore, it can be assumed that the major reform's encouragement of farmers' long-term investment is limited. The findings also demonstrate that the forest tenure supplementary reform has significantly boosted farmers' long-term investment. Forest farmers are more ready to manage and protect forest land or make other inputs if forest tenure mortgage and circulation develop in a controlled manner. Jacoby and Minten [110] and Melesse and Bulte [111] achieved similar conclusions when exploring the relationship between land property rights and investment, although their research is not focused on forest property rights reform and forestry investment. It is challenging to promote supplementary forest tenure reform, particularly in the loss of forest income in public welfare forest areas, where forest right mortgages and forest land transfers are complex [112]. Financial institutions typically consider that risk control of forest belt loans is still difficult to grasp and that the forest right certificate cannot fully fulfill the function of collateral. Farmers are allowed the right to mortgage forest land, but they are restricted in every step of the process. Farmers have less information about the transfer in forest land tenure reform because the forest land cannot be used for other purposes after the transfer, and standard forest land transfer procedures have not been developed [113]. Hence, farmers have less information about the transfer, and farmers frequently face difficulties such as information asymmetry during the transfer, causing the forest land transfer to fall short of its ideal state.

The whole forest land disposal right might save transaction costs and increase farmers' investment excitement. The right to mortgage and circulate forest land is crucial for the disposal tenure. The mortgage has a strong relationship with loan availability [104]. The easier it is for forest farmers to access forest management funds if the mortgage is liberalized correctly as part of the additional reform of forest tenure, the greater their investment and incentive ability. For forestry production's efficient distribution of land elements, forest land circulation is required. The seamless flow of land factors increases marginal productivity, increasing farmers' incentive to produce and invest [81].

5. Conclusions

The study's fundamental motive is to trace how forest land investment in public welfare forest regions changes over time. Based on the property tenure theory, the research employs the fixed-effect and DID models to examine the effects of forest rights subject

reform and supplementary reform on forest land investment. While the existing studies frequently overlook studying forest land in public welfare forest areas, this study portrays the following outcomes (i) The primary reform of forest tenure can promote the forest farmers' forest land investment in the short term, but the long-term incentive is insufficient. (ii) There are inequalities in investment between regions with a stronger development of forest right supplementary reform and those without one, and the disparity increasingly widens over time. This demonstrates that via the continual improvement and promotion of the additional reform of forest tenure, the rights of forest households to transact and dispose of forest land have been increasingly liberalized, successfully stimulating long-term investment by forest farmers.

Based on the above research conclusions, the study puts forward the following policy suggestions: (i) Relying on the primary reform dividend to promote forest producers' investment is insufficient. Government must continue to pay attention to the development of additional reforms and the liberalization of mortgages and forest land circulation. (ii) In the process of supplementary reform, we can improve the participation of forest farmers in social credit and financial connections. (iii) Build a forest land transfer platform and strengthen the supervision and service of the forest rights transfer. (iv) Combine forest right mortgages with circulation reform and have the market play the decisive role in the pricing and disposal of forest right mortgages through circulation. (v) Enhance the government's role by using government funds to establish forest rights collection and storage centers or guarantee institutions provide comprehensive services such as forest rights collection and storage and forest right transfers. (vi) Relying on the primary reform dividend to promote forest producers' investment is insufficient. Government must continue to pay attention to the development of additional reforms. They should develop normative policy documents for forest rights mortgages and initiate the consistent transfer with local circumstances.

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