

## REVIEW ARTICLE

# A review of research on collective forest property rights reform and changes in forest resources

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## ABSTRACT

The reform of collective forest property rights is of great significance to realize the sustainable growth of China's forest resources from the perspective of collective forest property right and its structure. This paper summarizes and analyzes the research on the reform of collective forest property right and the impact of forest property right security on the change of forest resources at home and abroad in recent 20 years. In order to clarify the research views and disputes on the impact of collective forest property right reform on forest resources, and analyze the defects and future research directions. Most of the existing studies believe that the reform of collective forest property rights can stimulate farmers' afforestation management and protection, reduce deforestation and forest degradation, and effectively achieve the growth of forest resources. The existing literature provides valuable clues for further research on the relationship between the two, but the existing theoretical research fails to investigate the objective situation of China's non-agricultural transfer, and ignores the interaction mechanism between forest rights; The empirical study lacks the analysis of the dynamic effects of collective forest property rights on forest resources, and fails to properly deal with the endogenous problems in the model. The future research should be improved from the following aspects: (1) bring the situation of labor non-agricultural transfer into the theoretical model, and investigate the interaction mechanism between forest rights; (2) scientifically identify the dynamic effects of property right and its structure on forest resources; (3) in econometric analysis, we should focus on the endogenous problems caused by measurement bias, missing variables, self-selection bias and two-way causality.

**Keywords:** Collective Forest Right Reform; Collective Forest Property Right Structure; Security of Forest Land Property Rights; Forest Resources; Theoretical Mechanism; Endogenesis

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## 1. Introduction

The area of collective forest land in China accounts for about 60% of the total forest land area, which plays a vital role in the cultivation of forest resources, the construction of ecological civilization and the realization of sustainable development. However, for a long time, China's collective forest areas have faced the dilemma of indiscriminate deforestation and low enthusiasm of farmers for forest management and protection. As a result, forest resources cannot be protected continuously<sup>[1,2]</sup>. The academia generally believes that this is caused by unclear property rights and frequent adjustments. Therefore, the Chinese government began to implement a new round of collective forest property rights system reform (hereinafter referred to as "new forest reform")

with “clarifying property rights and liberalizing management” as the main content in 2003. On the basis of improving the security and completeness of collective forest property rights, we hope to stimulate farmers’ enthusiasm for forest management and realize the sustainable growth of forest resources. In fact, through the right confirmation and supporting reforms, farmers have obtained long-term and highly exclusive forest land use rights, as well as the qualifications for transferring and mortgaging forest land. At the same time, the total amount of collective forest resources in China has shown a steady upward trend after the new forest reform. According to the data of the Eighth Forest Resources Inventory (2009–2013), the area of collectively owned forest land and the volume of living trees increased by 18.57% and 44.69% respectively, compared with the Sixth National Forest Resources Inventory (1999–2003), reaching 117 million hm<sup>2</sup> and 6,297 million m<sup>3</sup>. Therefore, the government attributed the growth of collective forest resources to the new forest reform<sup>[4]</sup>, and the academic research on the management and protection of farmers’ afforestation and forest harvesting to some extent supported this view<sup>[5-7]</sup>.

However, most studies have shown that the key engineering afforestation projects promoted by the government are the main reasons for the sustainable growth of China’s forest resources, including collective forests. At the same time, some scholars have confirmed that the new forest reform has failed to motivate farmers to carry out afforestation management and protection, the labor and capital investment are low, and the extensive forestry management is very obvious<sup>[3,10]</sup>. The result is that the productivity level of collective forest is significantly lower than that of state-owned forest. Moreover, after the new forest reform, there are still a large number of phenomena that destroy forest resources, such as the occupation of forest land by cultivated land, and logging without or beyond cer-

tificates. According to the research and calculation, from 2005 to 2010, the area of forest land transferred to cultivated land in the collective forest region in the South reached 285,000 hm<sup>2</sup>, accounting for 79.20% of the area of forest land transferred out<sup>[11]</sup>. The inspection data of China’s forest cutting quota also shows that 23.20% of the small cutting classes sampled in collective forest areas after 2008 have over licensed cutting in the highest year, and the unlicensed cutting is up to 28.30% of the total cutting<sup>[12]</sup>. Therefore, the view that the increase of collective forest resources is mainly attributed to the new forest reform is questionable<sup>[13]</sup>.

To sum up, scholars still lack a unified understanding of the role of the new forest reform in protecting forest resources. In order to discuss the focus of the existing research controversy and the reasons behind it, this paper summarizes and analyzes the relevant literature on the impact of the new forest reform on the change of forest resources. At the same time, considering that the new forest reform has an impact on forest resources on the basis of giving farmers safe and complete forest land property rights, this paper reviews the foreign studies on the relationship between forest land property rights security and forest resources. Considering that the essence of the new forest reform is to build an exclusive and complete collective forest property right structure for farmers<sup>[2,14]</sup>, different from individual rights, the property right structure can provide farmers with clearer behavior boundaries and more complex choice sets. The interrelated property rights elements systematically affect farmers’ income expectations and behavior decisions, and finally reflect the status of forest resources. Therefore, from the perspective of collective forest property right and its structure, this paper summarizes the existing research from both theoretical and empirical aspects<sup>1</sup>.

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<sup>1</sup> Collective forest property rights and its structure are analyzed from the perspective of institutional system, where collective forest property rights refer to the more stable and complete property rights status given to farmers by the forest reform as a whole, including the main reform and the supporting reform, which can be understood as the forest reform itself. Unless otherwise specified, the term “collective forest property rights” in the following refers to a separate property right factor. The structure of collective forest property rights refers to the elements of forest rights given to farmers by the main reform and various supporting reforms.

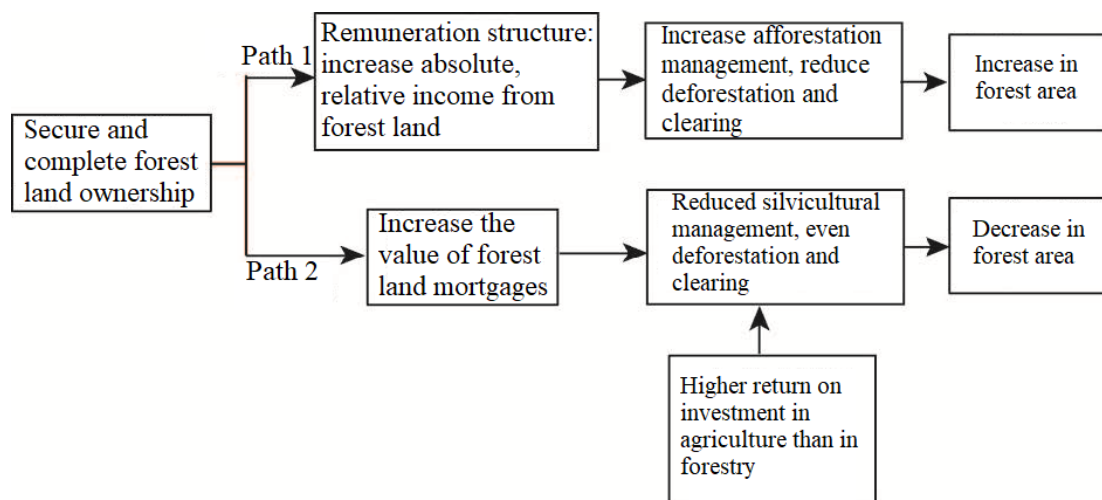
## 2. Study on the influence of collective forest property rights on the change of forest resources

Most of these studies regard the new forest reform as an independent whole, and explore the impact mechanism and empirical effect of the security and completeness of collective forest property rights on the change of forest resources after the new forest reform. This part first analyzes the relevant theoretical mechanism, and then reviews the relevant empirical research

### 2.1 Theoretical mechanism of collective forest property rights affecting forest resources change

The structure of rewards (incentives) generated by the institutional environment is key to influencing the configuration of decision makers' behavior<sup>[15,16]</sup>. As an important part of the institutional environment, property rights protection will change the farmers' compensation structure, and then affect the farmers' allocation behavior, which will eventually be reflected in the status of forest resources. As

shown in path 1 in **Figure 1**, some scholars consider the absolute income of forest land and think that unsafe or incomplete property rights are similar to random taxes. It will reduce the present value of the future forest revenue of the forest land<sup>[17,18]</sup> and reduce the probability that the forest land investment will realize its value in the future<sup>[6,20]</sup>. As a result, farmers tend to shorten the cutting cycle, expand the cutting scale and reduce the afforestation management<sup>[18,20]</sup>. Some scholars also considered the relative income of forestry, that is, the ratio of forestry income to agricultural income. By constructing the forestry income maximization model and the agricultural income maximization model including property rights factors, they found that the instability of forest land property rights will cause the decline of forestry income faster than that of agriculture<sup>[20,21]</sup>. At this time, the rational decision of farmers is to destroy forests and open up wasteland and put production factors into the agricultural field<sup>[22,23]</sup>.



**Figure 1.** Theoretical mechanism of collective forest property rights affecting forest resources change.

Path 2 in **Figure 1** shows the “investment effect” of collective forest property rights<sup>[24]</sup>, that is, the complete and safe collective forest property rights have a high mortgage value, and the funds obtained by their mortgage will stimulate forest operators to invest in land<sup>[25]</sup>. However, under the objective condition that the return on investment in agriculture is higher than that in forestry, forest op-

erators will reduce their investment in forestry or even deforestation and clearing<sup>[24]</sup>, thus destroying forest resources. Some scholars combined with von Thünen model to further confirm the rationality of the above theoretical mechanism from the perspective of unstable property rights<sup>[26]</sup>. However, the premise for the establishment of this theoretical path is questionable, because the stable and com-

plete collective forest property rights obtained by farmers after the new forest reform significantly increased the investment value of forest land and reduced the willingness of farmers to destroy forests and open up wasteland.

To sum up, the existing studies have confirmed that collective forest property rights do have an impact on the change of forest resources by constructing a forest operator income maximization model including property rights. However, most of the above studies focus on the agricultural sector, investigating how collective forest property rights affect the absolute income of forestry or the ratio of forestry to agricultural income, thus affecting the allocation of forest resources, and basically ignoring the objective reality of a large number of non-agricultural employment in rural China. It has been proved in the literature that a complete and safe collective forest property right can effectively reduce the probability of land occupation, reduce the time for farmers to supervise the forest land, and stimulate their non-agricultural employment<sup>[1]</sup>. At the same time, non-agricultural labor transfer increases the non-agricultural income of farmers, increases the labor opportunity cost of destroying forest resources, and reduces farmers' willingness to destroy forests and open up wasteland, thus affecting the change of forest resources<sup>[27]</sup>.

## 2.2 Empirical effect of collective forest property rights on forest resources change

The premise of empirical research is to define and measure collective forest property rights. Therefore, this part first summarizes and evaluates the measurement methods of collective forest property rights, then summarizes the main empirical results, and focuses on the endogenous problem of the model.

### 2.2.1 Definition and measurement of collective forest property rights

For different research objects, scholars have used different methods to measure forest land property rights. At the national level, the "national governance index"<sup>[21]</sup>, the "frequency of political insta-

bility events" and other indicators<sup>[22,28]</sup> are mostly used in research. However, the above indicators represent the protection of property rights in all areas of the country, and there is a problem of institutional measurement bias. Some scholars further focused on land property rights and replaced the stability of forest land property rights with "the weighted sum of the number of crimes caused by land conflicts, the number of land requisitions and the area of land requisition". Studies at the provincial level have mostly measured the degree of security and completeness of new collective forest property rights by using the question "whether new forest reform has been implemented in a certain area" or "the proportion of contracted household forest to the whole forest area after new forest reform"<sup>[3,29,30]</sup>.

At the level of farmers, scholars measure the size of forest rights from the perspective of farmers' perception of forest rights, the implementation results of the new forest reform, or the collective forest property rights system itself<sup>[31-33]</sup>, and form three dimensions of forest rights measurement methods, namely, perceived property rights, factual property rights and legal property rights. Specifically, in terms of the dimension of perceived property rights, most scholars use farmers' subjective cognition of the reform to characterize the size of collective forest property rights owned by farmers after the new forest reform, such as "farmers' satisfaction with the new forest reform"<sup>[34]</sup>, "whether farmers think they still own forest land or whether the forest land will be adjusted after five years"<sup>[31,35]</sup>. However, some studies have shown that subjective measurement method is easy to cause response error<sup>[36]</sup>. Therefore, based on the factual property rights, some scholars measure the collective forest property rights according to the implementation results of the new forest reform, such as "whether to issue forest property rights certificates" and "proportion of issued areas", but this measurement method mainly reflects the main body reform<sup>2</sup>. Based on this, some scholars started with legal property rights, systematically sorted out the county-level new for-

<sup>2</sup> The new forestry reform includes the main reform and supporting reform. Among them, the main reform is based on the confirmation of rights and certificates, the collective forest land contract management rights to farmers.

est reform policies, set the weights among forest rights, and calculated the collective forest property rights security index on the basis of scoring and assigning values to each forest rights system<sup>[36]</sup>. However, the size of rights measured by this method will vary greatly due to different weight setting methods.

Considering the institutional measurement challenges, some scholars have also used the quasi-natural experiment of new forest reform to construct a counterfactual framework to identify the causal relationship between collective forest property rights and forest resource changes using methods such as double difference (DID) or breakpoint regression (RD)<sup>[38-40]</sup>. However, because the new forest reform adopts the gradual promotion method, the practice of dividing the reference group and the treatment group according to the implementation time of the first reform reflects the reform performance of the main body of the new forest reform at best, not the overall effect of the new forest reform.

### **2.2.2 Results of collective forest property rights affecting forest resources change**

Some scholars conducted case studies on the reform of forest land property rights in Brazil and Bolivia and found that giving farmers stable and safe forest land property rights did reduce deforestation and forest degradation<sup>[41,42]</sup>. However, case analysis cannot control other factors that affect the change of forest resources. Therefore, some scholars used quantitative models to exclude other factors to further confirm that the practice of Nicaragua<sup>[43]</sup>, Vietnam<sup>[44]</sup>, Brazil<sup>[23]</sup> and other countries to delegate the management right of forest land to farmers helps to form a relatively stable expectation of forest land property rights, thus realizing the increase of forest area. Similar conclusions were also found in the relevant studies on small-scale forest farm owners in Europe and the United States<sup>[45]</sup>. Although the decentralization of forest rights can form the expectation of stable property rights, the imperfect national market and credit mechanism reduce the income of forest land<sup>[25]</sup>. Therefore, safe forest land property rights do not necessarily encourage forest operators to conduct afforestation

management and protection, and it is difficult to ensure the sustainable growth of forest resources<sup>[24]</sup>. In fact, the difference of forest land property rights' protection effect on forest resources is limited by the local social, economic and institutional background. It can be seen that a complete and safe forest land property right is a necessary but not sufficient condition for protecting forest resources<sup>[46]</sup>.

The research conclusions of China's new forest reform are also different. The existing literatures mostly use the survey data of farmers to investigate the impact of the new forest reform on the change of forest resources. Specifically, some scholars found through descriptive statistical analysis that after the new forest reform, farmers have obtained more complete and stable collective forest property rights<sup>[2,29]</sup>. Although the amount of deforestation has increased, the intensity of afforestation management and protection has also increased<sup>[47]</sup>. However, descriptive statistical analysis failed to exclude the interference of factors. Therefore, most of the literature further confirms that the property rights incentive effect of the new forest reform has significantly increased farmers' motivation for afforestation and forest management<sup>[7,31]</sup>, while alleviating over-harvesting of forests<sup>[48]</sup> and effectively achieving double growth of forested land area and forest stock<sup>[49]</sup>, based on controlling for other factors affecting forest resources (volume of change) using econometric models. However, some studies believe that farmers are skeptical about the stability of the new forest reform policy, and the new forest reform induces the fragmentation of forest land, which increases farmers' logging of forest resources<sup>[3,40]</sup>, but fails to motivate farmers to conduct afforestation management<sup>[37,38]</sup>. A few studies using national forest resources inventory data have also confirmed that the new forest reform has no significant impact on the total amount of forest resources, such as the area of forest land and the volume of living trees, and the reform has failed to achieve the sustainable growth of forest resources<sup>[3,13]</sup>.

### **2.2.3 Endogenous problems of collective forest property rights**

In addition to regional differences, endogeneity is also an important reason for widespread con-

troverly in existing research. The existing research focuses on the level of farmers, and systematically discusses the endogenous sources of forest land property rights in the model. First, the model may omit variables that affect both forest resources and collective forest property rights, such as farmers' personality characteristics, village religious culture and regional corruption, which are usually difficult to obtain or measure<sup>[24]</sup>; Secondly, there is often a two-way causal relationship between collective forest property rights and forest resources<sup>[23]</sup>. Specifically, when forest resources are wantonly destroyed, the state will readjust collective forest property rights<sup>[3]</sup>, such as the Chinese government's call to stop the forestry "Three Fixed" policy. Moreover, deforestation and afforestation management and protection are important means for farmers to declare forest land property rights and ensure the security of property rights<sup>[23]</sup> Yang *et al.*<sup>[35]</sup> quantitatively confirmed the above endogenous problems of collective forest property rights in the measurement model according to Wooldridge's method.

Based on this, some scholars selected "judicial expenditure<sup>[23]</sup>", "East-West division line" and "civil war"<sup>[24]</sup> as instrumental variables, and used 2SLS and other measurement means to alleviate endogenous problems, such as missing variables or two-way causality. However, with the exception of the "East-West division line", which satisfies exogeneity well, judicial expenditures and warfare are limited by the level of local government corruption, which is a key factor in the growth and decline of forest resources<sup>[49]</sup>. It can be seen that it is very difficult to find qualified tool variables. In this regard, some scholars have adopted RD or DID models to try to solve the problem of missing variables or two-way causality<sup>[38,39]</sup>. However, Yi *et al.*<sup>[31]</sup> used Besley<sup>[51]</sup> to prove that there is no two-way causal relationship between the new forest reform and the change of forest resources.

Some scholars have also considered the Self-selection Bias of the new forest reform<sup>[33,36]</sup>. It is found that the time for implementing the new forest reform in a certain place is not determined randomly, but determined by the government ac-

ording to the comprehensive conditions, such as forest resources and economic development<sup>[36]</sup>. Therefore, some studies used Heckman model or Propensity Score Matching (PSM) method to correct self-selection errors<sup>[33,36]</sup>.

To sum up, the quantitative research using provincial level data failed to properly deal with the endogenous problem of forest rights. Although the correlation analysis using the household survey data alleviates the endogenous problems, such as sample self-selection and two-way causality through PSM and DID models, most of them investigate the change of forest resources and fail to reveal the impact of collective forest property rights on the total amount of forest resources. More importantly, because most of the household survey data are cross-sectional data, the existing research has not been able to capture the dynamic effects of the new forest reform on forest resources. In order to more clearly show the research methods and conclusions of the existing literature, **Table 1** summarizes the above empirical studies from four aspects: collective forest property right measurement, forest resources measurement, empirical models and empirical results.

### 3. Study on the influence of collective forest property right structure on the change of forest resources

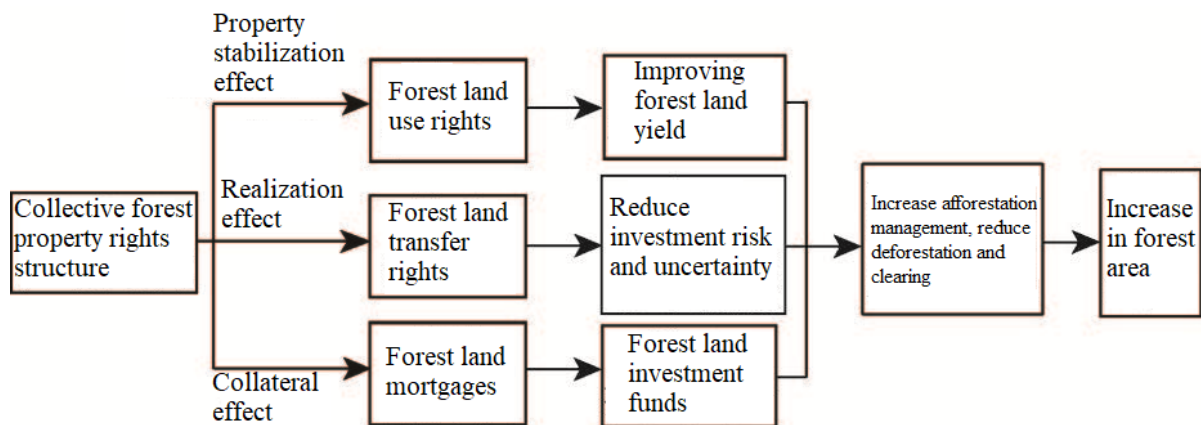
From the perspective of divisibility of property rights, most of the existing studies subdivide collective forest property rights into forest land use rights, forest land disposal rights and forest land revenue rights, forming the structure of collective forest property rights<sup>[14]</sup>, and further analyze the theoretical mechanism and empirical effect of each forest right element on the change of forest resources.

#### 3.1 Theoretical mechanism of collective forest property right structure affecting forest resources change

Referring to the relevant theoretical literature on the performance evaluation of agricultural land property rights, the academic circles have proposed that there are "property right stability effect"<sup>[25]</sup>, "mortgage effect"<sup>[25]</sup>, "realization effect"<sup>[51]</sup> and so

on in the impact of collective forest property rights structure on forest resources. Specifically, the larger and longer the current forest land owned by farmers, that is, the more stable the right to use the forest land<sup>[2,29]</sup>, the more confidence that farmers' current investment will realize the market value in the future<sup>[25]</sup>, which will stimulate farmers to increase forestry investment and prolong the cutting time<sup>[6,29]</sup>, that is, the “property right stability effect”. The above theoretical mechanism is shown in **Figure 2**.

Free forest land transfer right can produce “re-



**Figure 2.** Theoretical mechanisms of collective forest property rights structure affecting changes in forest resources.

To sum up, the existing studies have investigated in detail the theoretical mechanism of the impact of forest right elements on forest resources in the forest right structure. However, previous studies have generally ignored the coupling or mutually exclusive relationship among the forest rights elements, and how this relationship affects the change of forest resources. In fact, clarifying the relationship between the elements of forest rights and their forest protection effects will help to strengthen the synergy between various reform measures, so as to enhance the overall implementation effect of the new forest reform

### 3.2 Empirical study on the impact of collective forest property right structure on forest resources change

This section first reviews the relevant research on the definition and measurement of the collective forest property right structure, analyzes the current situation of the collective forest property right structure owned by farmers after the new forest re-

alization effect”, that is, farmers can transfer forest land and trees as asset resources, reduce investment risk and uncertainty<sup>[29]</sup>, reduce property right transaction cost<sup>[52]</sup>, encourage farmers to invest in forest land and reduce damage to forest resources<sup>[35,49]</sup>. “Mortgage effect” means that the complete forest land mortgage guarantees farmers’ access to more mortgage loans, meets farmers’ capital needs<sup>[25]</sup>, and stimulates them to increase investment in afforestation management and protection<sup>[31]</sup>.

form and its impact on forest resources, and finally discusses the endogenous nature of the collective forest property right structure in the model

#### 3.2.1 Definition and measurement of collective forest property right structure

Based on the property right theory of Zhang Wuchang, some scholars have proposed that the right to use forest land, the right to profit from forest land and the right to dispose of forest land can constitute a complete collective forest property right structure<sup>[14]</sup>. Guided by the theory of divisibility of property rights, scholars further cover forest land ownership rights, forest species selection rights and forest harvesting rights in forest land use rights<sup>[36]</sup>. However, it has also been pointed out in the literature that forest land use rights should also include the right to throw away land, the right to adjust land use and the right to operate non-wood forest products<sup>[31,53]</sup>. In terms of forest land disposal right, most scholars believe that it should include forest land mortgage right, forest land circulation right

and forestry cooperation<sup>[31]</sup>. In terms of forest land usufruct, most of the existing studies decompose it into forest sales right, forestry taxes and forestry subsidies<sup>[36]</sup>.

The academic circles mainly measure the forest right elements in the collective forest right structure from the perspective of perceived property right or factual property right, for example, “whether farmers perceive the existence of certain

property rights”<sup>[6,31,54]</sup> and “whether farmers actually obtain certain property rights”<sup>[29]</sup>. However, the above measurement methods can not characterize the size of forest rights enjoyed by farmers. Therefore, based on the analysis of the policy text, some scholars adopted the equal difference assignment method in combination with the characteristics of farmers to measure the forest rights actually owned by farmers<sup>[36]</sup>.

**Table 1.** Summary of research on the impact of collective forest property rights on forest resources

References	Collective forest property right measurement	Forest resources measurement	Empirical model	Empirical results
Araujo <i>et al.</i> <sup>[23]</sup>	Number of crimes and land requisition caused by land conflict and weighted sum of land acquisition area	Forest land area	2SLS (“judicial expenditure” is IV)	+
Bandiera <sup>[43]</sup>	Whether the farmer is the owner of the land	Afforestation input	OLS	+
Bohn <i>et al.</i> <sup>[22]</sup>	Political instability	Forest land area	OLS	+
Deacon <sup>[28]</sup>	Political instability	Forest land area	OLS	+
Lin <i>et al.</i> <sup>[33]</sup>	Ownership certificate	Afforestation input	Heckman, PSM	n
Liscow <sup>[24]</sup>	Farmers’ perception of land property security	Forest land area	2SLS, the East-West borders, and the “North-South War” is IV)	–
Liu <i>et al.</i> <sup>[3]</sup>	Whether to implement forest property right reform in a certain area	Forest land area Woodland accumulation Afforestation area	System GMM	– + –
Xie <i>et al.</i> <sup>[7]</sup>	Farmers’ satisfaction with the new forest reform	Forest land management and protection	Heckman	+
Xie <i>et al.</i> <sup>[37]</sup>	Proportion of self-reserved mountains in the forest land area	Forest land investment Labor input in forest land	Tobit Probit Truncated	– –
Zhang <sup>[30]</sup>	The proportion of contracted forest land area of farm households in each province to the collective forest land area of the province	Forest cover, forest harvesting	FE, OLS	South: –+ North: +-
Wang <i>et al.</i> <sup>[34]</sup>	Farmers’ subjective evaluation on the new forest reform	Afforestation, cutting, fertilization, management and protection	Probit	n
Yang <i>et al.</i> <sup>[35]</sup>	In fact, it owns the forest ownership certificate; In perception level, forest land adjustment expectation	Times of forestry management and protection Forestry management and protection investment	Negative binomial model, Tobit model	n +
Yin <i>et al.</i> <sup>[40]</sup>	Taking the area where the new forest reform is implemented as the treatment group	Timber harvest	DID, TE	+
Zhang <i>et al.</i> <sup>[38]</sup>	Taking the area where the new forest reform is implemented as the treatment group	Forest land input	DID, DDD	n
Zhang <i>et al.</i> <sup>[39]</sup>	Taking the area where the new forest reform is implemented as the treatment group	Number of forest fires; Area of pests and diseases	RD	–

Note: In the empirical results, “+” is a positive effect, “–” is a negative effect, “n” is no significant effect, and IV is an instrumental variable.



### 3.2.2 Analysis on the current situation of farmers' collective forest property right structure after the new forest reform

The new forestry reform allocated collective forests to farmers by “dividing the hills into households”, and re-measured the area of forest land and the boundaries of the “Four Areas”, and issued new forest rights certificates. By the end of 2016, the confirmed area of collective forest land was 180 million hm<sup>2</sup>, and the cumulative issued area reached 176 million hm<sup>2</sup>, and the contract period of forest land was extended to 70 years. It can be seen that farmers have obtained stable and exclusive forest land use rights. At the same time, after the new forest reform, although the state gives farmers the right to transfer forest land<sup>[2,29]</sup>, farmers still face high threshold restrictions on their participation in the forest land market<sup>[1]</sup>, for example, rotation period or years of forest species, restrictions on trading places, etc. According to the large sample field survey data of Liu *et al.*<sup>[55]</sup>, the proportion of farmers transferring forest land in the total number of farmers in 2010, 2012 and 2014 was 12.23%, 7.15% and 6.87% respectively. It can be seen that the enthusiasm of farmers transferring forest land after the new forest reform is not high, and there is a downward trend year by year.

After the new forest reform, farmers have obtained the qualification to mortgage forest land<sup>[1,29]</sup>, but the county-level governments and financial institutions have set up a series of credit controls on the conditions and contents of forest right mortgage loans. By the end of 2014, China has implemented a forest right mortgage loan area of 6,027,200 hm<sup>2</sup>, with a total loan amount of 179,706 million yuan<sup>[55]</sup>. However, among the subjects who obtained the forest right mortgage loan, the proportion of sample farmers with forest land area less than 3.33 hm<sup>2</sup> was less than 4%. It can be seen that banks tend to provide loans to large-scale farmers and companies<sup>[55]</sup>. As for the forest land usufruct, after the new forest reform, the state will gradually cancel or reduce forestry related taxes and fees, and give farmers various forms of forestry subsidies<sup>[2,9]</sup>, but the acquisition of forestry subsidies is still limited by the threshold of forest land

area<sup>[36]</sup>.

### 3.2.3 Impact of collective forest property right structure on forest resources change

With the implementation of the new forest reform, scholars have carried out a wealth of quantitative research on the impact of collective forest property right structure on forest resources change, but no consistent conclusion has been reached. The existing quantitative studies mostly focus on the change of forest resources, that is, the afforestation management and protection of farmers and forest cutting.

First of all, as far as the right to use forest land is concerned, most references confirm that having a stable right to use forest land will delay farmers' decision to cut trees, encourage them to increase afforestation investment<sup>[6,31,54,56]</sup>, and promote the increase of forest area. However, some scholars have found that the complete and stable forest land use right has not stimulated farmers to increase forest cutting<sup>[36,40]</sup>, but failed to encourage farmers to carry out afforestation management and protection<sup>[33]</sup>, making it difficult for forest resources to grow continuously.

Secondly, in terms of forest land cutting rights, most scholars believe that after the new forest reform, the relaxation of cutting rights by the state will improve the probability of farmers' cutting<sup>[6,35]</sup>, but also stimulate farmers' afforestation investment<sup>[6,29]</sup>. However, there are also a few documents that confirm that the impact of the logging rights owned by farmers on their forest investment is not significant<sup>[5]</sup>, because farmers can break through the existing logging control through power rent-seeking or illegal logging<sup>[57]</sup>.

Thirdly, for the research on the mortgage right and circulation right of forest land, most references found that giving farmers the circulation right and mortgage right of forest land would encourage their afforestation management<sup>[29,31,36]</sup>. However, a few references believed that the mortgage right of forest land owned by farmers after the new forest reform had little impact on the investment in afforestation management<sup>[49,58]</sup>, because farmers' participation in the mortgage loan of forest right was limited by a high threshold. Finally, most studies on the right to

income from forest land show that the improvement of farmers' right to income from forest land, especially when forestry taxes and fees are reduced and forestry subsidies are increased, farmers' investment in afforestation management and protection will increase significantly<sup>[29,56,59]</sup>. However, a few scholars have found that after the new forest reform, the forestry subsidies given by the government to farmers are weak and the threshold is high. Therefore, the right of return on forest land cannot significantly encourage farmers to carry out afforestation management and protection<sup>[60]</sup>.

### 3.2.4 Endogenous problems of collective forest property right structure

Scholars pay more attention to the problem of sample self-selection caused by the new forest reform, and try to use Heckman model, Propensity Score Matching (PSM) and other methods to alleviate this problem<sup>[36,61]</sup>. A few papers pay attention to and deal with endogenous problems such as two-way causality and missing variables. Zhang *et al.*<sup>[49]</sup> believed that the elements of forest rights obtained by farmers are brought about by the exogenous impact of the new forest reform. Therefore, there is no two-way causal problem between forest resources and the size of farmers' forest rights. However, Qin *et al.*<sup>[6]</sup> found that the change of forest resources will affect the size of forest rights actually owned by farmers due to the difference of

farmers' personal ability, that is, the two-way causal problem still exists. Based on this, this paper uses "the redistribution frequency of agricultural land" and "the proportion of the village's fellable timber in the whole living tree" as the alternative variables of farmers' forest land use right and forest tree cutting right, so as to alleviate the two-way causal problem between the forest right elements and the change of forest resources.

To sum up, the existing references focus on the individual impact of each forest right element in the collective forest property right structure on the change of forest resources, but ignore the interaction between forest rights, so it is impossible to judge the coordination of various reforms. More importantly, since it is very difficult to find qualified instrumental variables for multiple endogenous variables, most studies fail to properly identify and deal with the endogeneity of forest rights in the model, resulting in low reliability of model estimation results. In order to more clearly show the existing relationship between collective forest property right structure and forest resources change, **Table 2** summarizes the above quantitative literature from five aspects: definition of collective forest property right structure, measurement of collective forest property right structure, measurement of forest resources, empirical models and empirical results.

**Table 2.** Summary of research on the impact of collective forest property right structure on forest resources change

References	Definition of collective forest property right structure	Measurement of collective forest property right structure	Forest resources measurement	Empirical model	Empirical results
Lin <i>et al.</i> <sup>[33]</sup>	Cutting rights	The treatment groups were divided by "possession of forest rights certificates" and "ease of obtaining harvesting targets".	Forest land investment	Heckman	Cutting rights +
	Forestry subsidies			PSM	Forestry subsidies +
Liu <i>et al.</i> <sup>[29]</sup>	Mortgage rights Cutting rights Forestry tax Forestry subsidies	Whether a farmer actually acquires a forest rights	Forest land area	FE	Mortgage rights + Cutting rights – Forestry tax – Forestry subsidies +
Qin <i>et al.</i> <sup>[6]</sup>	Forest land use rights Tree cutting rights	Farmers' perception of property rights	Forest land investment	Random effect Tobit model	Forest land use rights + Tree cutting rights +
Yi <i>et al.</i> <sup>[31]</sup>	Conversion of forest land to agricultural use Change forest land type Self-selection of tree species	Farmers' perception of property rights	Forest land investment	Heckman	Conversion of forest land to agricultural use – Change forest land type + Self-selection of tree species –

**Table 2. (Continued)**

References	Definition of collective forest property right structure	Measurement of collective forest property right structure	Forest resources measurement	Empirical model	Empirical results
Yi <i>et al.</i> <sup>[31]</sup>	Operating non-wood forest products Abandoned forest land Forest right mortgage Intra-village transfer rights  Out-of-village transfer rights	Farmers' perception of property rights	Forest land investment	Tobit  RE	Operating non-wood forest products – Abandoned woodland n Forest mortgage rights + Intra-village transfer rights + Out-of-village transfer rights n
Cao <i>et al.</i> <sup>[59]</sup>	Tree cutting rights Forestry tax	Farmers' perception of property rights	Afforestation area	Multiple regression model	Tree cutting rights nnn Forestry tax nn+
Cao <i>et al.</i> <sup>[59]</sup>	Forest land circulation  Forestry cooperation organization Ecological public welfare compensation Policy forest insurance	Farmers' perception of property rights	Tending area  Cutting area	Multiple regression model  Seemingly unrelated regression	Forest land circulation ++  Forestry cooperation organization ++n Ecological public welfare compensation nnn Policy forest insurance nnn
He <i>et al.</i> <sup>[36]</sup>	Ownership of forest land (trees) Tree cutting rights Forest mortgage rights Forest income rights	Whether a farmer actually acquires a forest rights	Tree cutting	Heckman	Ownership of forest land (trees) + Tree cutting rights + Forest mortgage rights n Forest income rights –
Ji <i>et al.</i> <sup>[54]</sup>	Right of use Circulation rights Mortgage rights	Farmers' perception of property rights	Forest land input	Double-Hurdle	Right of use + Circulation rights – Mortgage rights n
Ren <i>et al.</i> <sup>[60]</sup>	Right of use Disposal rights Income rights	Size of forest rights actually owned by farmers	Forest land input	Double-Hurdle	Right of use + Disposal rights + Income rights n
Sun <i>et al.</i> <sup>[61]</sup>	Management rights Trading rights Mortgage rights	Farmers' perception of property rights	Forest land input	Heckman	Management right + Trading rights n Mortgage rights –
Yang <i>et al.</i> <sup>[56]</sup>	Cutting index Afforestation subsidy Forestry loan	Farmers' perception of logging rights, and whether afforestation subsidies are actually obtained and forestry loan	Planting input Nurturing input	Tobit	Cutting index nn Afforestation subsidy+ Forestry loan n+
Zhang <i>et al.</i> <sup>[5]</sup>	Transformation of forest land type Forest species option Right to use understory resources Circulation rights and mortgage rights	Farmers' perception of property rights	Tree cutting	Probit  FE, RE	Transformation of forest land type n Forest species option + Right to use understory resources – Circulation rights and mortgage rights n
Zhang <i>et al.</i> <sup>[49]</sup>	Cutting rights Right of use Circulation rights Desertion rights Mortgage rights	Measure each forest property index and calculate the forest weighted comprehensive index value	Forest coverage  Forest accumulation	OLS  SUR	Cutting rights –n Right of use nnN Circulation rights ++ Abandonment rights nn Mortgage rights nn
Zhu <i>et al.</i> <sup>[58]</sup>	Cutting rights Mortgage rights Circulation rights Afforestation subsidy	Whether a farmer actually acquires a forest rights	Forest land input	FE and RE mixed estimation	Cutting rights + Mortgage rights n Circulation rights + Afforestation subsidy +

## 4. Conclusion and discussion

In 2003, China began to implement the new

forest reform in order to improve farmers' enthusiasm for forest management through forest division

to households, so as to realize the sustainable growth of forest resources. However, the academic circles still lack a unified understanding of the role of the new forest reform in protecting forest resources. Therefore, starting with the collective forest property right and its structure, this paper systematically combs the references at home and abroad about the impact of the new forest reform and the security of forest property right on the change of forest resources in recent 20 years, and attempts to reveal the theoretical mechanism and empirical effect of the impact of collective forest property right on the change of forest resources. After the review, it is found that the existing theoretical analysis mostly uses the property right theory to confirm that the collective forest property right and its structure will differentiate the farmers' remuneration structure, that is, the absolute income of forestry or the ratio of forestry to agricultural income, and then have an impact on the allocation of forest resources. Empirical studies mostly use household survey data to analyze the impact of the new forest reform on the change of forest resources, that is, the impact of afforestation management and protection and forest cutting. A few articles use provincial data to explore how the new forest reform affects the total amount of forest resources. Although the existing empirical studies have not reached a unified conclusion, most of them show that the new forest reform can stimulate farmers' afforestation management and protection, reduce deforestation and forest degradation, and effectively achieve the growth of forest resources.

The existing references provide valuable clues for further revealing the theoretical mechanism of collective forest property rights affecting forest resources, and also provide corresponding methodological guidance for empirical analysis. However, in general, the existing research has the following shortcomings that need to be discussed in depth: First, the existing theoretical analysis focuses on the agricultural and forestry production departments, fails to combine with the objective situation of China's non-agricultural transfer, and ignores the interaction mechanism between various forest rights elements and the impact of this mechanism on for-

est resources, so it is impossible to judge the synergy between various reforms; Second, the existing references mostly use one or several periods of sample data in a few regions to identify the causal relationship between the new forest reform and the change of forest resources, but they cannot scientifically reveal the impact of the new forest reform on the dynamic performance of forest resources. Therefore, it is difficult to provide more empirical evidence and reasonable explanations for the performance evaluation of the new forest reform; Third, most econometric analyses fail to scientifically identify and properly deal with the endogenous problems that may exist in the model, such as institutional measurement errors, missing variables, self-selection errors and two-way causality, which may lead to biased estimation results.

Based on this, in order to further enrich the research on the relationship between the new forest reform and the change of forest resources, and provide a more solid theoretical and empirical basis for deepening the new forest reform, future theoretical research should be based on the objective situation of China's collective forest areas to investigate how collective forest property rights affect non-agricultural employment and forest resources. In addition, it is also necessary to pay attention to the interaction between the elements of forest rights and the impact of this relationship on the change of forest resources. Its significance lies in scientifically identifying the systematic effect of the new forest reform and judging the coordination degree between various reforms. In the future quantitative empirical research on the performance evaluation of the new forest reform, we should also start with the collective forest property right and its structure, focus on the dynamic changes of the collective forest property right, and explore the dynamic effects of the new forest reform on forest resources by using large samples and multi-level long-term survey data. At the same time, we should fully consider the endogenous problems that may exist in the forest ownership structure in the measurement model, such as institutional measurement bias, missing variables, self-selection bias and two-way causality.

## Conflict of interest

The authors declare that they have no conflict of interest.

## References

1. Xu J, Hyde WF. China's second round of forest reforms: Observations for China and implications globally. *Forest Policy and Economics* 2019; 98: 19–29.
2. Yin R, Yao S, Huo X. China's forest tenure reform and institutional change in the new century. *Land Use Policy* 2013; 30(1): 825–833.
3. Liu C, Wang S, Liu H, *et al.* Why did the 1980s' reform of collective forestland tenure in southern China fail? *Forest Policy and Economics* 2019; 98: 8–18.
4. General Office of the State Council. Guowuyuan bangongting guanyu wanshan jiti lin-quanzhidu de yijian (Chinese) [Opinions of the General Office of the State Council on improving the system of collective forest rights] [Internet]. Beijing: General Office of the State Council; [updated 2016 Nov 16; published 2016 Nov 25]. Available from: [http://www.gov.cn/zhengce/content/2016-11/25/content\\_5137532.htm](http://www.gov.cn/zhengce/content/2016-11/25/content_5137532.htm)
5. Zhang Y, Song W. Effect of collective forest tenure reform on people's harvesting behaviors. *Scientia Silvae Sinicae* 2012; 48(7): 161–169.
6. Qin P, Xu J. Forest land rights, tenure types, and farmers' investment incentives in China. *China Agricultural Economic Review* 2013; 5(1): 154–170.
7. Xie Y, Wen Y, Zhang Y, *et al.* Impact of property rights reform on household forest management investment: An empirical study of southern China. *Forest Policy and Economics* 2013; 34: 73–78.
8. Hen W, Xu J, Zhang H. Can the forest logging quota management system protect forest resources? *China Population, Resources and Environment* 2016; 26(7): 128–136.
9. Zhang D. China's forest expansion in the last three plus decades: Why and how? *Forest Policy and Economics* 2019; 98: 75–81.
10. Zhang H, Liu C, Yao S, *et al.* Does more forestland improve farmers' forest management enthusiasm? A propensity score matching approach with 1504 households dataset of nine provinces. *Journal of Natural Resources* 2016; 31(11): 1793–1805.
11. Ouyang B, Zhang M, Wang K, *et al.* The characteristics of the changes of the land cover and landscape pattern in southern hillside during 2000–2010. *Research of Agricultural Modernization* 2013; 34(4): 467–471.
12. He W, Xu J, Zhang H. How does the intensity of the forest logging quota management system affect forestry harvesting income. *Journal of Agrotechnical Economics* 2016; (9): 104–118.
13. Liu C, Lv J. On China's forest resources environmental Kuznets Curve. *Research of Institutional Economics* 2010; (2): 138–161.
14. Zhang H. Farmers forest right status study after the collective forest tenure reform. *Forestry Economics* 2015; 37(1): 16–22.
15. Ostrom E. Micro constitutional change in multi constitutional political systems. *Rationality & Society* 1989; 1(1): 11–50.
16. Acemoglu D. Reward structures and the allocation of talent. *European Economic Review* 1995; 39(1): 17–33.
17. Barbier EB, Burgess JC. The economics of tropical deforestation and land use. *Land Economics* 2001; 77(2): 155–171.
18. Zhang D. Faustmann in an uncertain policy environment. *Forest Policy and Economics* 2001; 2(2): 203–210.
19. Zhang D. Why no trees grow in a lot of forest land of China? *Management World* 2001; (3): 141–146.
20. Mendelsohn R. Property rights and tropical deforestation. *Oxford Economic Papers* 1994; 46: 750–756.
21. Robinson BE, Holland MB, Naughton-Treves L. Does secure land tenure save forests? A meta-analysis of the relationship between land tenure and tropical deforestation. *Global Environmental Change* 2014; 29: 281–293.
22. Bohn H, Deacon RT. Ownership risk, investment, and the use of natural resources. *American Economic Review* 2000; 90(3): 526–549.
23. Araujo C, Bonjean CA, Combes JL, *et al.* Property rights and deforestation in the Brazilian Amazon. *Ecological Economics* 2009; 68(8–9): 2461–2468.
24. Liscow ZD. Do property rights promote investment but cause deforestation? *Journal of Environmental Economics and Management* 2013; 65(2): 241–261.
25. Brasselle AS, Gaspart F, Platteau JP. Land tenure security and investment incentives. *Journal of Development Economics* 2002; 67(2): 373–418.
26. Angelsen A. Forest cover change in space and time: Combining the Von Thünen and forest transition theories. Washington: World Bank Publications; 2007. p. 1–43.
27. Zhu Z, Xu Z, Shen Y, *et al.* How off-farm work drives the intensity of rural households' investment in forest management: The case from Zhejiang, China. *Forest Policy and Economics* 2019; 98: 30–43.
28. Deacon RT. Deforestation and ownership: Evidence from historical accounts and contemporary data. *Land Economics* 1999; 75(3): 341–359.
29. Liu C, Liu H, Wang S. Has China's new round of collective forest reforms caused an increase in the use of productive forest inputs? *Land Use Policy* 2017; 64: 492–510.
30. Zhang Y, Uusivuori J, Kuuluvainen J. Impacts of economic reforms on rural forestry in China. *Forest Policy and Economics* 2000; 1(1): 27–40.
31. Yi Y, Köhlin G, Xu J. Property rights, tenure security

- and forest investment incentives: Evidence from China's collective forest tenure reform. *Environment and Development Economics* 2014; 19(1): 48–73.
32. Nichiforel L, Keary K, Deuffic P, *et al.* How private are Europe's private forests? A comparative property rights analysis. *Land Use Policy* 2018; 76: 535–552.
  33. Lin Y, Qu M, Liu C, *et al.* Land tenure, logging rights, and tree planting: Empirical evidence from smallholders in China. *China Economic Review* 2020; 60: 101215.
  34. Wang X, Xie Y, Wang L, *et al.* Factors affecting farmers, forest management behaviors in the reform of collective forest property right system: Cases in Shaowu City and Youxi County of Fujian Province. *Scientia Silvae Sinicae* 2013; 49(6): 135–142.
  35. Yang Y, Li H, Xue C. Impact of forestland tenure security on farmers' forestry management in Zhejiang and Jiangxi provinces. *Journal of Agrotechnical Economics* 2018; (7): 51–63.
  36. Hen W, Zhang H, Wang H. Forest tenure reform, forest tenure structure and farmer's logging behavior: Based on the forest reform policy of 7 key forestry counties (cities) in the southern collective forest area and the survey data of 415 households. *Chinese Rural Economy* 2014; (7): 81–96.
  37. Xie Y, Gong P, Han X, *et al.* The effect of collective forestland tenure reform in China: Does land parcelization reduce forest management intensity? *Journal of Forest Economics* 2014; 20(2): 126–140.
  38. Zhang H, Zhou L, Xu J, *et al.* Property rights reform, grassroots democracy and investment incentives. *China Economic Quarterly* 2016; 15(3): 845868.
  39. Zhang Y, Chen S. Property right reform and resource Management. *Chinese Rural Economy* 2015; (10): 15–27.
  40. Yin H, Xu J. Empirical analysis of the influence of collective forest tenure reform on timber supply. *Forestry Economics* 2010; (4): 27–30.
  41. De Oliveira JAP. Property rights, land conflicts and deforestation in the Eastern Amazon. *Forest Policy and Economics* 2008; 10(4): 303–315.
  42. Paneque-Gálvez J, Mas JF, Guèze M, *et al.* Land tenure and forest cover change. The case of southwestern Beni, Bolivian Amazon, 1986–2009. *Applied Geography* 2013; 43: 113–126.
  43. Bandiera O. Land tenure, investment incentives, and the choice of techniques: Evidence from Nicaragua. *The World Bank Economic Review* 2007; 21(3): 487–508.
  44. Do QT, Iyer L. Land titling and rural transition in Vietnam. *Economic Development and Cultural Change* 2008; 56(3): 531–579.
  45. Zhang D, Flick WA. Sticks, carrots, and reforestation investment. *Land Economics* 2001; 77(3): 443–456.
  46. Place F. Land tenure and agricultural productivity in Africa: A comparative analysis of the economics literature and recent policy strategies and reforms. *World Development* 2009; 37(8): 1326–1336.
  47. Hou Y. The impact of forest tenure reform on forest ecosystem: A case in Fujian Province. *Reform* 2015; (11): 86–94.
  48. Chen J, Innes JL. The implications of new forest tenure reforms and forestry property markets for sustainable forest management and forest certification in China. *Journal of Environmental Management* 2013; 129: 206–215.
  49. Zhang Y, Song W. Study on the impact of forest tenure system reform on forest resources in collective forest areas. *Journal of Agrotechnical Economics* 2012; (4): 96–104.
  50. Amacher GS, Ollikainen M, Koskela E. Corruption and forest concessions. *Journal of Environmental Economics and Management* 2012; 63(1): 92–104.
  51. Besley T. Property rights and investment incentives: Theory and evidence from Ghana. *Journal of Political Economy* 1995; 103(5): 903–937.
  52. Siikamäki J, Ji Y, Xu J. Post-reform forestland markets in China. *Land Economics* 2015; 91(2): 211–234.
  53. Holden ST, Xu J, Jiang X. Tenure Security and Forest Tenure Reform in China [PhD thesis]. Norwegian: Norwegian University of Life Sciences; 2009.
  54. Ji D, Ma X, Shi X. The impact of forest property rights on forestland investments: From the perspective of property rights integrity and security: A case from Suichuan and Fengcheng of Jiangxi Province. *Issues in Agricultural Economics* 2015; 36(3): 54–61.
  55. Liu C, Zhang Y, Liu H, *et al.* Collective forest tenure reform and its matching reform farmer households willingness and behavior research: Based on long-term big sample data of farmer households. *Forest Economics* 2015; 37(12): 3–13.
  56. Yang Y, Li H, Xue C, *et al.* Impact of forest property rights and market environment on peasant household forestry investments in different production links in Fujian. *Resources Science* 2018; 40(2): 427–438.
  57. Qin P, Carlsson F, Xu J. Forest tenure reform in China: A choice experiment on farmers, property rights preferences. *Land Economics* 2011; 87(3): 473–487.
  58. Zhu W, Zhang L. The effect of new round of confirming collective forestland property rights on farmers, long-term input in forestry. *Reform* 2019; (1): 109–121.
  59. Cao L, Wang L, Zeng Y. Empirical research on household forestry production behaviors that support collective forest tenure reform policy in Hunan. *Resources Science* 2015; 37(2): 391–397.
  60. Ren Y, Kuuluvainen J, Yao S, *et al.* Effect of land rights structure and village democracy on farmer's forestry inputs. *Journal of Northwest A & F University (Social Science Edition)* 2019; 19(1): 128–136.
  61. Sun Y, Xu J. Analysis on the performance of collective forest tenure reform. *Forestry Economics* 2011; (7): 6–13.