

# Property Rights Effects on Farmers' Management Investment in Forestry Projects: The Case of Camellia in Jiangxi, China

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**Abstract** China's central government has carried out a series of collectivization and de-collectivization attempts of forest tenure over time, which have led to multiple forest tenure arrangements within provinces. This paper investigates the motivation of farmers to maintain forestry under various forest tenure regimes. First, the paper provides a qualitative analysis of the different forest tenure regimes using the New Property Rights Theory. Second, an econometric analysis based on data from camellia projects in Jiangxi province is carried out. Camellia projects are long-term projects for the production of non-timber forest products which are important for rural income generation. Qualitative results of the research show that a multitude of different tenure regimes exist across forestry projects. Community-based or collective forest management regimes are the most important tenure regimes in forest management in Jiangxi province. Village communities and farmers are the main actors in forest resource management and investment in camellia projects in Jiangxi province. The results of the econometric analysis show that higher degrees of tenure security and residual claimancy for farm households lead to a higher use of

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household labor and capital within camellia forestry projects. Uncertainty about the future forestland distribution is an obstacle for household investments in forestry.

**Keywords** Forest tenure · Tenure security · Farm household · Household management investment · Decentralization

## Introduction

Forestry provides a variety of products and services to improve rural livelihoods and contributes to regional and global ecosystem stability (FAO 2012). In that forests remove carbon dioxide from the atmosphere, the conservation of forests helps to mitigate climate change. Therefore, international donor organizations and governments in developing countries have been setting up projects in which farmers are provided with financial and technical support for continued forest conservation and afforestation. Examples include REDD+ and domestic carbon offset projects. These projects however have been criticized for creating incentives towards centralized governance, as well as for putting community tenure rights at risk (Sandbrook et al. 2010; Larson 2011). Starting in the 1980s, governmental forest tenure regimes in developing countries have been increasingly devolved to community-based forest tenure institutions (Edmunds et al. 2003). The devolution of forest tenure, and the recognition of customary land tenure institutions, is aimed at more equitable resource management under the responsibility of communities. Community-based resource management is furthermore assumed to lead to more sustainable resource use (Ambus and Hoberg 2011).

Particularly in Asia, decentralization has emerged as a major forest resource management strategy (Dahal et al. 2011). China is one of the countries where the central government carried out a series of forest tenure reforms starting in earnest in the 1980s. In the early 2000s, it started further forest tenure reform by devolving a large share of decision-making power over forest tenure and use rights to the village level. Under a variety of local socioeconomic conditions, this led to villages establishing a diversity of forest tenure and management arrangements within a province (Liu 2008). With such a variety of local forest tenure regimes, China provides an interesting case for comparing the effects of forestry projects under different kinds of decentralized forest tenure regimes. Moreover, with the devolution of forest governance in developing countries, local communities and smallholders are playing increasingly important roles in forest management and governance (Hlaing et al. 2013). The farmers' decisions to plant trees and their choices to allocate their natural and capital resources need further investigation (Martin et al. 2012). Wang et al. (2014) showed that the current Chinese forest reform has an important impact on small farm household livelihoods. As a developing country with a large number of smallholders, it is important to involve smallholders and stimulate forest investment through the efficient use of forestland in China.

The aim of this paper is to investigate whether forestry projects have led to a (re)centralization of forest tenure and to identify the motivation of farmers to

maintain forests, i.e., to invest labour effort and inputs in forestry. Literature so far has investigated the relationship between tenure rights and investments in China. Ma et al. (2013) analyzed investments in agricultural land improvements and Qin and Xu (2013) and Xie et al. (2013) analyzed investments in forest management practices, and they found better tenure security rights encourage more investment. This paper contributes to the literature by looking at the impact of property rights on farmers' management investment incentives not only from the conventional tenure security perspective, but by adding a dimension of analysis based on the New Property Rights Theory (NPRT). In line with this theory, incentives are not only affected by the security of property rights but also by the distribution of residual control and income rights as a result of the incompleteness of the definition of property rights. The final objective of this paper is to apply this extended framework of property rights to different tenure regimes in the context of Chinese forestry projects and to derive implications for household incentives and management investments in forestry projects.

This paper investigates the case of camellia projects in Jiangxi province, China. Camellia (*Camellia Olifera*) is a perennial oil-producing tree species, native to subtropical areas of China. The seeds are processed into cooking oil. Camellia trees reach full production potential in 5 years and produce oil-bearing seeds for up to 50 years. Hence, camellia projects are long-term projects where non-timber forest products can generate much needed rural income. Camellia has a long cultivation history in Jiangxi, and local farmers are experienced in planting and extracting oil from it.

## Conceptual Framework

The starting point of this analysis is the concept of tenure security. Tenure security is assumed to be crucial for farm households' production incentives in forestry. First, a brief discussion of the concept of tenure security is provided. Next, the NPRT, which will be applied to the analysis of the tenure regimes in the results section, is introduced. NPRT allows adding more depth to the analysis because it complements the conventional notion of tenure security. Finally, we review the literature that relates property rights to investments in agriculture and forestry.

### Tenure Security

Land tenure consists of legal or customary rules that define how property rights to land are allocated within societies (FAO 2002). These rules define how access to land is granted, who has rights to use, control and transfer the land and which associated responsibilities and constraints apply. In other words, land tenure systems determine who can use what resources for how long and under what conditions. Land tenure security can be defined as the certainty that a person's rights to land will be recognized and protected against the acts of others (FAO 2002). Land tenure security can be weak because of conflicts of interest between different parties in society. In the case of China, overriding interests over land may occur because

government authorities have the power to expropriate land for further land reforms. Furthermore, overlapping interests can exist in the case of collective tenure regimes in which individuals share the rights to use and benefit from the land.

Arnot et al. (2011) provide an overview of the concept of tenure security in a forest management context. They distinguish between tenure security based on assurance and tenure security based on substance of rights. Tenure insecurity in terms of assurance refers to the uncertainty of rights, the probability of losing rights, uncertainty over changes in government policy or the probability of non-extension or renewal of rights. Studies that investigate tenure security in terms of substance have used indicators such as the duration of rights, the legal title to land, renewability of rights and the right to sell or transfer land. An important distinction that can be made is that assurance type tenure security is based more on individuals' perceptions of security, while substance type security relates to actual attributes of tenure as defined by customary, legal or contractual rules.

According to the FAO (2002), security of tenure cannot be measured directly and people's perceptions about security are the basis for their investment decisions. The reason for this is that attributes of security will change depending on the context (e.g. length of time until crop maturity). In line with this view, several authors have criticized the use of substance attributes of tenure security, such as holding a legal title to land, for not adequately representing the perceptions of individuals about tenure security (Arnot et al. 2011; Ma et al. 2013). The majority of studies that have investigated the effect of tenure security on investments from the assurance perspective have focused on the risk of expropriation, or in other words, the effect of overriding interests on land tenure.

In general, there are two main ways in which security of property rights over land can encourage investments: through increased assurance that investors will be able to reap the benefits from their investment; and through improved access to funds, also called the collateralizability effect (Arnot et al. 2011; Ma et al. 2013). In the case of management investments, i.e., the investment of variable inputs and labour effort, the focus will be especially on the effects of increased assurance. Household incentives are not only affected by uncertainty over the protection of property rights but also by the allocation of property rights. Even with secure property rights—in the sense that the perception of expropriation risk is minimal—investment incentives may be low if there is uncertainty over the claim to the benefits of the effort and variable input investments that have been made. It could be argued that such uncertainty may arise in the case of overlapping interests over land (see FAO 2002) and this presents an additional dimension of land tenure insecurity. At the core of this discussion is the notion that all social contracts—no matter if they are based on legal, customary or contractual rules—are incomplete. Investment incentives are therefore also importantly driven by what is not specified in laws or contracts. This perspective was formalized in the NPRT.

### **Property Rights Theory**

Furubotn and Richter (2005 p.5) defined property rights as “the rights to use and to gain benefits from physical objects or intellectual works and the rights to demand

certain behavior from other individuals.” Property rights have long been considered as a bundle of rights, with property being defined as a set of rights that describe what people may and may not do with resources; the extent to which they have them at their disposal, can use, transform, transfer them or exclude others from their property (Furubotn and Richter 2005; Slangen et al. 2008). Empirical research on farmers' land tenure often has used this understanding of property rights (Besley 1995). Following this approach, investment incentives would be higher the more ‘power of control’ an individual holds over the total bundle of rights to land (Slangen and Polman 2008). The incentives for an individual to invest in an asset such as forestland, are stronger if he/she holds a larger share of the bundle of rights. However, this “old” property rights theory may not capture the complexity at stake in developing countries where collective property rights were widespread and the management process was difficult to be analyzed using the “old” property rights theory.

The NPRT—also referred to as the Grossman-Hart-Moore model of property rights—came to the forefront with the development of transaction cost economics and incomplete contract theories (Hart and Moore 1990). In essence, the NPRT investigates the optimal allocation of property rights with respect to the alignment of incentives for economic actors. Property rights are considered incomplete contracts because under conditions of bounded rationality and environmental uncertainty it is impossible to specify complete contracts. Hence, some details of allocation and use of the resource are left to future specification or the discretion of economic actors. This leads to the notion of residual rights and claims over resources (Segal and Whinston 2013).

Central to NPRT is the notion of residual claimancy, which depends on the owner's ability to exercise residual control rights over the property and to derive residual income from it (Barzel 1997). The residual control right is the right to make any decision concerning an asset that is not explicitly controlled by law or assigned to another person (or organization) by contract. The residual income rights are the rights over the residual income which is the amount that remains from the gross-return of a company, activity, good or service after all the contractual commitments are fulfilled (Slangen et al. 2008). In the discussion of property rights and the respective incentives to make productive investments in land, NPRT states that incentives will be maximized if residual control rights and residual income rights are with the same decision-maker. Separating control of the assets would therefore reduce the incentive to invest (Hart and Moore 1990).

## Property Rights and Investments

The evolution of property rights and their effects on investment are central issues in the development literature (Besley 1995). Land tenure security is expected to positively influence investment in land, as it improves the claims on benefits from the investment, access to credit markets and gains from land trading with other farmers (Besley 1995; Fenske 2011). Several studies have investigated the relationship between land tenure security and investment in the agricultural sector. For crops with long periods until maturity, like trees, property rights are essential for

providing management incentives (Holden et al. 2011). Since forestry requires long-term investment, the security and capacity to reap future benefits is crucial. In a literature review, Godoy (1992) discusses the factors that affect smallholders' tree cultivation. The two most important determinants appear to be a sustained increase in the relative output prices and land tenure security. The studies suggest that more secure and formalized land rights promote longer-term investment such as tree planting (Martin et al. 2012; Ali et al. 2011; Koo 2011).

Only a few studies discuss the influence of forest tenure on forest management in China. Land rights are relevant for household decision-making in China because village collectives officially own the land but individual households may have fixed-term contracts to use the land for their own production activities (Mullan et al. 2011). Based on a comparative qualitative analysis, Gao and Zhang (2012) found that the recent forestland reform that intended to increase households' forest tenure security and decision-making power, indeed increased farmers' motivation to invest. The forestry reform furthermore gave farmers greater power to make decisions about their forest management (Liu 2008). Finally, Qin and Xu (2013) found that forestland rights affect fertilizer and labour investment. The literature suggests that for long-term forestry projects, tenure security is crucial to maintain farmers' investments. In the analysis that follows, the dimension of residual claimancy will be added to the discussion of property rights effects on incentives.

Throughout the paper, reference is made to management investments measured in terms of labour and variable input use. While this use of the term investment differs from the traditional interpretation in the field of economics, it is in line with studies by Qin and Xu (2013) and Xie et al. (2013) which refer to farmers' investments measured by chemical fertilizer and labour input and forest management investments measured by labour and monetary input, respectively. In line with these authors, it is believed that property rights can also have a substantial effect on these types of incentives and investment decisions, and this holds especially in the case of forestry crops where the benefits from management investments today may only be accessible after a long crop maturation period.

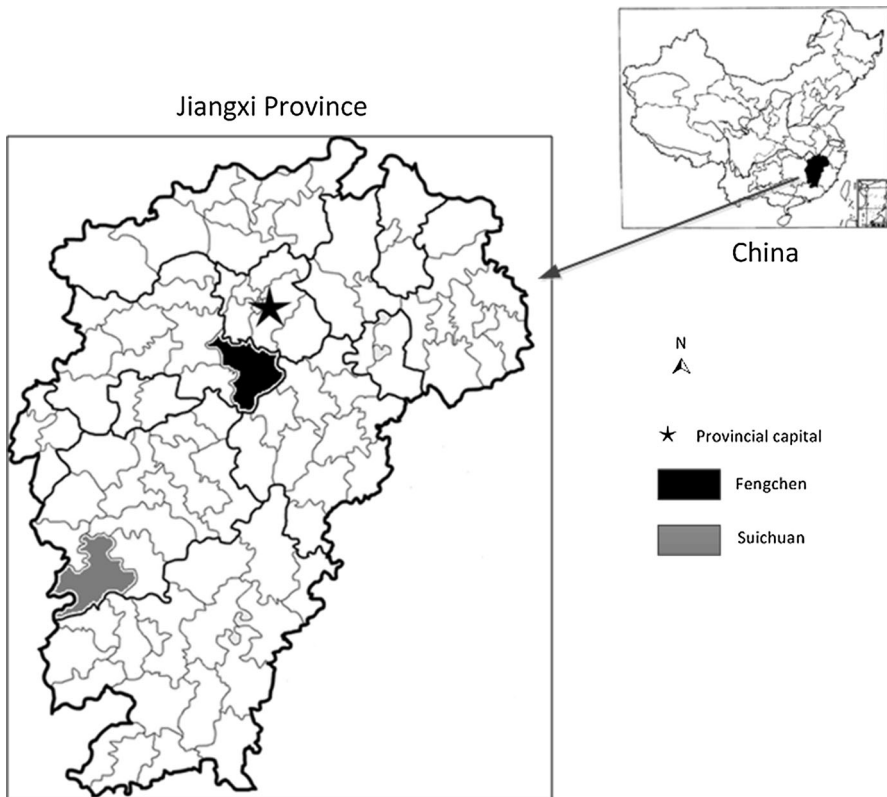
## The Study Areas

Jiangxi province was selected as the study area because it is the second province in China to start the latest forest tenure reform, and collective forest tenure covers around 85 % of the total forest area in the province. Furthermore, a number of large-scale forestry projects have been implemented in Jiangxi.

Jiangxi province is located in the south of China (Fig. 1) and is one of the most forested provinces with 158 million Mu<sup>1</sup> (10.54 M ha) of forestland (National Bureau of Statistics of China 2011). Forest covers 58.3 % of the province which is nearly three times higher than the national average of 20.4 %. Jiangxi ranks second among China's provinces in terms of forest coverage (National Bureau of Statistics of China 2011).

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<sup>1</sup> 1 mu = 1/15 hectare.



**Fig. 1** Location of study sites

In Jiangxi, a number of forestry programs have been carried out for a variety of purposes including the erosion mitigation, the promotion of bio-energy for increasing energy security, carbon sequestration, and food security (Forestry Department of Jiangxi Province 2012). This paper takes the case of camellia projects in Jiangxi. Jiangxi is one of the key provinces for camellia production. Plantations were first established in autumn of 2008, forest plantations hence were still in the initiation stage when this research was conducted. Camellia trees reach full production potential in 5 years and greatly benefit from fertilizer, pesticide and intensive labour inputs during this period. In this study, two camellia projects in Jiangxi province were examined, one making use of subsidies from the central government, the other from foreign loans.

## Research Methods

For this study, a survey was carried out in Jiangxi province in July and August 2011. Two counties were selected based on the difference in economic development levels, geographic conditions and camellia development levels. Suichuan county

(with both a domestic and a foreign loan project) is located in the south western part of Jiangxi province (Fig. 1) which is relatively poor and less developed, while Fengchen county (with a domestic project) is located in central Jiangxi which is relatively rich and more developed. Both counties have a long history of camellia plantations.

In each county, 14 villages were randomly selected. For each village, around ten villagers were randomly selected and interviewed. One hundred and thirty-nine out of the 280 interviewees participated in the camellia projects, representing 182 camellia forestry plots. In addition to basic household characteristics (age, gender, education, family size, and assets), questions on the investment for each forest plot and the characteristics of each plot (slope, soil quality, and distance to home) were included, as well as a question on the kind of forest tenure regime.

### Empirical Model and Variables

Equation (1) is the regression model that was used to examine the link between land property rights and farm household management investments (based on Besley 1995).

$$Y_{ij} = \beta_0 + \beta_1 R_j + \beta_2 TS_{ij} + \beta_3 X_{ij} + \beta_4 z_i + \varepsilon_{ij} \quad (1)$$

- $Y_{ij}$  was the measure of management investment by household  $i$  on a given plot  $j$ . Two separate investment models were estimated in which  $Y_{ij}$  was defined respectively as:
  - (a) *Labour* refers to the labour use (including hired labour) on the plot during the second year after plantation, divided by the size of the plot. The unit was Working days/Mu.
  - (b) *Capital* comprises the expenditures for fertilizer and pesticides on the plot during the second year after planting, divided by the size of the plot. The unit was Yuan/Mu.

For both, *Labour* and *Capital*, data on first year investment was not used since the government, the natural village or the camellia processing company financially supported first year investment in seedling and soil preparation for some of the survey households. Therefore, second year investment after the establishment of the plantation is a better proxy to estimate individual households' investment in their forestry land.

- $R_j$  referred to the different tenure regimes. A dummy was 1 for a plot under a certain tenure regime such as *Individual*, *Partnership*, *Collective-Individual* and *Company* regime, and 0 otherwise.
- $TS_{ij}$  was a proxy for tenure (in)security and was measured as the risk of expropriation in the next 10 years as perceived by the respondents. It took the value of 1 if expropriation risk was perceived as high, and 0 otherwise.



- $X_{ij}$  was a vector of plot-specific characteristics. It included *Slope*, *Soil quality*, *Size*, and *Distance*.
  - (a) *Slope* was defined as a dummy variable that was 1 for plots that have an inclination of 25° or more which indicated steep, and 0 otherwise.
  - (b) *Soil quality* was defined as a dummy, where 1 indicated good quality soils, and 0 medium or bad quality soils as reported by the farmers.
  - (c) *Distance* was the distance from the household homestead to the forest plot in kilometer.
  - (d) *Size* was the area of the plot in Mu.
  
- $Z_i$  included measures of household characteristics. It included *Age*, *Gender*, *Education*, and *Value of house*.
  - (a) *Age* was the age of the household head in years.
  - (b) *Gender* was the gender of the household head, where 1 indicates male and 0 is female.
  - (c) *Education* was the years of schooling of the household head.
  - (d) *Household size* denoted the number of household members.
  - (e) *Value of house* represented the value of the house in thousand Yuan, and has been recognized as a more accurate measure of wealth than income (Uchida et al. 2007).

## Results

Three distinct kinds of results are presented. The qualitative results in the section on tenure regimes show if a recentralization of forest tenure regimes has taken place with the implementation of camellia forestry projects. Next, combining the property rights dimension of tenure security with the NPRT, hypotheses are developed to identify whether the different tenure regimes provide different incentives for farmers' management investments. After presenting some descriptive statistics to provide insight into the survey sample, the hypotheses are tested using regression analysis.

### Tenure Regimes

China experienced a series of property rights reforms since the founding of the People's Republic (see Supplementary Materials). These reforms resulted in the present complexity of China's forest tenure regimes and have created uncertainty over forest property rights and respective investment returns for farmers.

As a result of the devolution since 2003, multiple forestry management practices under various tenure regimes exist, involving a diversity of actors (Liu 2008). Tenure regimes furthermore are the result of different physical and socio-economic conditions as well as different governance arrangements at the village level (Xu et al. 2008).

From the survey, five types of forestry management tenure regimes are identifiable in the study area, which are distinguish based on the different kinds of property rights (Table 1).

The forest tenure regimes of the study area have some similarities but also some differences with those in the literature (e.g. Xu et al. 2008; Holden et al. 2011). The regimes “*Individual*” and “*Partnership*” are the same as those mentioned by Xu et al. (2008) and Holden et al. (2011). The regime “*Company*” is a kind of “*Outsider contract management*” described by Xu et al. (2008). Management by a Villagers’ Group (Xu et al. 2008) is divided into two different regimes, i.e., the “*Collective*” and the “*Collective-Individual*” on the level of the natural village. In both regimes, the village representatives are of crucial importance. In general, village representatives are responsible to manage the collective land (forestland and agricultural land) as well as public goods such as infrastructure. In Jiangxi, representatives are not formally elected but become representatives based on their influence, clan membership, or profession or previous profession (e.g. teacher, soldier). Under the *Collective-Individual* regime, the village representatives coordinate the start of the plantation with all villagers, and then the village representatives distribute the forestland plots to individual households to manage the forest afterwards. Under the *Collective* regime, the village representatives manage the forest together with the villagers. Even though benefits and income formally belong to all villagers under these regimes, corruption is reported among villagers’ representatives.

In line with the conceptual framework, two dimensions of property rights are distinguished, tenure security and residual control/income rights. Tenure security is interpreted here in terms of assurance, namely whether individual households hold land rights and hence can control the destiny of the land (security is high) or not (security is low). In the Chinese context, forestland can only belong officially to the government or the collective. Individual land titles should hence be interpreted as user rights for a particular duration set by the central policy. In the discussion of the tenure regimes in terms of the residual control and income rights, residual control

**Table 1** Tenure regimes in the study area

		Collective	Company	Collective-Individual	Partnership	Individual
Residual control rights	Labour	Individual	Individual	Individual	Individual in partnership	Individual
	Capital	Natural village	Individual	Individual	Individual in partnership	Individual
Residual income rights		Natural village	Individual/Company	Individual	Individual in partnership	Individual
Tenure security		LOW	LOW	LOW	MEDIUM	HIGH
Management investment incentives		LOW → HIGH				

over capital input and labour input is distinguished. The reason for this is that different parties may be responsible for decisions over labour and capital.

Under the *Collective* regime, management of forests is coordinated by the natural village<sup>2</sup> representatives. Natural village representatives control the level of capital investment. Individuals are assigned the tasks of working on the forestland and making day-to-day decisions about the labour effort they put in and the care they take in performing the assigned tasks. Hence, individuals have residual control rights over labour. The natural village community, however, has residual income rights. Tenure security under the *Collective* regime is low as land titles are held collectively.

In the case of the *Company* regime, the company and village representatives agree on the management of the camellia plantation at the start of the project. The forestland is leased to the company with the agreement of (the majority of) the farmers and a contract is established with the company with village representatives acting on behalf of the farmers. Households are involved in the daily management and have residual control rights. The company and the natural village representatives monitor the projects. Residual income rights are shared between individuals and the company in the short-run, where the contract specifies that the company receives the larger share of the residual. However, in the long-run, the company and the village representatives hold the power to decide on the future of the forestland and as a consequence, tenure security is low under this regime.

Under the *Collective-Individual* regime, the village representatives distribute the forestland plots to individual households who manage them, thus the residual control and income rights are transferred to the farm households, and the farm household decides on the labour and capital use. As the households do not receive a forestland certificate, the representatives still have the power to redistribute the forestland at a later stage, which means that farmers' tenure security is low in the long-term, where uncertainty about the duration of use rights exists.

Under the *Partnership* regime, individual farm households join together in a partnership and make joint decisions on the plantation inputs and outputs, more specifically, the labour and capital use are generally decided jointly by the partnership. Residual control rights belong to the individuals in the partnership. The individuals in the partnership decide how to share the residual income. Incentives are expected to be stronger under the partnership regime than under the previously discussed regimes because residual control and income rights are assigned to the same parties. However, decision-making—especially in the long-run—is the result of mutual agreement between the members of the partnership. This may mean that there remains some uncertainty over long-run residual income distribution as partner motivations and the impact of future events on partners' decision-making is not known. Furthermore, tenure security may be lower for the partnership as a whole as individual land rights are bundled in the partnership.

Under the *Individual* regime, residual control and residual income rights belong to the individual. Moreover, land tenure rights are assigned to individuals and hence the tenure security is assumed to be strong.

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<sup>2</sup> Natural village is a sub-unit of an administrative village.

**Table 2** Descriptive statistics of variables used in the analysis

Investment	Mean/percentage	SD	Min	Max
Labour (days/Mu)	3.20	3.54	0	30
Capital (Yuan/Mu)	34.76	56.87	0	300
Partnership	7.1 %	–	0	1
Collective-individual	36.3 %	–	0	1
Company	21.4 %	–	0	1
Individual	35.2 %	–	0	1
Tenure insecurity	76.9 %	–	0	1
Size (Mu)	15.69	28.53	0.23	200
Distance (km)	1.19	1.13	0.05	7.5
Slope	25.1 %	0.43	0	1
Soil quality	17.6 %	0.38	0	1
Gender	97.8 %	0.15	0	1
Age (years)	49.68	11.21	24	78
Education (years)	6.87	3.07	0	14
Household size	5.16	2.02	2	13
Value of house (1000 Yuan)	55.72	72.15	0.02	600

In conclusion, these five forms of forest tenure regimes differ in various property rights dimensions, implying different degrees of tenure security and residual claimancy for farm households. As a result, investment incentives are also expected to vary across tenure regimes.

### Descriptive Statistics of the Survey Sample

Descriptive statistics of the data are presented in Table 2. Just over a third, 36.3 % of the respondents are part of a *Collective-Individual* regime and similar number 35.2 %, are part of an *Individual* regime. Twenty-one point four percent of the respondents cooperate with a company, and only 7.1 % are in a *Partnership* with other farmers.<sup>3</sup> Clearly a multitude of different tenure regimes across in forest projects in the study area, and there is no evidence of recentralization of forest tenure observed. Furthermore, with the exception of *Partnership*, the observed regimes are rather equally distributed in their occurrences. Perceived tenure insecurity seems to be high: for more than 75 % of the sampled plots, households indicate that there is a high risk of expropriation in the next 10 years.

Second year management investments in the cultivation of camellia cannot be considered high with an average labour intensity of 3 days/Mu, and a mean capital input intensity of 35Yuan/Mu. This is much lower than the general technical requirements stipulated by the government.

<sup>3</sup> Note that the *Collective* regime is not included in the analysis because survey households had little involvement in forestry management under this regime and are hence not familiar with the situation.

Cultivation conditions are favorable in terms of slope (only 25.1 % of the trees grow on land with a slope of more than 25° steepness), and a relatively short distance to the households (on average 1.2 km), plot size is small (average size of 15 Mu or 1 ha), and the percentage of good soil quality is only 17.6 %, with the majority of plots being of medium quality. In general, the conditions for forest plantations may be considered favorable.

Compared to other remote mountainous areas in China (Tu et al. 2011), household characteristics of the survey respondents are fairly representative. Survey household heads are mainly male and on average 50 years old, with a rather low education level of 7 years (first year middle school). The average housing value is 55,000 Yuan which is around 10 times higher than the average net income per capita in the rural areas of Jiangxi province.

## Regression Results

Because household investments in labour effort and input use are censored at the lower bound, i.e., the lower bound is zero when no effort or inputs are applied, a Tobit regression model was used. This was especially relevant for estimating the capital investment model because 53 % of the sampled plots received no fertilizer or pesticide inputs in the second year after plantation.

The results of the Tobit estimation are presented in Table 3. The Tobit model is designed to estimate linear relationships between variables when there is either left- or right-censoring in the dependent variable. In our case, left-censoring occurs for all households that have spent zero labour days and/or zero Yuan of capital investment on their Camilla plantations. The Tobit model is therefore appropriate. Tobit regression does not have an equivalent to the R-squared that is found in OLS regression and interpretation of the goodness-of-fit of the overall model is not straightforward. The likelihood ratio Chi square and *p* value for the model estimating labour and capital investments in Table 3 tells us that our model as a whole fits significantly better than an empty or null model (i.e., a model with no predictors).

The results show that the only tenure regime that has, in comparison to the *Individual* regime, a positive impact on capital investment, is the *Partnership* (significant at 5 % level). However, labour use under *Partnership* is not significant. This result leads to the conclusion that *Partnership* has higher fertilizer and pesticide inputs than the *Individual* regime. This result contradicts the assumption that incentives are lower under *Partnership* than under the *Individual* regime. A reason for this may be that farmers who join a *Partnership* are often friends and relatives, which means that they may have more trust in the long-term stability of the arrangement and therefore perceive a high security of investments within this relationship. Furthermore, since partners have joint responsibility for the partnership, they may not be likely to abandon the plantation afterwards. As a result, farmers in a *Partnership* may have a higher management investment intensity compared to the *Individual* regime.

**Table 3** The impact of tenure regimes and tenure security on the household management investment

Variable	Labour		Capital	
	Coefficient	t-value	Coefficient.	t-value
Partnership	-0.82	-0.84	85.45***	3.25
Collective-individual	-2.66***	-4.25	-80.20***	-4.20
Company	-1.72**	-2.50	-81.24***	-3.73
Individual	Reference <sup>a</sup>		Reference <sup>a</sup>	
Tenure insecurity	-1.02*	-1.73	25.69	1.46
Size	-0.03***	-3.08	0.43*	1.72
Distance	-0.13	-0.57	7.31	1.17
Slope	1.35**	2.38	-5.96	-0.36
Soil quality	-0.57	-0.90	6.53	0.34
Gender	-2.21	-1.36	68.51	1.46
Age	0.06**	2.52	0.72	1.01
Education	-0.01	-0.08	-6.34**	-2.46
Household size	-0.48***	-3.87	0.78	0.22
Value of house	-0.01*	-1.68	0.00	-0.04
Constant	7.63***	3.17	-64.61	-0.89
LR $\chi^2$ (13)	62.06		63.28	
Prob > $\chi^2$	0.0000		0.0000	
Number of observations	182		182	

\* Significant at 10 % level, \*\* significant at 5 % level, and \*\*\* significant at 1 %

<sup>a</sup> Reference is *individual* regime

Trust in the continuation of the current arrangement<sup>4</sup> seems to be a crucial factor for farmers' management investment. This finding is supported by other research having pointed at the importance of trust in economic decisions (Tu et al. 2011). A further reason for higher capital investment can be related to partnerships' easier access to credit, which increases partners' financial capacity to purchase capital inputs. Findings are somewhat supportive of the central and local government's policy to promote partnerships. During the survey, some farmers indicated that they join together to get access to subsidies and credit, but the management was practiced individually which might result in the impact on labour investment not being significant.

Results show that under the *Company* regime, investment is significantly lower than under the *Individual* regime, both for labour and capital. This is in line with the expectations and confirms that under the *Company* regime, the residual control and income rights are not completely under the authority of the individual. Similarly, the farm household investment level is quite low under the *Collective-Individual*

<sup>4</sup> Note that the continuation of a (contractual) relationship can be related to the assurance perspective of tenure security. This is, however, distinctly different from the perception of long-term tenure security as captured by the variable TS (*tenure insecurity*).

regime. According to farmers interviewed, a reason for this may lie in the fact that the village representatives decided about the initiation of the forestry projects, while not all farmers may be interested in participating (interview with farmers). Labour use intensity under *Collective-Individual* is even lower than under the *Company* regime. This may be explained by the village representatives' or company's random monitoring visits under the *Company* regime. During these visits, they check whether farmers work on the field and monitor the seedlings' survival rate. Such monitoring does not exist for the *Collective-Individual* regime.

In conclusion, the regression results show that under the different tenure regimes, farm households' investment of labour and capital differs. The *Partnership* regime turns out to be the regime with the highest investment. The *Collective-Individual* regime and *Company* regime have lower investment levels.

The results related to tenure insecurity are identifiable in the regression results, but because both tenure insecurity and tenure regimes are included in the model, the interpretation of the coefficients should be done under the *ceteris paribus* assumption. In other words, all else being equal what will be the effect of increased tenure insecurity? The results show that there is a significant effect of tenure insecurity on households' management investment incentives, regardless of the property rights effects that were already discussed for the different tenure regimes. Specifically, a significantly negative effect of tenure insecurity on labour investments is found. This result supports the hypothesis that uncertainty about the future forestland distribution may be an obstacle for security of investments. Farmers' decisions on labour and capital investment may differ because the use of capital inputs is not only affected by the incentives resulting from land tenure security but also by the farmers' financial capacity to buy such inputs. Farmers that are financially constrained may therefore not invest in more capital inputs with increasing tenure security but rather use relatively more labour. The incentive increase due to tenure security may hence result in an unequal influence on labour and capital investments.

Apart from the tenure regimes and tenure insecurity, results in Table 3 show that characteristics of plots also affect farm households' labour and capital investment levels. The size of the plot has a negative impact on labour intensity and a positive impact on capital investment. For each Mu increase in size, the labour use intensity decreases and the capital use intensity increases. Smaller farm households hence use relatively more labour and spend less money to purchase fertilizers and pesticides. Furthermore, forestland is allocated based on household size in China. This means that small forest areas relate to small households which may have less monetary capital to invest and use labour to substitute for capital. The positive and significant slope coefficient in the labour investment regression implies that a plot with a steeper slope requires more labour input. However, steep slopes are not compensated for with higher capital input. Interestingly, distance to home and soil quality prove not to have a significant influence on investment intensity.

At the household level, results show that the age of the household head has a positive impact on labour use, i.e., the older the household head, the higher the investment of labour on forestland. Education has a negative impact on capital input, which is in line with studies on agricultural production costs (Tan et al. 2008).

The reason may be that farmers with a higher education level are more skilful in forest activities, which decreases investment inputs. Moreover, household size has a negative impact on labour use, because the larger households may adopt better management methods and may be more able to manage the crop in a timely manner (Tan et al. 2008). However, for the capital variable, household size is not significant. Finally, the value of the house has a negative impact on labour use intensity which means that wealthy households spend less labour on the plot.

## Conclusion

Following recent devolution trends of forest tenure, many international organizations and developing countries have taken measures to facilitate farmers' participation in forest cultivation and management. Some concerns exist whether international or national projects may reverse this trend and lead to a more centralized governance and a recentralization of forest tenure (Sandbrook et al. 2010; Agung et al. 2014). Qualitative results of the research presented here show that no recentralization of forest tenure happened in the case of Jiangxi Province, China, because a variety of tenure regimes exist in villages participating in forest projects, with none of the regimes dominating.

This paper furthermore found that devolved property right regimes have considerable impact on household management investments in the camellia forestry projects studied. We found for Jiangxi Province that the tenure regime with the highest level of farmers' investment in pesticides and fertilizers is the *Partnership* regime. The success of the *Partnership* regime may be explained by factors of trust and associates' authority over alteration rights. NPRT states that incentives will be maximized if residual control rights and residual income rights are with the same decision-maker. As a result, keeping the residual control and residual income rights together within a partnership, creates stronger incentives to invest and can make large-scale forestry projects sustainable in the long term.

A further reason for the high level of capital investment may be the easier access to bank loans. Only 7.1 % of the sample farmers in our research have joined a partnership. Investment of the large majority of farmers is hence not optimal within the given projects. The constraint in accessing credit may be a reason for farmers of the *Individual* regime not having a higher level of management investment. Hence, credit support to smallholders can facilitate farmers' participation in large-scale forest projects. These findings are in line with research in other countries (Zhang and Owiredo 2007; Herbohn et al. 2004).

These findings also confirm that the de-collectivization process and the property rights reform have resulted in a diversification of management actors including individual households, village communities, and private enterprises (FAO 2011). The developments that are observed in China fit into this wider process. The evolution of property rights and their effects on investment are central issues in the development literature. Our results are in line with the literature and other empirical studies on the relationship between forestry investment and tenure security (Besley 1995; Fenske 2011; Martin et al. 2012; Ali et al. 2011; FAO 2011). On the other



hand, security of forest tenure will reduce uncertainty over forest property rights and over respective investment returns for farmers. Hence, secure forest tenure is a fundamental element in achieving sustainable large-scale forestry projects and improved livelihood.

The following results may however be more specific to the context of China. First, tenure security of the *Collective-Individual* regime is lower than that of *Partnership* and *Individual* regimes, due to some uncertainty on land property rights remains because of the redistribution rights of natural villages. Village representatives furthermore played an important role in the establishment of property rights regimes and implementation of projects. Their legitimacy and liability will be crucial for their village regime's viability, because otherwise, local elites may easily capture residual income from forestland. In Jiangxi, natural village leaders are not formally elected. Even if benefits and income formally belong to all villagers, corruption was reported for the activities of some villages' representatives. In addition, the dominance of the *Partnership* regime in the results on investment incentives can be viewed in light of the specific Chinese context, namely the importance of *guanxi* (connection) within family relations. High levels of trust in these relations may lead to stronger incentives in partnerships.

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