GRIPS Discussion Paper 13-24

The impacts of a community forestry program on forest conditions, management intensity and revenue generation in the Dang district of Nepal

Narayan Rajpoudel
Nobuhiko Fuwa
Keijiro Otsuka

January 2014

GRIPS
NATIONAL GRADUATE INSTITUTE
FOR POLICY STUDIES

National Graduate Institute for Policy Studies
7-22-1 Roppongi, Minato-ku,
Tokyo, Japan 106-8677

The impacts of a community forestry program on forest conditions, management intensity and revenue generation in the Dang district of Nepal

NARAYAN RAJ POUDEL

Graduate School of Asia-Pacific Studies, Waseda University,
1-21-1 Nishi-Waseda, Shinjuku-ku, Tokyo 169-0054, Japan.
Email: mnkpoudel@yahoo.com

NOBUHIKO FUWA
Graduate School of Asia-Pacific Studies, Waseda University,
1-21-1 Nishi-Waseda, Shinjuku-ku, Tokyo 169-0054, Japan.
Email: nfuwa@waseda.jp

KEIJIRO OTSUKA
National Graduate Institute for Policy Studies, 7-22-1 Roppongi,
Minato-ku, Tokyo 106-8677, Japan
Tel: +81-3-6439-6228
Email: Otsuka@grips.ac.jp

Submitted 30 July 2013

ABSTRACT. A growing literature documents the positive impact of community management on non-timber forest conservation, but not on the management of timber forests which require higher management intensity than do non-timber forests. We find in Nepal that better market access encourages felling of mature timber trees before but not after the community management began and that population pressure leads to deforestation, which would have taken place under government management, but encourages forest management in recent years under community management. Longer period of community management is found to be associated with the higher density of larger trees, indicating that the community management facilitates rehabilitation of timber forests.

1. Introduction

Forests are being depleted at an alarming rate in recent decades in developing countries (World Bank, 2009). The depletion of forest resources is most likely to occur in state-managed forests because the capacity of and incentives for the governments to protect and manage forests are limited (Somanathan, 1991; Ostrom, 1990; Jodha, 2001). Responding to this problem, various forest management systems have been practiced to manage forest resources. Among these systems, the community forest management system has become popular in recent decades, particularly in developing countries (Baland et al., 2010; Tachibana et al., 2001).

Hayami (2009) argues that the community has an inherent informal mechanism that can serve as an effective system to enforce collective action among community members. This is because information asymmetry is not so serious within the community, where everyone knows everybody else. Since forest resources are non-excludable to a considerable extent, however, people may extract resources excessively under community management, which may lead to "the tragedy of the commons," as described by Hardin (1968). To address this, secure use rights on natural resources can be provided to the community groups which may have incentives to protect and manage forests effectively (Gerald et al., 2001). Realizing this, the community management system, in which the use rights are handed over to community groups, has been practiced in recent decades worldwide. The community management system is considered as an institutional innovation which empowers local people to manage forests for better livelihoods and forest conditions (Ojha et al., 2009). Further, the community management system can be a superior alternative to the individualized management system in the protection of common forest resources (Kijima et al., 2000; Bromley and Chapagain, 1984). In fact, there has emerged a flourishing literature reporting the success of the community management system where the major forest management issue is how to prevent excessive exploitation of forest resources (Gilmour and Fisher, 1991; Tachibana et al., 2001; Ostrom, 1990, Bromley, 1992).

However, a question arises as to whether the community forest management system can work where high valued timber trees dominate. The literature is weak in the analysis of timber forest management, as distinct from that of copse forests, under the community management system. This is problematic because the production of valuable timber trees requires labor for silvicultural operations, unlike the production of non-timber products which usually does not require much labor for care of trees. In addition, the limited existing literature is subjected to methodological criticism such as the lack of rigorous econometric analysis (e.g., Chakraborty, 2001; Nagendra, 2001), the subjective judgment of the forest condition (e.g., Agrawal and Chhatre, 2006), the lack of ground level data (e.g., Bhattarai and Conway, 2008), and the endogenous choice of management regime not being properly taken into account in explaining the forest condition.[1]

The main purpose of this study, therefore, is to conduct a rigorous econometric analysis of the management of timber forests with special reference to the impact of the hand-over of forest use rights to the community. More specifically, using the community forest level data from the Tarai region of Nepal, where forests used to be largely open access under government management but are more effectively managed at present under community management, this study attempts to contribute to the current understanding of forest management on three issues. First, it explores the determinants of deforestation and

[1] Edmonds (2002) and Tachibana and Adhikari (2009) are a few notable exceptions in terms of methodological rigor.

forest degradation, which would have taken place under government management. Second, it investigates the determinants of forest management intensity and revenue generation at present under community management. Third, it attempts to identify the effects of the community forest management system on reforestation by examining the effect of the length of community management on the density of small and medium-sized trees. We hypothesize that when the forest was managed by the state, population pressure created a higher demand for firewood, and agricultural and grazing land, which resulted in deforestation, whereas favorable market access led to the felling of large trees for sale. However, once the forest use rights were handed over to the community forest user groups, the larger the demand for forest resources, the greater became the incentives to manage the forests, thereby leading to faster rehabilitation of the forest condition through the regeneration of young trees.

Based on a rigorous econometric analysis using the ground level data of the forest conditions, our empirical results support these hypotheses. Our strategy for identifying the impact of community management on forest conditions with cross-section data rests on two factors. First, this paper is among the few studies utilizing ground level data on forest conditions.[2] A snapshot information on the density of trees of different sizes can allow us to infer the changes over the recent decade that are likely to have occurred in the forest. Secondly, we exploit the fact that the year when forest use rights were handed over to community groups differs across community forests, which creates variations in the number of years when those community forests had been under community management at

[2] Baland et al. (2010), Tachibana and Adhikari (2009) and Gautam (2009) are notable exceptions in this regard.

the time of our data collection. We identify the impact of community management by correlating the forest conditions with the length of exposure to community management. Since the timing of hand over is likely to be correlated with unobserved characteristics of communities, however, we treat the timing of hand over as an endogenous variable in our analysis.

This paper is structured as follows. In section 2, we discuss the evolution of community forestry in Nepal. In section 3, we briefly explain the main issues and hypotheses of the study. In section 4, we discuss the data and methodology used in the analysis. In section 5, we report the estimation results and their interpretations. Finally, Section 6 concludes the paper.

2. Evolution of community forestry

Forest management issues occupy a central place in the national policy discourse in Nepal because of their importance in the livelihoods of the people and in the state revenue (Ojha, 2009). Historically, local governments controlled the forest resources in the feudal Rana regime from 1846 to 1950. They undertook the harvesting of timber trees, particularly in the Tarai region and in some parts of the hill region accessible to markets, but the collection of minor forest products was unregulated (Tachibana et al., 2001). After the collapse of the Rana regime in 1950, its feudal forest management system also collapsed, resulting in massive deforestation and forest degradation. Responding to this situation, all the forest areas were nationalized in 1957. However, the government could not manage the forests effectively. Observing the effective and voluntary management of forests by communities in selected areas in the 1960s and 1970s, the government of Nepal gradually realized the importance of a decentralized management system to arrest deforestation and forest degradation.

Following the recommendation of the Ninth Forestry Conference in 1974, the government of Nepal drafted a National Forestry Plan to combat deforestation and forest degradation. For the first time, the plan officially recognized the role of local people in forest management activities (Pokharel, 1997). In response to this plan, the government enacted Panchayat Forest Rules and Panchayat-Protected Forest Rules in 1978, which allowed the locally elected body called the village Panchayat to manage the degraded forestland. The Decentralization Act in 1982 introduced the 'user group' concept and promoted it as an effective means to combat the deterioration of the stock of forest resources. Another landmark development in community forestry was the preparation of the 25-year master plan in 1988, which emphasized the importance of forest user groups to revitalize the age-long indigenous practices of forest resource management.

After the restoration of the democratic system in 1990, the Nepalese government enacted the new Forest Act in 1993 and Forest Regulations in 1995 for the proper management of forests. The Act and Regulations placed high priority on the community forestry program. The new forest rule specifies a procedure for the formation of community forest user groups (CFUGs) and identifies them as self-governed autonomous entities (Gautam et al., 2004). The second amendment of the community forest development guidelines in 2005 focuses more clearly on the rights of the poor and outlines the detailed roles of forest stakeholders such as foresters and CFUGs. The handing-over process of the forest use rights from the government to the local community begins with a discussion between the local forest users and the local forest officers. A general assembly meeting of the villagers must be held where the forest user group committee (FUGC) members are elected. Foresters help to organize the assembly and FUGC to prepare a constitution and an Operational Plan (OP) describing the detailed forest management plan for the coming 5-

year period. Then, CFUGs submit these documents to the District Forest Office (DFO), and if all the requirements are fulfilled, the DFO hands over the forest use rights to the CFUGs.

In recent decades, the community forest management system has become popular in Nepal. About 1.6 million people participate in the community forestry programs, and about one and a half million hectares of forest have been handed over to the communities nationwide (Ojha, 2009). It is widely accepted that the community forestry program has been successful in enriching the forest conditions in the Hill region of the country. However, there has been a genuine dispute regarding the prospect of the success of community timber forestry in the Tarai region.

3. Issues and hypotheses

3.1. Deforestation and forest degradation before the handover

Given the importance of halting deforestation and forest degradation in Nepal, various forest management systems have been implemented. However, the depletion of forest resources has not stopped yet. Many studies have attempted to identify the factors associated with deforestation and forest degradation processes. Often documented are the extension and expansion of roads, agriculture expansion, and population pressure on the use of forest resources, among other things. Most studies are based on satellite imagery showing forest conditions (e.g., Nagendra, 2001; Kanel and Niraula, 2004). Studies using ground level data of the forest conditions and management practices under the community management regime have seldom been carried out.

According to the Department of Forest and Research Survey (1999), forest covers about 40% of the total land area of the country, and the forest area per capita is 0.27 ha in Nepal. The forest area had decreased at an annual rate of 1.7 % during the period from

1978/79 to 1994. The latest survey conducted in 20 Tarai districts of Nepal finds that forest cover had decreased at an annual rate of 0.06% in the 1990s (Ministry of Forests and Soil Conservation, 2009).

The population of the Tarai region of Nepal has been increasing due primarily to out-migration from the Hill and the Mountain regions over the last several decades. According to Regmi (1994), the push factors of migration from the Hill to Tarai region are population pressure, insufficient food production, deteriorating environmental conditions, natural calamities, and the lack of employment opportunities. Pull factors are better transportation facilities, greater availability of food, health services, and schooling systems, and higher agricultural wages. Improved road access in Tarai also helps stimulate the migration process and offers good market access for forest products (World Bank, 2007).[3]

State managed forests tend to be degraded severely because they are loosely managed or *de facto* open access. If so, higher population pressure and better market access would have accelerated the rate of deforestation and forest degradation due to the higher demand for forest products (e.g., timber, firewood, and fodder grasses) and forest land (e.g., for agricultural and settlement purposes). If the purpose of felling mature timber trees is the sale at the market, it is likely that large trees were felled in forests with favorable access to markets. Based on these arguments, we postulate the following hypothesis:

Hypothesis 1: Higher population pressure leads to deforestation by clearing the forest for the expansion of agricultural land and settlement area as well as by excessive grazing, while better access to market leads to forest degradation due to the loss of large trees for logging and selling.

---

[3] In line with this, Liu et al. (1993) find negative relationships between distance to roads and the loss of forest cover in the Philippines.

In this study, the population pressure is measured by the number of households per unit area of the community forest area, and the market access is proxied by the distance to the main road. We attempt to test whether this hypothesis holds under state management by examining the associations between the estimated proportion of deforested area at the time of handover and population density, and between the current volume of large trees per unit of area (at the time of survey) and distance to road. The deforested area that would have been observed at the time of handover is estimated by adding the tree planted area, barren area and encroached area because timber forests in the Tarai region have the capacity to regenerate trees unless they are severely damaged. The fact that trees were artificially planted in certain parts of forest implies that forest lost capacity to regenerate trees in such parts due to complete eradication of trees.

3.2. Forest management operation after the handover

Community forest management refers to the use and management of forest resources by the local people living in and around the forest area who are integrated ecologically, socially, and culturally. Forest management operations are needed to maintain and improve the forest condition. The activities of the forest management operations include: i) protecting the forest from over-exploitation, ii) improving the forest condition by weeding, pruning, thinning, planting, and singling, and iii) harvesting the forest products (Malla et al., 2001). Community forest user group members are supposed to obey the rule of restricted forest resource extraction, participate in various silvicultural operations, and receive benefits accrued from community projects funded by the sale revenue of forest resources and the privilege of purchasing firewood, timber, and other forest resources at prices lower than market prices. Forest management begins with the planning process, in which every CFUG needs to prepare an OP through a participatory approach, which directs the way in which the forest is managed for the next operational plan period (usually 5 years). The plan must contain information on the objective of the forest management, forest condition/inventory, forest protection and development activities, provisions for income generation and expenses, penalties, and plantation activities (Forest Act 1993 and Regulation 1995). Specifically, forest protection, silvicultural operations and harvesting, a regeneration strategy, and income generation are the issues of primary concern in the community forest management.

Effective forest protection requires the prevention of grazing, encroachment, and illicit harvesting. To ensure the sustainability, the regeneration of new plants is necessary after harvesting mature trees. Regeneration can take place through various ways such as new growth from the existing rootstock, plantation, and natural seedling. Plantation is needed if the forest is completely destroyed and self-regeneration of the new trees is not possible. If we plant the new trees in the barren forests, it will significantly reduce the pressure on natural trees in areas where fuelwood collection is a major cause for deforestation (Kohlin and Parks, 2001). Silvicultural operations such as weeding, pruning, thinning, and singling are needed to improve the timber forest condition and the quality of timber. Such operations not only stimulate the growth of high-quality timber trees but also supply minor forest products for the forest users. We hypothesize that higher population density and better market access accelerate deforestation and forest degradation, if forest is *de facto* open access under government management, but stimulate the forest management if its use right is handed over to the community. This is because higher population density and better market access create higher demand for forest resources, which would result in excessive exploitation of forest resources if nobody owns them but would provide the incentives for the forest users to manage the forests collectively if use rights are handed over to them. In other words, the benefits of collective management would be larger when the demand for the forest products is greater.

CFUGs generate income from various sources such as the sale of forest products and membership fees (Kanel and Niraula, 2004). The sustainable generation of revenue from the forest resources has a number of synergetic effects on forest conditions and livelihood improvement of the people (Gautam et al., 2004; Bampton et al., 2004; Kanel and Niraula,, 2004; Kanel, 2004). For example, if they generate enough revenue, they can spend such revenues on forest management, poverty reduction and social development activities (e.g., making fences along forest boundaries, financing pro-poor program and constructing school buildings and village trails). Jumbe and Anglsen (2006) find that community forestry program protects poor households from extreme poverty. Many other studies have been conducted to explore the income generation and utilization pattern by the CFUGs (e.g., Pokharel, 2009; Khanal Chettri et al., 2009). Based on the data from three Hill districts, Pokharel (2009) finds that three-quarters of the income of CFUGs comes from forestry sources, of which timber alone contributes about 68 percent of the total income. Khanal Chettri et al. (2009) find that income generation by the community groups depends on the forest area, forest quality, species composition, and market access. They also confirm that CFUGs with higher income tend to spend it in local development activities. While most of these studies focus on the Hill forests, studies exploring the determinants of revenue collection have seldom been conducted in the Tarai region of Nepal.

We expect that CFUGs carrying out intensive management operations also extract more forest products in a sustainable manner, resulting in more revenue per unit of forest area. Based on these arguments, we postulate the following hypothesis:

Hypothesis 2: Higher population density and better market access not only lead to more intensive management of community forests but also help to generate more revenue per unit area after the forest use rights are handed over.

We test this hypothesis by examining the association between population pressure measured by the number of households per unit of forest area and the intensity of forest management, and between population pressure and the amount of revenue generation per unit area. The intensity of forest management is measured by the percentage of managed forest area during the last 5 years from the time of data collection, and revenue per unit area is measured by the revenue generation per hectare of forest area by the CFUGs in the fiscal year 2009/2010.

3.3. Impact of community forestry on reforestation

Reforestation is one of the main objectives of the community forest management,[4] which contributes to maintaining forest conditions sustainably and rehabilitating the damaged forests. Therefore, the extent of reforestation is a good indicator to measure the success of initiating the community forestry with the devolution of forest use rights to the community.

The success of the community forest management system in revitalizing forest conditions has been well documented in the Hill region of Nepal (Acharya, 2005; Dev et al., 2003; Tachibana and Adhikari, 2009; Yadav et al., 2003). However, the literature on reforestation is relatively scanty in the case of the Tarai region. Forests in the Hill region are copse forests, which require protection but not much silvicultural operations for reforestation. In contrast, forests in the Tarai region are timber forests which require both protection and silvicultural operations to produce valuable timber trees (Tachibana et al.,

[4] Other main objectives of community forestry programs include forest conservation and the livelihood improvement of the poor.

2001). To carry out silvicultural operations properly, work incentives are critically important, and whether community management succeeds in the silvicultural operations by organizing collective work is an important empirical question.

The possession of forest use rights helps strengthen the incentives for the community participation in the resource management by assuring their rights to receive the generated benefits (Aggarwal and Elbow, 2006). Therefore, handing over the forest use rights is expected to encourage the local people to protect forests and improve their condition. While conducting the survey, we observed a large number of small and medium-size trees growing in our research sites. Based on such an observation, we postulate the following hypothesis:

Hypothesis 3: Community forest management has positive impacts on reforestation after the use right is handed over to the local community.

To test this hypothesis, we use the average number of small and pole trees per unit of forest area as proxy measures for the extent of reforestation. We expect that if the forests are managed intensively, pole trees are abundant in the forests handed over relatively early, and small size trees are dominant in the forests handed over recently.

4. Data and estimation method

Our dataset comes from the community forestry program in the Dang district which is located in the Inner Tarai region of Nepal.[5] The Dang district is recognized as a pioneer district in initiating community forestry in the Tarai region of Nepal. In this district, some communities have resumed timber forest management informally since around 1980

[5] The forest quality and tree composition in the Dang district are similar to the other part of the Tarai region.

(Sakurai et al., 2004). Given the similarity in the forest quality and tree composition between the Dang district and other districts in the region, the forests in the Dang district can be considered as representative of the Tarai region.

The area of this district is nearly 296 thousand hectares, of which about 66 percent of the area is covered by forest. The elevation of the Dang district ranges from 213 meters to 2,058 meters from sea level. The district has a subtropical monsoonal climate in the lowland and a temperate climate in the highland. Loam and clay soils can be found in the valleys, whereas rock, slates, and mixed soil are found in the hill area. Most of the forests in the Dang district are dominated by hard wood trees such as Sal trees except in some places in the hill sides. The use rights of the majority of accessible forests have been already handed over to local communities.

Among the 447 registered CFUGs as of 2010 in the District Forest Office (DFO) of Dang, 200 were randomly selected excluding the planted forests and those registered later than 2005. Planted forests were excluded because the management of these forests is qualitatively different from Sal-based natural forests. Recently registered CFUGs were excluded because they were considered to be too new to assess the impacts of handing over on the forest conditions. Relevant data were collected from primary and secondary sources. The secondary sources are the constitutions and operation plans of the CFUGs,[6] which they have to submit to the district forest office. We used the data on the forest conditions

[6] Every community group has to submit its constitution at the time of the handover, but they can be revised later. The constitution contains information about the number of user households, functions, duties and power of the user group and user group committee, and financial regulations. The CFUG must submit the operational plan at a regular interval of usually 5 years. This report contains information about the objective of the forest management, forest development activities that have to be carried out in the plan period, forest characteristics such as the number of trees in the forest by size and type, slope, soil type and so on. The operational plan is prepared by the CFUG with the technical support of the district forest office.

reported by the operation plan which was originally collected in association with forestry technicians using a standard forestry approach. The number and volume of the different sizes of trees per unit area are used to measure the forest condition. Besides these, other information such as silvicultural activities in terms of the area covered in the last 5 years, revenue generation in the last one year, and deforested area was collected by our own survey based on interviews with the forest user committee members (the data are available upon request).

Our survey collected the data on the extent of deforestation by asking the newly planted area, the area of barren land, and the area of encroachment for agriculture and human settlement purposes. According to our respondents, severe deforestation took place almost exclusively before forests were handed over. As mentioned earlier, the Sal (Shorea robusta) tree is dominant in the forests, and it has high regenerative capacity, so that unless trees are completely uprooted or heavily grazed, regeneration takes place. Therefore, we can interpret all the areas of community forest which are barren, planted artificially, and encroached upon as the areas that were severely degraded at least once due to the complete felling of trees and heavy animal grazing. We thus use “barren, planted and encroached areas” as our proxy measure for the extent of deforestation under state management. After the hand-over of the use rights, some parts of the barren area have been planted to fast growing trees by CFUGs. We should note, however, that this measure is likely to underestimate the deforested area, because the regeneration of trees could have taken place gradually on deforested area over time, if they are surrounded by Sal trees, which is not counted as deforested area in our measure of deforestation.

The second type of indicators of the forest condition includes (i) the average number of trees per hectare belonging to different diameter classes and (ii) tree volumes per hectare. We categorize the trees into three distinctive groups. Trees less than 10 cm diameter at breast-height are classified as *small trees*; trees between 10 cm to 30 cm diameter are classified as *pole size trees*; and trees greater than 30 cm diameter are classified as *mature trees*. In our empirical analyses, we assume that a larger number of small and pole size trees per hectare is an indication that reforestation is taking place, for the following reasons. Roughly speaking, mature trees are at least older than 20 years. Since the average time elapsed since the forest was handed over in our sample is about 12 years, the presence of large size trees in the community managed forests cannot be a result of reforestation after the handover. Rather, it is more reasonable to assume that those large trees have been protected since the period before the handover, and thus this part of the forest was intact even before the hand-over. In contrast, the presence of small and pole size trees (i.e., trees of age younger than 20 years) can be interpreted as a result of recent regeneration. For mature trees, data are also available in volume, which is a better measure of biomass than the number of trees.

To measure the intensity of forest management in recent years, we collected the data on the total area of the forest where the community forest user members carried out silvicultural operations during the past 5-year period before the year of data collection (e.g., from 2005 to 2009). Silvicultural operations comprise weeding, singling, thinning, pruning, planting and harvesting. For the revenue generation, we asked the amount of total revenue collected by the CFUGs per unit area of the forest in 2008/2009 fiscal year. The main source of revenue comes from selling the timber. Additional sources of income are the sales of firewood, non-timber forest products such as herbs, and non-forestry income such as donations and punishment fees.

In this study, we consider that the timing of handover of the forest use rights to the community is endogenously determined by CFUGs. Based on informal interviews with a large number of CFUG committee members, we assume that the effective or intensive community management was launched in the year of the handover. We use a two-stage least squares (2SLS) model to deal with the endogeneity problem associated with the year of handover. The econometric specification expressing the determinants of forest conditions, management intensity and revenue generation is assumed to take the following form:

$$\textit{Forest\_Condition, Forest\_Management or Revenue}_{i} = \beta_0 + \beta_1 \textit{Hand\_Over}_i + \delta \mathbf{X}_i + \upsilon_\iota , \quad (1)$$

where *Hand_Over*$_i$ is the year when the forest was handed over to the community i, υ_ι is an error term. As discussed in detail earlier, *Forest_Condition*$_i$ is proxied by the following set of variables: i) the percentage of barren, planted and encroached areas, ii) the volume of mature trees per hectare, iii) the number of pole trees per hectare, and iv) the number of small trees per hectare. *Forest_ Management*$_{i,}$ is measured by the percentage of managed forest area during the last 5 years from the data collection date, and *Revenue* by the amount of revenue generation per hectare of forest area by the CFUGs in the fiscal year 2009/2010, as mentioned earlier. $\mathbf{X}_i$ is a vector of the characteristics of the community forest which include physical characteristics of the forests such as the area of the forests, distance to road, distance to the forest from the village center, the slope of the forests, and demographics such as the number of households per unit of forest area and the total number of households involved in the community forestry. We incorporate the year of latest operational plan submission in the model as an explanatory variable in order to control for the effects of the timing of the data collection on forest conditions and management activities. In the regression equations of management and revenue, we also include the characteristics of the president (age, sex, and education level) of the CFUG committee as explanatory variables to control for the effect of his/her attributes in the forest management and revenue generation. Since presidents change frequently, we do not include these variables in the equations for forest conditions, which are stock variables.

The regression equation for the determinants of the timing of the forest handover, in turn, is assumed to take the following form:

$$Hand\_Over_i = \phi_0 + \phi_1 \mathbf{Z}_i + \eta \boldsymbol{X}_i + \xi_i \, , \qquad (2)$$

where ξ_I is an error term. Identification of the coefficient on Handover (β_1) requires instrumental variables ($\mathbf{Z}_i$) that are correlated with the timing of the forest handover but do not directly affect forest conditions. Our identification assumption is that the timing of the handover is affected by the accessibility to the forest offices and the foresters' workloads. As Edmonds (2002) argues, while foresters do not directly participate in the management of forests, they play a decisive role in the process of the handing over of the forest use rights to the local communities (including its timing). In the process of handing over, foresters help the community people in a number of ways from the formation of the community user groups to the handing-over decision. The handing-over process is quite time consuming and tedious since the transaction cost is very high in the group formation and collective decision making. The foresters have to go repeatedly to the forests and villages, and need to be involved in activities like group formation, assembly meeting, forest inventory measurement, and the preparation of the constitution and the operational plan. Therefore, the foresters might prefer to be involved first in the handing-over to those forests which are easily accessible from the forest offices. Moreover, the handing-over decision may also depend on the workload of the foresters. If the forest offices have to cover a large area, the average handing-over rate of the forest is likely to be comparatively low. Based on those arguments, the year of hand-over is instrumented by the time taken to reach range posts from the forest border (foresters' accessibility) and the total forest area covered by the corresponding range post (foresters' workload). We estimate the regression functions by using the 2SLS model.

5. Estimation results

5.1. Descriptive statistics and first-stage regression results

For expository purposes, we divide the samples into two groups by the median year of handover (on or before 1998 and after 1998) and examine the difference in the means of the variables used in the regression analyses between the two groups using the *t*-test. Since some data are missing, the sample sizes are different for different items. As shown in Table 1, for which data were collected from October 2010 to December 2010, difference is significant in the percentage of deforested area suggesting that severely deforested forests were handed-over earlier. Table 2 exhibits the difference in the mean of the explanatory variables. The mean differences are significant in the distance to road, slope of the forest, time taken to reach range post, and area covered by the range post. That is, the forests, which were handed-over earlier, are located in flat places, near from the road and the range posts, and intensively covered by the foresters.

Table 3 presents the first-stage regression results where the year of handover is the dependent variable. The coefficients of the instruments are positively significant in the first-stage regression results regardless of changes in sample size and specifications, suggesting that the larger the area covered by the range post and the longer the time taken to reach the forest from the range post, the later was the year of the forest handed-over. The F-statistics for testing the significance of the excluded instruments are equal to or well above 10 in all equations, suggesting that the problem of weak instruments is not of concern (Angrist and Pischke, 2009). In the test of the over identifying restriction, we cannot reject the null hypothesis that the instruments are correlated with the error term in all first-stage regressions.[7]

5.2. Determinants of deforestation and forest degradation

Table 4 reports the estimation results of the regression equations explaining the percentage of deforested area in the forests and the volume of the mature trees. We show two regression results with slightly different specifications. In the second model, we include the slope of the forests as an additional explanatory variable, which contains 14 missing observations, leading to a smaller sample size.

The coefficient of population pressure, measured by the number of households per unit of forest area, is positive and significant when the dependent variable is the percentage of deforested area in the community forests. This clearly supports hypothesis 1 that population pressure is a key factor explaining deforestation before the handover. The coefficient of the total forest area is negatively significant indicating that the proportion of severely degraded forest area is smaller in larger forests. When the dependent variable is

[7] The reduced form results are available upon request. The results are consistent with the 2SLS regression results discussed in the text.

the average volume of mature trees per hectare, the coefficient of the distance to the main road is positively significant in the second model (i.e., with the slope of the forests included). This indicates that favorable road access contributes to the loss of mature trees because it facilitates the transportation of timber to distant markets where the demand for timber is high. Note that unlike the case of severe deforestation, felling of some mature trees might have taken place after the handover. If repeated cutting and grazing are prevented, the regeneration of new trees can take place in those places where mature trees were cut down. Therefore, under ordinary conditions, the harvesting of mature trees does not lead to deforestation but only to short-term forest degradation. It is worth emphasizing that the determinants of deforestation due to grazing and the expansion of agricultural land and those of forest degradation due to the felling of large mature trees are quite different. These findings support hypothesis 1.

One should note that the year of handover is insignificant in all the cases (i.e., both models and both dependent variables) reported in Table 4. These results indicate that deforestation and the loss of mature trees were not affected by the community forest management initiated 12 years earlier on average because many more years are needed to grow large mature trees.

5.3 Determinants of management intensity and revenue generation

Table 5 presents the second-stage regression results for the percentage of area where the management operation was carried out as well as for the revenue generation per hectare under community management. The estimated coefficients of household density are positively significant in both regression equations, which is in sharp contrast with the results on deforestation. These results together suggest that the large demand for forest land and for tree resources induced by population pressure contributes to the deforestation when the forest is open access under government management but intensifies the management activities and generates more revenue per unit area once the user rights are handed over to the local community. The higher the demand for forest products, the more resources are extracted from the forests, resulting in more revenue generation. Moreover, the coefficient of distance to the road is negatively significant in the equation for the percentage of the management area, which indicates that people manage forests intensively in forests near roads. These results support the validity of hypothesis 2.

Contrary to hypothesis 2, however, the coefficient of distance to the road is not significant in the equation for the revenue per hectare. Recall that favorable road access contributes to the loss of mature trees according to the analysis of the volume of mature trees reported in Table 4. So far as selling harvested timber is a major source of revenue, these estimation results suggest that mature timber trees were harvested in areas with better market access primarily before handover of forest use rights when the forests were under government management.

The coefficient of the area of the forest is negative and significant in the equation for the percentage of the managed area, suggesting the high cost of managing large forest areas. In addition, the coefficient of the distance to the village is negatively significant in the equation for revenue per hectare, suggesting that CFUGs harvest valuable forest products such as timber from the nearby forests from the villages. Furthermore, CFUGs headed by younger presidents manage forest more intensively and collect more revenue, which suggests that younger presidents, who must have longer horizon, would have greater interest in managing forests and generating revenue. Moreover, it is interesting to observe that CFUGs collect more revenue if the president is female. Although extracting firewood and feed grasses from the forest is hard work, traditionally it is women's job in Nepal. Thus, female president of CFUG may have stronger interest in the extraction of forest resources. The year of handover has no significant effect on forest management, which may be taken to imply that the forest management intensity is independent from the year of handover. On the other hand, it has weakly positive effects on the revenue generation.

5.4. Determinants of reforestation

As shown in Table 6, the coefficients of the year of handover are positively significant in the equation for small trees and negatively significant for pole trees. These findings indicate that pole size trees are dominant in the forests which were handed over earlier, whereas small size trees are dominant in the recently handed over forests. These results are consistent with our argument that CFUGs began to protect and manage the forests intensively after the handing-over of the forest use rights and, hence, new trees began to regenerate. It is estimated that the diameter of the Sal trees increases by nearly 1cm annually under normal conditions at the sapling and seedling stages (Sapkota and Meilby, 2009). If the trees are properly managed, we expect that a newly regenerated Sal tree can graduate to become a pole size tree after 10 years. Since the average age of the CFUGs is around 12 years, we can safely infer that newly regenerated trees after the handover have become pole trees in the forests handed over earlier than the average age of the CFUG. Under the community management regime, grazing and harvesting the fodder are severely restricted in most cases. Therefore, we expect that regeneration takes place immediately after the forest management began, which increases the number of small trees in newly handed-over forests. The regression results support hypothesis 3.

It can be also seen that the coefficient of forest area is negatively significant in the equation for small trees. This may be due to the higher cost of protection from grazing and harvesting in larger forests. Another significant variable is the distance to the road, which is positively significant in the equation for pole trees, but negatively significant in the equation for small trees. These results indicate that pole size trees are better preserved in remote areas. Small trees generally grow naturally after large trees are harvested because they need enough sunlight and space to grow. Therefore, in recent years, CFUGs may harvest trees from the nearby portions of the forests from roads. However, this conjecture needs further scrutiny, particularly because the distance from road is found to have no effect on the revenue. Furthermore, the coefficient of the year of submission of the latest operation plan is positively significant in the equation for pole trees because the later the year of operation plan submission, the longer the period of regeneration after the year of handover.

6. CONCLUDING REMARKS

A considerable number of studies have attempted to explain the success of community forestry in the Hill region of Nepal where non-timber forests dominate (Gilmour and Fisher, 1991; Hobley 1996; Tachibana et al., 2001). However, there is controversy about the impacts of community management on the timber forests in terms of forest conditions, management intensity and income generation. According to Otsuka and Place (2001), non-timber forests can be maintained and rehabilitated by preventing the excessive extraction of resources, but timber forests need to be managed intensively by conducting various management operations such as thinning, pruning, weeding and harvesting, in order to produce valuable trees. It is not obvious whether such activities can be effectively organized by community management, because the collective management may reduce incentives to work. Thus, whether the community forestry is a viable mechanism to manage the timber forest is a remaining issue.

Our analysis revealed that the community forestry program had desirable impacts on the rehabilitation of the forests. We found that forests handed over earlier contained more pole size trees, whereas forests handed over more recently contained more small size trees. This evidence clearly indicates that new trees tend to be regenerated after the community forest users start to manage the handed-over forests. Furthermore, population pressure, measured by the number of households per unit of forest area, not only fostered the deforestation in the past when the forests were *de facto* open access, but also contributed to better management and the generation of more revenue per unit area in recent years due to the handover of the forest use rights. The results also showed that small trees were actively grown in the forests near roads, whereas mature trees were better preserved in more distant forests from roads.

In short, this study demonstrated that the community forestry program contributed to the reforestation, intensive forest management, and income generation in the forest communities with high population pressure and favorable market access. In other words, community forest management seems conducive to the sustainable management of timber forests with income generation, which is likely to be beneficial for the poor who are dependent on forests for their livelihood. Furthermore, to the extent that sustainable timber production is profitable, promotion of such forests will contribute to reforestation and, hence, carbon sequestration in developing countries. Therefore, a clear policy implication of this study is to encourage the development of community-based forest management systems for timber forests.

References

Acharya, K.P. (2005), 'Private, collective and centralized institutional arrangements for managing forest "Commons" in Nepal', *Mountain Research and Development* **25**(3): 269-277.

Aggarwal, S. and K. Elbow (200), "Role of property rights in natural resource management, good governance and empowerment of the rural poor', available from http://usaidlandtenure.net/sites/default/files/USAID_Land_Tenure_Property_Rights_and NRM_Report.pdf. (Accessed on March 29, 2013).

Agrawal, A. and A. Chhatre (2006), 'Explaining success on the commons: community forest governance in the Indian Himalaya', *World Development* **34**(1): 149–166.

Angrist, J. D. and J. Pischke (2009), *Mostly Harmless Econometrics: An Empiricist's Companion*, Princeton: Princeton University Press.

Baland, J., P. Bardhan, S. Das, and D. Mookherjee (2010), 'Forests to the people: decentralization and forest degradation in the Indian Himalayas', *World Development* **38**(11): 1642-1656.

Bampton, J., B. Vickers, B. Rana, and J. Statz (2004), 'Community forestry in the Terai', in K.R. Kanel, P.Mathema, B.R. Niraula, A.R. Sharma and M. Gautam (eds), *Twenty-Five Years of Community Forestry: Contributing to Millennium Development Goal, Proceedings of the Fourth National Workshop on Community Forestry,* Kathmandu, Nepal: Department of Forest, Nepal.

Bhattarai, K., and D. Conway (2008), 'Evaluating land use dynamics and forest cover change in Nepal's Bara district (1973-2003)', *Human Ecology* **36**(1): 81-95.

Bromley, D.W. (1992), 'The commons, property, and common-property regimes', in D.W. Bromley (ed), *Making the Commons Work*, San Francisco, CA: ICS Press.

Bromley, D.W. and D.P. Chapagain (1984), 'The village against the center: resource depletion in South Asia', *American Journal of Agricultural Economics* **66**(55): 868-873

Chakraborty, R.N. (2001), 'Stability and outcomes of common property institutions in forestry: evidence from the Terai region of Nepal', *Ecological Economics* **36**(2): 341-353.

Department of Forest Research and Survey (1999), 'Forest resources of Nepal (1987–1998)', Kathmandu, Nepal: Ministry of Forests and Soil Conservation.

Dev, O.P., N.P. Yadav, O. Springate-Baginski, and J. Soussan (2003), 'Impacts of community forestry on livelihoods in the middle Hill of Nepal', *Journal of Forest and Livelihood* **3**(1): 64-77.

Dhakal, M., and M. Masuda (2009), 'Local pricing system of forest products and its relations to equitable benefit sharing and livelihood improvement in the lowland community forestry program in Nepal', *Forest Policy and Economics* **11**(4): 221-229.

Edmonds, E. (2002), 'Government initiated community resource management and local extraction form Nepal's forests', *Journal of Development Economics* **68**(1): 89-115.

Gautam, A.P. (2009), 'Group size, heterogeneity and collective action outcomes: evidence from community forestry in Nepal', *International Journal of Sustainable Development and World Ecology* **14**(2007): 574-584.

Gautam, A.P., G.P. Shivakoti, and E.L. Webb (2004), 'Forest cover change, physiography, local economy, and institutions in a mountain watershed in Nepal', *Environmental Management* **33**(1): 48-61.

Gilmour, D.A., and R.J. Fisher (1991), *Villagers, Forests and Foresters: A Philosophy, Process and Practices of Community Forestry in Nepal*, Kathmandu, Nepal: Sahayogi Press.

Hardin, G. (1968), 'The Tragedy of the Commons', *Science* **162**:1243-1248.

Hayami, Y. (2009), 'Social capital, human capital and the community mechanism: toward a conceptual framework for economists' *Journal of Development Studies* **45**(1): 96-123

Hobley, M. (1996), *Participatory Forestry: The Process of Change in India and Nepal*. London, UK: Overseas Development Institute.

Jodha, N.S. (2001), 'Common property resources and the rural poor in dry region of India', *Economic and Political Weekly* **21**(27): 1169-1181.

Jumbe, C.B.L. and A. Angelsen (2006), 'Do the poor benefit from devolution policies? evidence from Malawi's forest co-management program', *Land Economics* **82**(4): 562-581

Kanel, K. (2004), 'Twenty-five years' of community forestry: contribution to Millennium Development Goals', in K.R. Kanel, P. Mathema, B.R. Niraula, A.R. Sharma, and M. Gautam (eds), *Twenty-five Years of Community Forestry: Contributing to Millennium Development Goal*, Proceedings of the Fourth National Workshop on Community Forestry, Kathmandu, Nepal: Department of Forest.

Kanel, K.R. and D.R. Niraula (2004), 'Can rural livelihood be improved through community forestry?' *Banko Janakari* **14**(1): 19-26.

Kijima, Y., T. Sakurai, and K. Otsuka (2000), '*Iriachi*: collective vs. individualized management of community forests in post-war Japan', *Economic Development and Cultural Change* **48**(4): 867-881.

Khanal Chhetri, B.B., J.F. Lunda, and Ø.J.Nielsena (2010), 'Rural development potential of community forestry in Nepal', available from http://www.cifor.org/publication/pdf_files/events/montpellier/scientific-session/Presentations/Session%205/Khanal %20Chhetri%20and%20Jens%20 Lund.pdf. (Accessed on 29 March 2013).

Kohlin, G. and P.J. Parks (2001), 'Spatial variability and disincentives to harvest: deforestation and fuelwood collection in South Asia', *Land Economics* **77**(2): 206-218

Liu, D.S., L.R. Iverson, and S. Brown (1993), 'Rates and patterns of deforestation in the Philippines: application of geographic information system analysis', *Forest Ecology and Management* **57**(1): 1-16.

Malla, Y.B., P. Branney, H.R. Neupane, and P.R. Tamrakar (2001), *Participatory Action and Learning, a Field Worker's Guidebook for Supporting Community Forest Management*, Project Document, University of Reading, UK.

Ministry of Forests and Soil Conservation (2009), 'Nepal forestry outlook study', Kathmandu, Nepal.

Nelson, G.C., V. Harris, and S.W. Stone (2001.), 'Deforestation, land use, and property rights: empirical evidence from Darien Panama', *Land Economics* **77**(2): 187-205

Nagendra, H. (2001), 'Using remote sensing to assess biodiversity', *International Journal of Remote Sensing* **22**(12): 2377-2400

Ojha, H., L. Persha, and A. Chhatre (2009), 'Community forestry in Nepal: a policy innovation for local livelihoods', Discussion Paper 0913, Washington, DC: International Food Policy Research Institute.

Ostrom, E. (1990), *Governing the Commons: The Evolution of Institutions for Collective Action.* Cambridge. UK: Cambridge University Press.

Otsuka, K. and F. Place (2001), *Land Tenure and Natural Resource Management: A Comparative Study of Agrarian Communities in Asia and Africa*. Baltimore, MD: Johns Hopkins University Press.

Pokharel, B.K. (1997), 'Foresters and villagers in contention and compact: the case of community forestry in Nepal', thesis submitted for the Degree of Doctor of Philosophy, University of East Anglia, Norwich, UK.

Pokharel, R.P. (2009), 'Pro-poor programs financed through Nepal's community forestry funds: does income matter?' *Mountain Research and Development* **29**(1): 67-74

Regmi, M.C. (1978), *Land Tenure and Taxation in Nepal*, New Delhi, India: Adroit Publisher.

Sakurai T., S. Rayamajhi, R. Pokheral, and K. Otsuka (2004), 'Efficiency of timber production in community and private forestry in Nepal', *Environment and Development Economics* **9**(4): 539-561.

Sapkota P**.** and B. Meilby (2009), 'Modeling the growth of shorea robusta using growth ring measurements', *Banko Janakari* **19**(2): 25-32.

Somanathan, E. (1991), 'Deforestation, property rights and incentives in the Central Himalayas', *Economics and Political Weekly* **26**(1): 37-46

Tachibana, T. and Adhikari, S. (2009), ‘Does community-based management improve natural resource condition?: evidence from the forests in Nepal’, *Land Economics* **85**(1): 107-131.

Tachibana T., H.K. Upadhyaya, R. Pokharel, S. Rayamajhi, and K. Otsuka (2001), ‘Common property forest management in the Hill region of Nepal’, in K. Otsuka and F. Palace (eds), *Land Tenure and Natural Resource Management: A Comparative Study of Agrarian Communities in Asia and Africa*, Baltimore, MD: Johns Hopkins University Press.

World Bank (2007), ‘Nepal Transport Sector’, available from http://go.worldbank.org/I99TRS72B0 (Accessed on 29 March, 2013).

World Bank (2009), ‘Forests sourcebook: practical guidance for sustaining forests in development cooperation’, available from https://openknowledge.worldbank.org /handle/ 10986/6455 (Accessed on 29 March 2013).

Yadav, N.P., O.P. Dev, O. Springate-Baginski, and J. Soussan (2003), ‘Forest management and utilization under community forestry’, *Forest and Livelihood* **3**(1): 37-50.

Table 1. *Descriptive statistics of dependent variables by the timing of handover*

Dependent variables	On and before 1998	No. of Obs.	After 1998	No. of Obs.	Difference (*t*-statistics)
Small Trees (mean # per ha)	12370	116	11617	73	760 (0.58)
Pole Trees (mean # per ha)	936	116	879	73	57 (0.66)
Mature Trees (mean volume per ha)	124	107	125	67	-.8 (-.05)
% Deforested Area	1.5	107	0.9	67	-.6* (-1.94)
% Managed Area	40.6	114	37.5	65	3 (0.651)
Revenue (Rs per ha)	1568	114	1878	65	-310 (-.50)

Notes: *, **, and *** indicate statistical significance at 0.1, 0.05, and 0.01 level, respectively.

Table 2. *Descriptive statistics of independent variables by the timing of handover*

Independent variables	On and before 1998	No. of Observations.	After 1998	No. of Observations	Difference (*t*-statistics)
Household density	1.5	126	1.2	75	.36 (1.46)
Forest area (1,000 ha)	2.9	126	3.4	75	-.45 (-1.15)
Distance to road (km)	5.7	126	7.7	75	-1.98***(-2.39)
Distance to village (km)	0.6	126	0.6	75	-.05 (-.52)
Year of latest Operation Plan submitted	2007	126	2007	75	-.41 (-1.40)
Slope of forest (degree)	11	117	15.5	66	-3.99*** (-3.18)
Time taken to reach range post (minutes)	1.6	126	2.2	75	.59*** (-5.69)
Area under range post (km^2)	123.4	126	208.2	75	-84.77*** (-4.66)
Age of president of CFUG	43.0	126	42.3	75	.68 (.45)

Notes: *, **, and *** indicate statistical significance at 0.1, 0.05, and 0.01 level, respectively.
T-statistics are shown in parentheses.

Table 3. *First-stage regression of the year of handover*[1]

	(1)	(2)	(3)	(4)	(5)	(6)
Household density	-0.085 (-0.649)	-0.026 (-0.201)	0.069 (0.499)	0.128 (0.927)	-0.071 (-0.599)	-0.00 (-0.002)
Area of forest	0.037 (0.495)	0.051 (0.685)	0.073 (0.957)	0.073 (0.946)	0.00 (0.003)	0.026 (0.343)
Distance to road	0.00 (0.012)	-0.015 (-0.437)	0.012 (0.321)	0.011 (0.282)	-0.015 (-0.425)	-0.027 (-0.748)
Distance to village	0.405 (1.409)	0.461 (1.631)	0.469* (1.664)	0.458 (1.614)	0.449 (1.527)	0.469 (1.59)
Year latest OP	0.147 (1.557)	0.138 (1.471)	0.078 (0.837)	0.071 (0.754)	0.122 (1.281)	0.102 (1.06)
Education 1 of president [a]			-0.975** (-2.427)	-0.818** (-1.976)		
Education 2 of president [a]			-0.987 (-1.435)	-0.774 (-1.085)		
Female president dummy			0.162 (0.261)	0.018 (0.028)		
Age of the president			-0.01 (-0.492)	-0.022 (-0.974)		
Time taken to reach Range Post	0.943*** (3.411)	0.987*** (3.541)	0.944*** (3.285)	0.930*** (3.168)	0.902*** (3.231)	0.900*** (3.151)
Area under Range Post	0.004*** (2.909)	0.004*** (2.966)	0.004** (2.391)	0.004** (2.419)	0.005*** (2.857)	0.005*** (2.919)
Slope of forest		0.050** (2.071)		0.026 (1.05)		0.048* (1.94)
Constant	1699.5*** (8.962)	1716.6*** (9.102)	1838.3*** (9.785)	1852.5*** (9.775)	1749.9 *** (9.142)	1789.9 *** (9.277)
N	174	160	179	165	189	173
F	6.221	6.239	4.690	4.236	5.418	5.172
R-squared	0.207	0.248	0.236	0.250	0.173	0.201
F_excluded	15.524	14.712	11.905	13.634	14.613	10.962

Notes: *, **, and *** indicate statistical significance at 0.1, 0.05, and 0.01 level, respectively.
T-statistics are shown in parentheses.
Predicted values of the year of handover in equations (1) and (2) are used for the second-stage regressions of deforestation and timber volumes, in equations (3) and (4) for management intensity and revenue per ha, and in equations (5) and (6) for the number of small and poll trees per ha.
a. Education 1 and 2 refer to secondary and tertiary education, respectively.

Table 4. *Determinants of deforestation and the number of mature trees: second-stage estimation*

	Sample size=174		Sample size=160	
	Deforestation	Mature trees	Deforestation	Mature trees
Household density	0.299*** (2.957)	-3.363 (-0.588)	0.296*** (2.848)	-1.588 (-0.303)
Area of forest	-0.106* (-1.892)	2.501 (0.788)	-0.105* (-1.735)	1.222 (0.399)
Distance to road	-0.029 (-1.145)	2.199 (1.53)	-0.017 (-0.619)	2.791** (1.987)
Distance to village	0.054 (0.254)	-11.588 (-0.956)	-0.025 (-0.109)	-14.952 (-1.293)
Year of latest operation plan	-0.028 (-0.371)	4.886 (1.155)	-0.042 (-0.518)	5.21 (1.285)
Year of handover	-0.039 (-0.291)	-6.00 (-0.785)	-0.007 (-0.044)	-0.584 (-0.080)
Slope of forest			-0.03 (-1.426)	-0.938 (-0.887)
Constant	135.5 (0.512)	2293.1 (0.153)	100.0 (0.329)	-9170.9 (-0.647)
F-statistics	4.168	0.819	3.647	1.037

Notes: *, **, and *** indicate statistical significance at 0.1, 0.05, and 0.01 level, respectively.

T-statistics are shown in parentheses.

Table 5. *Determinants of management operation and revenue generation: second-stage estimation*

	Sample size=179		Sample size=165	
	Management intensity	Revenue generation	Management intensity	Revenue generation
Household density	9.647*** (6.913)	912.215*** (4.526)	9.769*** (6.659)	784.920*** (3.774)
Area of forest	-2.808*** (-3.589)	4.862 (0.043)	-2.640*** (-3.141)	-14.924 (-0.125)
Distance to road	-0.56 (-1.515)	-36.071 (-0.675)	-0.689* (-1.715)	5.986 (0.105)
Distance to village	2.63 (0.918)	-584.378 (-1.412)	1.997 (0.658)	-768.744* (-1.787)
Year latest op	-0.504 (-0.521)	-91.779 (-0.656)	-0.702 (-0.685)	-106.944 (-0.736)
Education 1 of president [a]	-0.132 (-0.028)	-591.433 (-0.872)	1.884 (0.384)	-1011.943 (-1.453)
Education 2 of president [a]	4.474 (0.632)	-138.695 (-0.136)	7.216 (0.937)	-305.033 (-0.280)
Female president dummy	3.600 (0.574)	1742.385* (1.924)	4.279 (0.638)	1902.121** (2.001)
Age of the president	-0.371* (-1.744)	-84.892*** (-2.765)	-0.248 (-1.016)	-84.028** (-2.425)
Year of handover	1.141 (0.608)	426.206 (1.572)	1.694 (0.830)	53.371 (1.567)
Slope of forest			0.203 (0.739)	-112.324*** (-2.889)
Constant	-1.21E+03 (-0.311)	-6.62E+05 (-1.175)	-1929.213 (-0.459)	-6.85E+05 (-1.149)
F-statistics	9.944	4.444915	7.962	4.465024

Notes: *, **, and *** indicate statistical significance at 0.1, 0.05, and 0.01 level, respectively.
T-statistics are shown in parentheses.
a. Education 1 and 2 refer to secondary and tertiary education, respectively.

Table 6. *Determinants of the number of small and pole trees per hectare: second-stage estimation*

	Sample size=189		Sample size=173	
	Small trees	Pole trees	Small Trees	Pole Trees
Household density	-294.966 (-0.637)	-42.399 (-1.411)	-514.646 (-1.172)	-36.188 (-1.195)
Area of forest	-529.816* (-1.861)	-20.143 (-1.091)	-544.768* (-1.881)	-19.11 (-0.953)
Distance to road	-465.528*** (-3.610)	16.836** (2.013)	-467.029*** (-3.567)	13.879 (1.532)
Distance to village	-951.887 (-0.851)	93.453 (1.288)	-950.774 (-0.857)	95.323 (1.244)
Year of latest operation plan	508.818 (1.34)	56.178** (2.281)	558.945 (1.49)	54.815** (2.126)
Year of handover	2189.414*** (3.087)	-113.486** (-2.466)	1767.569** (2.247)	-119.753** (-2.437)
Slope of forest			-37.498 (-0.369)	8.771 (1.266)
Constant	-5.38e+06 *** (-3.794)	1.15E+05 (1.249)	-4.63e+06 *** (-3.027)	1.30E+05 (1.326)
F-statistics	4.050	2.524	3.057	1.983

Notes: *, **, and *** indicate statistical significance at 0.1, 0.05, and 0.01 level, respectively.
T-statistics are shown in parentheses.