

RESEARCH ARTICLE

Partitioning Commons and Devolving Them from Communal to Sub-Communal Groups: Evidence from China's Community Forest Management Organizations

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Existing research has extensively explored various approaches to enhancing the governance of community-managed commons; however, limited studies have discussed whether it is effective to partition commons and devolve them from communal to smaller, sub-communal groups. We examine this question based on the evidence from two common-property timber production communities that devolved their forests from the administrative village to villagers' groups in Fujian, China. Using the comparative case study method, we explore the mechanisms by which this organizational restructuring affected democratic governance, revenue allocation and economic efficiency of timber production. We find that by decreasing the size of forest management units, the restructuring increases the participation of ordinary villagers in community forestry and enhances the equity of revenue allocation. However, physically partitioning forests may undermine scale economies, and the small, sub-communal forest management groups tend to have weak financial and managerial capacities. Thus, partitioning forests into villagers' groups threatens the long-run efficiency of commercial timber production. This research not only presents an innovative toolkit of enhancing community forest management but also sheds light on the optimal organizational structure of community forest management under different organizational goals and contexts.

Keywords: commons; community forest enterprise; forest decentralization; forest tenure reform; group size; organizational restructuring

1 Introduction

Small groups are often argued to better organize the collective actions of managing the commons than large groups (Olson, 1965; Poteete & Ostrom, 2004). This argument has a clear policy implication: it may be worth partitioning the commons and assigning the divided commons to smaller subgroups. However, putting this idea into practice involves some problems, especially how to partition the commons, create new subgroups and equitably allocate the partitioned commons to subgroups. Second, some studies have shown that small groups may lack the capacity for mobilizing resources required for collective actions (Agrawal & Goyal, 2001; Agrawal & M.Haas, 2000), which indicates that partitioning the commons to subgroups may have downsides. To sum up, it is unclear by what approaches and under what conditions we can partition the commons into subgroups to better govern the commons.

An easy way of exploring the above questions is to find the communities that partitioned the commons into subgroups and to examine the effects of the restructuring. However, the restructuring of common-property resource management organizations has drawn scant attention. Moreover, although a large number of studies have investigated the role of group size in governing the commons, they generally use cross-sectional data and examine how communities of different sizes perform differently in governing the commons (Agrawal & Goyal, 2001; Chhatre & Agrawal, 2008; Perez-Verdin, Kim, Hospodarsky, & Teclé, 2009;

Yang et al., 2013). It remains unclear for a given community, what will happen if it adjusts the size of its common-property resource management organizations.

This paper endeavours to fill these gaps by focusing on two common-property timber production communities in Fujian Province, China. These two communities devolved forest commons from the administrative village to villagers' groups. Villagers' groups are self-governance units smaller and lower than the administrative village (J. He & Sikor, 2017); thus, the two cases provide an opportunity for us to explore the outcomes of partitioning the commons into subgroups in the real world. We find that the restructuring enhanced democratic governance and improved the distribution of timber revenues within the community but had mixed effects on the economic efficiency of timber production. We also compare our findings with relevant evidence from Mexico and discuss the likely effects of group size change under different restructuring strategies and different contexts of governing the commons.

This research expands the literature on group size and governing forest commons from research contexts and methods. Existing studies on group size and governing the commons often assume that a group of small-scale, uncapitalized users individually appropriate forest products primarily for subsistence needs (Agrawal, 2007; Ostrom, 1990). However, they pay scant attention to the context that users manage forests for commercial timber in a relatively large-scale and capitalized manner and users share cash after exchanging timber in the market (Orozco-Quintero & Davidson-Hunt, 2010). This context is the focus of our research. Moreover, unlike previous research that makes cross-sectional comparisons between large and small communities, we investigate how the change in group size affects forest management for the same community.

This paper makes another contribution by introducing the Chinese evidence of governing forest commons. Despite many rounds of privatization reforms, China still has a large area of forest commons (Xu, Sun, Jiang, & Li, 2008), and these forest commons are rarely discussed. China's forest commons governance is embedded into a unique rural self-governance system under an authoritarian regime and a rapidly-changing community forestry context shaped by broad socio-economic and policy transitions (Hyde, 2018). Thus, introducing China's evidence may enrich the literature on governing common forests. Moreover, we compare our findings with relevant evidence from Mexico. China and Mexico have a strikingly similar rural forestry system dedicated to commercial timber production, and the systems are experiencing similar restructurings. The cross-country comparison enables us to explore the generalizability of our findings.

The remaining of the paper is organized as follows. The second part describes the institutional evolution of forest commons in Fujian, China. The third part discusses the likely impact of partitioning forest commons into villagers' groups through the lens of theories on group size and governing the commons. The fourth part shows the research methodology and the basic conditions of case communities. Research findings are summarized in the fifth part, and discussions and conclusions are made in the sixth part.

2 Institutional evolution of forest commons in Fujian, China

2.1 History of China's forest commons from the perspective of group size change

China's forest commons should be understood from its unique collective land system. In 1949, the Chinese Communist Party (CCP) came to power and launched the Land Reform. Rural land was confiscated from their original owners and was equally allocated to households (Lin, 1993). The egalitarianism-oriented private land ownership, however, was soon terminated by the collectivization campaign in 1956 (Lin, 1993). Farmers had to pool their private production means (including land) to state-controlled collective production units. Private land ownership changed into collective land ownership, and household-based production was replaced by team production within the collective production unit.

Under the CCP's ambition of advancing communism, the collective production unit became increasingly larger (Putterman, 1987). It evolved from elementary cooperatives comprising dozens of households to advanced cooperatives comprising hundreds of households, and finally to the People's Commune comprising thousands of households (D. Liu, 2001). Enlarging the collective production unit led to severe free-ride behaviours in agricultural production; finally, the Great Famine occurred (Lin, 1993). To solve the agricultural crisis, the government decreased the size of collective production units and restructured the land tenure around 1960. Collective land ownership and team production maintained; however, farmland was devolved to production teams, which were established on former elementary cooperatives (Ho, 2006). Unlike farmland, forests experienced complex tenure changes. In Fujian, forests were generally devolved to production brigades, which were established on former advanced cooperatives (Compilation Committee of Fujian District Records, 1996).

In the late 1970s, the collectivization period ended, and agricultural production reverted to the household-based system. People's Communes, production brigades, and production teams were replaced with townships, administrative villages, and villagers' groups (Ho, 2006). Administrative villages and villagers' groups, which together are called village collectives, inherited the ownership of land from their predecessors. At the national scale, village collectives owned 57.55% of forestland (China Forest Bureau, 2014). The correspondences of different rural governance units and their group size are shown in **Figure 1**.

2.2 Community forestry in Fujian in the early 2000s

Fujian is the most important timber production province in South China, and collective forestland (8.71 million hectares) accounts for 71% of all its land (Zhao, 2018). From 1980 to 2000, Fujian took many measures to restructure its community forestry system. In the early 2000s, Fujian's community forestry system displayed high institutional diversities. As shown in **Table 1**, a typical forestry community had four types of forests, and these forests were managed under different regimes.

Our focus is on the timber forests managed by the administrative village in the early 2000s. Their area accounted for about 30% of collective forestland at the provincial scale (Xu et al., 2008). These forests were rival and individually non-exclusive and thus fell into the common forests defined by

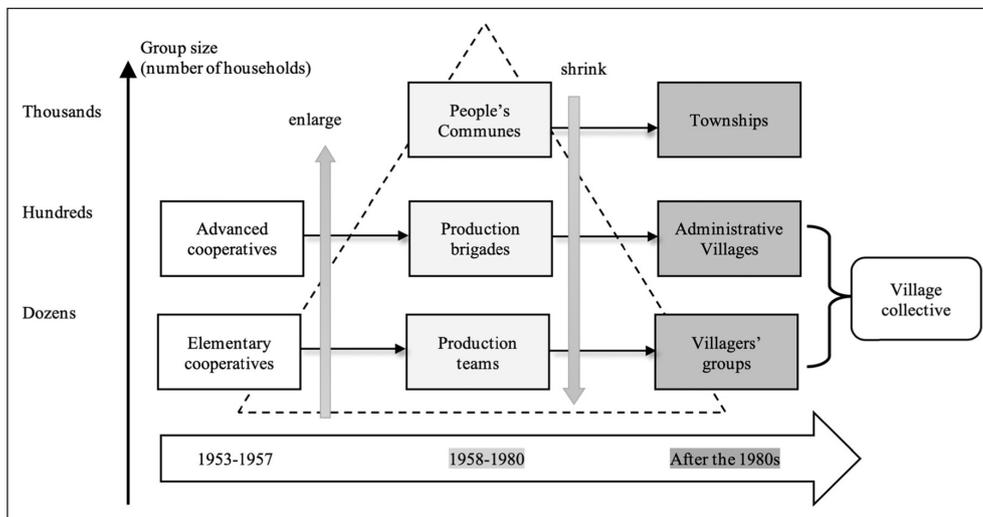


Figure 1: Rural governance units in different periods: group size, evolution, and correspondences.

Table 1: The types of forests and their management regimes in the early 2000s.

	Timber forests	Ecological forests	Economic forests	Bamboo forests
Main purposes (functions)	Produce commercial timber	Environmental and farmland protection, national defence, scientific research, etc.	Produce fruits, woody oil plants, medicinal plants, industrial raw materials, etc.	Produce bamboo timber and bamboo sprouts
Predominant species	Chinese fir (<i>Cunninghamia lanceolata</i>), Masson pine (<i>Pinus massoniana</i>)	Diversified species: various coniferous trees, broadleaf trees, etc.	Diversified species: various fruit trees, tea, camellia, etc.	Meso bamboo (<i>Phyllostachys edulis</i>)
Proportion of area (%)	49	32	11	9
Predominant management regime	Diversified	Collective	Household-based	Household-based

Note: Proportion of area is at the provincial level; data is from China Forestry Handbook (2017).

Ostrom. Most of these forests were man-made plantations, and two dominant species were Chinese fir (*Cunninghamia lanceolata*) and Masson pine (*Pinus massoniana*). Their rotations were about 30–40 years. Key forest management operations included planting, tending, daily management, thinning, harvesting, and sales. Among these operations, planting and tending affected future output most and required intensive technical and financial inputs. The economic efficiency of timber production depended on the capacity for making plans and arranging funds for forest regeneration.

Although Fujian has abundant forest resources, its large rural population makes forests scarce in the per-capita sense. In the early 2000s, each administrative village on average managed 267 hectares of timber forests (Xu et al., 2008), and the employment provided by collective forestry was limited. In most villages, the harvest did not happen every year. When forests became mature, villages usually sold standing timber to outside traders rather than conduct logging by themselves. Villages could also transfer young and middle-aged forests, which made villages realize forest value earlier but sacrificed some long-run interests. After outside traders harvested forests and returned bare land to villages, villages could either manage forests by themselves or lease the bare land out for the next rotation. In theory, the revenues derived from collective forestry should be equally allocated to all community members.

2.3 Devolving forests from the administrative village to villagers' groups

For the forests managed by the administrative village, the elected villagers' committee exercised forest management powers, and its forest management suffered many problems. Although under governmental interventions and supervisions, the committee could complete basic forest management operations, low investments and mismanagement were common due to the lack of funding and business capacities (Hyde & Yin, 2018). The more serious problem was that farmers were excluded from collective forestry and shared few timber revenues (C. Liu, Wang, Liu, & Zhu, 2017). Due to the limited access to timber revenues, farmers lacked the incentives to protect forests, and timber theft was rampant (Yiwen, Kant, & Liu, 2019).

To solve these problems, Fujian launched a forest tenure reform in 2003, which is also considered the start of China's new wave of forest tenure reform (Chen & Innes, 2013). Its major objective was to devolve the forests managed by the villagers' committee to households. In practice, many forests were devolved to villagers' groups instead of households for many reasons. First, at the village level, the area of committee-managed forests was small, and forest parcels varied considerably in tree species, timber volumes, and soil quality. Thus, equitably allocating these parcels to households was difficult to implement and would undermine the scale economies of timber production. Moreover, as Section 2.1 shows, as early as around 1960, the state had tried to improve farmland productivity by devolving farmland to production teams. Thus, it seemed reasonable to believe that devolving forests to villagers' groups, the successor of production teams, would also have positive outcomes. China's new wave of forest tenure reform has drawn substantial attention; however, existing studies tend to focus on either the forests devolved to households (Chen & Innes, 2013; Qin, Carlsson, & Xu, 2011; Xie, Berck, & Xu, 2016) or the forests retained by the villagers' committee (Meng, Liu, & Long, 2015), while little attention has been paid to those devolved to villagers' groups.

As sub-communal self-governance units, villagers' groups significantly differ from the administrative village in group size and governance structure. One administrative village has around ten villagers' groups, so the former is much larger than the latter. The standing agency of the administrative village is called the villagers' committee (B. He, 2007), which is directly elected by village adults and is accountable to the villagers' assembly. Since the cost of assembling villagers is high in large administrative villages, the Organic Law of the Villagers' Committee (OLVC) allows administrative villages to elect representatives to make decisions on behalf of the villagers' assembly. Unlike the administrative village, villagers' groups are much smaller and have fewer public affairs; thus, their governance structure is flat. Villagers' groups have no standing agency and have only one unsalaried head. Public affairs are often addressed via the discussion of all household heads. **Figure 2** shows the governance structures of the administrative village and villagers' groups.

3 Changing group size in governing the commons

Although partitioning forests into subgroups may affect many variables of social-ecological systems, based on Ostrom's advice (2009), we should only focus on certain key variables based on our particular questions and contexts. This section discusses the likely effects of the restructuring through the lens of theories on group size and governing the commons. We first discuss how group size may affect forest governance differently in the classic forest commons context and the collective timber production context. Then we discuss the likely impact of partitioning forest commons into villagers' groups by summarizing existing theories and examining relevant evidence from Mexico's community forestry practices.

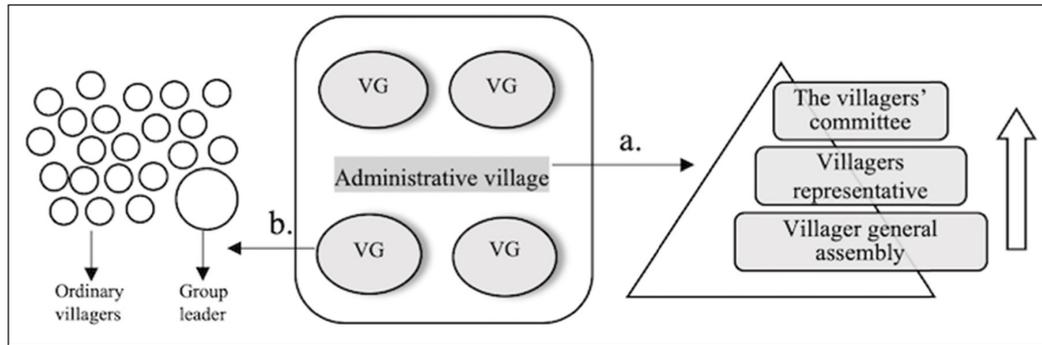


Figure 2: Governance structures of the administrative village and villagers' groups.

Note: VG denotes villagers' groups. a. and b. denote the governance structures of administrative villages and villagers' groups.

3.1 Group size in the classic forest commons literature

The classic forest commons literature usually holds the following assumptions (Agrawal, 2007; Chhatre & Agrawal, 2008; Ostrom, 1990). First, many small-scale users appropriate forest commons independently. If users appropriate forest resources excessively, forest resources will be exhausted. Second, in most cases, users directly use raw forest products instead of sharing cash income after selling them in the market. Third, forests is a natural rather than a man-made system, and forest regeneration is primarily a natural process. Under these assumptions, the locus of the classic forest commons literature is how to form collective actions to regulate the individual appropriation of forest resources so that forest resources are not depleted (Ostrom, 1990). These collective actions involve many aspects such as restraining the appropriation of forest resources, attending meetings to make rules on monitoring and sanctions, electing leaders, appointing patrollers, etc., and enforcing these rules (Adhikari & Lovett, 2006; Agrawal & Ostrom, 2001; Ostrom, 1990).

The classic commons literature shows that the relationship between group size and collective actions is complex. On one hand, small groups have several advantages in organizing collective actions. First, the externality problem is less serious in small groups. Users can receive sufficient returns from their individual contributions to collective actions and thus have more incentives to contribute (Partelow et al., 2019). Moreover, the frequent interactions and intense social networks in small groups enhance reciprocity, trust, and social norms, thereby making individuals more likely to contribute to collective actions (Rahman, Hickey, & Sarker, 2012). Third, small groups have smaller transaction costs in seeking information, negotiating, bargaining and monitoring (Casari & Tagliapietra, 2018; Ray & Bhattacharya, 2011). Therefore, small groups can promote collective actions by more effectively enforcing monitoring and sanctions and providing selective incentives for individuals. Despite these advantages, small groups may lack the resources required for forming effective collective actions. In particular, when the rivalry in forest appropriation exists across communities, small communities often face great challenges to defend their forests because of their limited manpower, funds, social resources and government support (Agrawal & M.Haas, 2000).

Since group size affects governing forest commons through multiple mechanisms and the weights of these mechanisms are context-specific, empirical studies have not found a consistent relationship between group size and forest governance outcomes. Some studies find a positive relationship between group size and forest governance outcomes (Agrawal & M.Haas, 2000; Agrawal & Yadama, 1997); some indicate an inverted U-shaped relationship and the medium-sized group performs best (Agrawal & Goyal, 2001; Yang et al., 2013); others find that relationship between group size and forest governance outcomes is weak (Chhatre & Agrawal, 2008) or even insignificant (Gautam, 2007; Perez-Verdin et al., 2009).

3.2 Group size in collective timber production

This paper focuses on community-based commercial timber production, which has similarities and differences compared to the classic forest commons context. In both cases, forests are common-property resources, and users need to form collective actions to manage forests. However, commercial timber production has unique characteristics (Antinori & Bray, 2005; Carías Vega & Keenan, 2016; Orozco-Quintero & Davidson-Hunt, 2010). First, it entails the large-scale, collective appropriation rather than small-scale, individual appropriation of forest commons. Second, users need to exchange timber in the competitive market and share cash. To maximize profits, users not only need to extract timber sustainably but also need to cope with market risks. Third, the administration of commercial timber production is centralized. As

forest owners, villagers entrust a few managers to initiate and implement timber production decisions, and villagers only ratify and supervise these decisions. Because of these characteristics, we need to place more attention on scale economies and organizational accountability when exploring the role of group size in community-based commercial timber production.

The collective appropriation of timber into the marketplace leads to the high scale economies of commercial timber production. A unified group often has a lower production cost but a higher sales price than a divided group (Haines, Kennedy, & McFarlane, 2011). For example, performing harvesting on ten separated one-hectare parcels is more costly than on one unified 10-hectare parcel; large groups also have greater bargaining power in purchasing inputs and selling final products (Carias Vega & Keenan, 2016b). The scale economies may also pertain to capital and entrepreneurship. A unified large group is more likely to obtain loans from banks and produce sufficient surplus to hire specialized expertise (Beck & Demircuc-Kunt, 2006).

Large groups, however, may suffer from the managers' low accountability to users. This is because monitoring the managers' behaviour, which requires the collective participation of users, is more difficult to form in large groups. In addition to the collective action perspective, the low organizational accountability can be understood from the multiple-tiers structure of large groups. The large group often has several subgroups, and users in each subgroup meet face-to-face and elect representatives, and then the representatives meet face-to-face to develop rules applicable to the entire large group (Casari & Tagliapietra, 2018). This multiple-tiers structure saves the cost of assembling users and exchanging information. However, representatives may seek their personal agendas at the cost of users' interests. The centralization of forest management powers and the managers' low accountability to users have been found in the community-based timber production in many regions such as China (Song, Wang, Burch, & Rechlin, 2004), Mexico (Wilshusen, 2010), and Guatemala (Carias Vega & Keenan, 2016a).

3.3 Devolving forests to subgroups: what will happen?

To enhance collective actions and increase organizational accountability, one approach is to partition forest commons into multiple commons and assign them to subgroups. This is called the group-clustering strategy. To some extent, this strategy resembles forest decentralization, which means transferring forest management powers to lower-level, more autonomous authorities or communities (Larson & Soto, 2008). The group-clustering strategy, however, may decrease the capacities of groups for mobilizing resources and prevent them from realizing the scale economies of timber production.

Little literature has discussed restructuring community-based timber production groups and changing their sizes, and the only studies are based on Mexican evidence. Community-based commercial timber production is popular in Mexico, and the elected community-level executive committee exercised forest management powers for a long time (Antinori & Bray, 2005). However, community-level timber production suffered from corruption and mismanagement, and villagers had limited access to timber revenues. After the neoliberal reform in 1992, some communities devolved forest management powers to sub-communal workgroups (Cubbage et al., 2015). Some studies indicate that the restructuring reduced the corruption of community leaders and increased farmers' participation in community forestry as well as their access to timber revenues (Taylor, 2003; Wilshusen, 2010). However, workgroups tend to be less capable of seeking business partners, coping with market risks, investing in wood processing facilities, and stabilizing timber supply (Carias Vega & Keenan, 2016b).

The above studies have provided clues to understanding the effects of transferring forests from the administrative village to villagers' groups in China. By decreasing the group size, this restructuring strategy may increase villagers' participation in community forestry and enhance the managers' accountability to villagers. Therefore, the democracy of forest governance and the equity of benefit-sharing may increase. However, commercial timber production requires intensive inputs and has large scale economies. Partitioning forests into subgroups may reduce the community's capacity for mobilizing resources and making investments and may also undermine scale economies. Thus, the economic efficiency of timber production may decrease.

To sum up, some gaps exist in the literature. First, a large number of studies have discussed the relationship between group size and forest governance but have paid scant attention to community-based commercial timber production. Other studies have systematically analyzed the particularities of community-based collective timber production but have paid scant attention to the role of group size in this context. Furthermore, the studies that have focused on transferring forest commons to subgroups are very limited,

and all of them are based on Mexican evidence. These studies have their own research agendas and cite no literature on group size and governing the commons. It is unclear whether their findings can be generalized to other countries, and the connection between their findings and the commons literature is missing.

4 Methodology

4.1 Research strategy

This paper focuses on the restructuring of devolving forests from the administrative village to villagers' groups in Fujian, China. The outcomes of the restructuring are investigated from three aspects of community-based commercial timber production: democratic governance, revenue distribution, and economic efficiency. To explore the question, the comparative case study method was chosen. This method excels in integrating contextual factors into the analysis and revealing the complex process in which an institutional change affects multiple outcomes (Gerring, 2006). Comparing different cases enables us to perform literal and theoretical replications and make conclusions with higher internal validity (Yin, 2013).

To examine the changes in the three aspects of forest governance outcomes, structured questionnaires and semi-structured interviews were used. In the questionnaire, indicators on democratic governance include the transparency of decision-making and the strength of monitoring managers; indicators on revenue allocation include the equity of allocating timber revenues and the number of timber thefts; indicators on economic efficiency include forest investment capacity and forest management cost; villagers' overall satisfaction with collective timber production is also elicited. For each indicator, villagers were asked to choose from four options: *increase, no changes, decrease, it's hard to say*.

We selected these indicators and measured them by eliciting villagers' subjective assessment for several reasons. First, as forest owners and community forestry participants, villagers know their forests best and have the most say in the effects of the restructuring. Second, data for objective measurements, such as the indicators related to inputs-outputs and timber volumes, are unavailable. Since the restructuring was implemented in 2004, and the forest rotation is 30–40 years, currently we cannot obtain data on future outputs and revenues. Moreover, rural communities, which are poor at book-keeping, have no historical records on timber production costs and revenues; thus, we cannot calculate efficiency-related indicators such as the input-output ratio, net present value, or internal rate of returns. Similarly, since villages never measured the bio-physical indicators of forests due to financial and technical constraints, we cannot obtain data on tree diameter, canopy density, and tree height and investigate the change in forest growth.

The semi-structured interviews focused on two key topics: (i) methods of splitting forest commons and allocating forests to villagers' groups (ii) forest management institutions related to investments, daily management, harvest and sales, benefit-sharing, monitoring, and sanctioning before and after the restructuring. We also consulted archival records including policy documents, summary reports and meeting minutes regarding forest management.

4.2 Investigation site

The purposive sampling method was used, and Sha County, Sanming City, was selected as the investigation site. Sha County is famous for its institutional diversity in governing forest commons (Meng et al., 2015). We first had interviews with county-level forest bureau officials. The interviews indicated a mixed outcome of the restructuring, and most villages faced challenges in forest regeneration after the restructuring. At our request, local officials recommended six representative villages. In these villages, the pilot survey was conducted, and X Village and B Village were finally selected as key cases. X Village represents the vast majority of villages that encountered the forest regeneration dilemma, while Beimen is the very rare village that properly administered timber production after the restructuring. By selecting two villages that vary in forest management outcomes, we can better understand the factors that affect the efficacy of the restructuring.

The basic conditions of the two villages are shown in **Table 2**. Both are multi-surname villages, and they are similar in the number of villagers' groups and farmers' reliance on forest income. In both villages, most villagers have been disengaged in agricultural and forestry activities. Two villages, however, considerably differ in population, per-capita income, forest endowments, and forest management outcomes. Another particularity of B Village is that it is a suburban village, and most of its farmland has been used for urban constructions.

Under the guidance of the local government, two villages devolved forests from the administrative village to villagers' groups in 2004. In X Village forest parcels were evaluated and divided into seven clusters, with each cluster having a similar total area. Then all villagers were divided into seven forest user groups (FUGs)

Table 2: Basic conditions of two cases.

	X	B
Number of villagers' groups	10	11
Number of households	426	987
Total population	1640	2906
Per-capita income (CNY)	14285	18231
Proportion of villagers whose surnames are among the ten most popular ones in the village	60%	51%
Proportion of forest-related income in total income	5.7%	6.1%
Total area of forests (ha)	1768	459
Area of forests that were partitioned into villagers' groups (ha)	286	201
Outcomes of the restructuring	Mixed	Positive

Note: Data is collected from village archives (Year of 2015).

based on existing nine villagers' groups,¹ and lotteries were drawn to distribute seven clusters of parcels to seven FUGs. Finally, each FUG obtained about 40 hectares of forests with four to nine parcels. B Village implemented the restructuring in a similar but more complex manner. Similar to X Village, B Village divided forest parcels into 11 clusters and drew lotteries to allocate 11 clusters to 11 villagers' groups. Then B Village adjusted the sizes of FUGs to guarantee that different FUGs have the same per-capita forest holdings. Finally, each FUG obtained about 18 hectares of forests with two to four parcels. **Table 3** provides detailed information on the forestland parcels obtained by FUGs in two villages.

4.3 Data collection and analysis

Data was collected in three surveys. The first two surveys, which were semi-structured in-depth interviews, were conducted in July 2016 and February 2017. To reduce data bias and obtain maximum information, we interviewed various forest management stakeholders including forest bureau officers at the county level (N = 4) and the township level (N = 3), incumbent and former leaders of administrative villages and FUGs (N = 40), forest rangers (N = 3), and ordinary villagers (N = 11). The third survey, which is a structured questionnaire survey, was conducted in September 2017 to explore farmers' subjective evaluations on seven indicators regarding the outcomes of the restructuring. Respondents in the survey were randomly selected from the villager name list provided by the villagers' committee. Enumerators visited villagers' homes and asked household heads to serve as respondents. Enumerators explained questions to respondents and finished the questionnaire according to their responses. The number of respondents is 53 and 40 in X Village and B Village, respectively.

Data analysis included three steps. We first calculated the proportion of respondents choosing each option by indicators and villages to understand their subjective evaluations of the restructuring. The statistical result was compared with the information derived from archival records and semi-structured interviews for data triangulation. Then we coded the qualitative data from archival records and semi-structured interviews based on the key themes discussed in Section 3 to understand the mechanisms by which the restructuring affects democratic governance, revenue allocation, and economic efficiency. After understanding how the restructuring affects forest governance in each case, we synthesized findings from two cases and obtained final results.

5 Results

5.1 Farmers' assessment of the changes in forest management outcomes

Table 4 indicates that the restructuring has significantly positive effects on all indicators of democratic governance and revenue allocation while it affects economic efficiency differently in two villages. Forest management capacity has no significant change in X Village ($p = 0.68$), while it significantly increased in B Village ($p = 0.00$). The change in forest management cost is inconsistent between the fisher's exact test and the one-sample median test. The former indicates the change in forest management cost has no

¹ X Village had nine villagers' groups in 2004 before a new group joined in 2010. In the restructuring, Group 3 and 9 merged into one FUG; Group 6 and 8 merged into one FUG; each of the remaining five groups became one FUG.

Table 3: Forestland plots distributed to FUGs in X Village and B Village.

Village	FUG No.	Number of forest parcels	Total area of forests (ha)	Total number of members	Average size of forest parcels (ha)	Standard errors of parcels (ha)	Forest species
X Village	1	8	40.53	241	5.07	3.67	1,2
	2	4	40.80	222	10.20	6.69	1,2
	3	7	41.80	231	5.97	4.12	1,2,3
	4	9	41.80	248	4.64	3.41	1,2
	5	9	41.73	186	4.64	2.17	1,2,3
	6	6	40.33	254	6.72	4.24	1,2
	7	8	39.47	130	4.93	3.17	1,2
In total		51	286.47	1512			
B Village	1	2	18.13	207	9.07	6.00	1
	2	3	18.87	215	6.29	5.33	1
	3	4	18.33	209	4.58	3.59	1
	4	2	18.67	213	9.33	5.72	1
	5	4	18.07	206	4.52	2.30	1
	6	3	18.07	206	6.02	3.86	1
	7	3	17.40	199	5.80	3.86	1
	8	4	19.13	218	4.78	4.28	1
	9	4	18.87	215	4.72	3.67	1
	10	3	17.27	197	5.76	3.78	1
	11	2	17.87	204	8.93	6.44	1
In total		34	200.67	2289			

Note: Data is collected from village archives. Tree species: 1. the Chinese fir 2. the pine tree 3. mixed forests.

significant differences across two villages, while the latter indicates that this indicator increases in X Village but decreases in B Village. Next, we will closely investigate how the restructuring causes these changes.

5.2 How restructuring affects forest management?

5.2.1 Democratic governance

Before the restructuring, according to the OLVC, important decisions related to managing collective assets should be made by the villagers' assembly. However, because of the high cost of assembling villagers, the villagers' assembly was held every three years only for village elections and never discussed forest management issues. The introduction of the villager representatives' assembly in 1998 also failed to enhance democratic decision-making because many representatives had close relationships with the cadres on the committee. The low participation of villagers in collective decision-making also prevented them from effectively monitoring the behaviour of village cadres.

After the restructuring, FUGs received the powers of arranging timber production operations and distributing timber revenues, and villagers' participation in forest management significantly increased. Compared to the administrative village, FUGs were much smaller and had fewer forests to manage. Thus, the FUG could make decisions by the participation of all its members. FUG heads and representatives were only responsible for proposing discussion agendas and organizing group members, while the decisions were made according to the one-household-one-vote and the unanimous consent rules.

Villagers' higher participation in collective decision-making strengthened their supervision over FUG leaders. Moreover, since FUGs are based on villagers' groups, their members resided closely and interacted frequently. The information related to forest management spread quickly, and it was difficult for FUG leaders to pursue their own agendas without being noticed. Furthermore, FUG members had close relationships, and the pursuit of good reputations deterred FUG leaders from seeking rents. As one

Table 4: Villagers' subjective assessment of changes in the forest management outcomes.

Indicators	Transparency of collective decision-making	Strength of monitoring FUG managers	Equity of allocating timber revenues	Number of timber thefts	Capacity for investing in forest management activities	Costs of conducting forest management activities	Overall satisfaction with forest management
Villages	Frequency (%)						
X Village (sample size = 53)							
increase	53	51	60	2	25	40	72
no change	32	34	17	21	36	34	13
decrease	8	8	11	70	21	15	13
hard to say	8	8	11	8	19	11	2
Is the change significant? (p-value)	0.00	0.00	0.00	0.00	0.68	0.02	0.00
B Village (sample size = 40)							
increase	78	73	78	0	43	30	83
no change	15	23	13	23	50	40	10
decrease	5	3	3	75	8	25	5
hard to say	3	3	8	3	0	5	3
Is the change significant? (p-value)	0.00	0.00	0.00	0.00	0.00	0.67	0.00
Is the change different between X Village and B Village (p-value)	0.10	0.15	0.28	0.74	0.00	0.41	0.56

Note: One sample median test (Wilcoxon signed-rank test) is used to test for a given village, whether the indicator has significant change after the restructuring (samples choosing *hard to say* are excluded). Fisher's exact test is used to test if the indicator has different changes across two villages.

FUG head in X Village said: "We are either friends or relatives. If I embezzled the revenue from forests, I wouldn't be holding up my head in this village".

5.2.2 Revenue allocation

Before the restructuring, villagers shared no dividends other than the 20 CNY in 1984 and 1985 respectively. A considerable number of timber revenues were used for constructing infrastructures, but these projects often incurred disputes because villagers benefited from these projects differently. For example, in 1999, X Village spent timber revenues building roads; although this action was endorsed by villagers residing close to the road, it was criticized by those residing distantly from it. Moreover, since the detailed budget and accounting information was rarely disclosed, many villagers suspected village cadres of embezzling timber revenues.

The larger problem, however, was the diversion of timber revenues to government assignments, which should be understood from the relationship between the committee and the local government. In theory, the committee should be elected by villagers and accountable to them, while in practice the committee was the hybrid of a village self-governance body and a government branch. This is because under China's authoritarian regime, village elections were interfered with by the township government, and the elected committee was overshadowed by the CCP village branch. In addition, to execute its responsibilities of governing villages, the committee highly relied on the political support and financial assistance from the local government. Thus, when allocating timber revenues, the committee tended to subordinate villagers' needs to township orders such as implementing family planning policies, collecting rural taxes and fees, and building infrastructures. Though some township orders might benefit villagers, most of them were

unpopular. For example, in the late 1990s, a village and township levy, whose amount was 5% of the per-capita income of the village, was imposed on each villager, and the committee was ordered to collect. Considering the difficulty of collecting money from each villager, in both villages, the committee diverted collective timber revenues to paying these levies.

After the restructuring, villagers highly involved in the decision-making of allocating timber revenues and obtained the opportunity to make benefit-sharing rules. Moreover, unlike the villagers' committee, the villagers' groups had no standing agencies and salaried staff and were immune to government interventions. These characteristics were inherited by FUGs, which were built on villagers' groups. Thanks to the high autonomy of FUGs, villagers were able to distribute timber revenues according to their own needs. In X Village FUG 2 reserved part of revenues to lend small loans to its members, and FUG 3 spent revenues on building roads. Other FUGs in two villages distributed timber revenues to all members.

The restructuring also contributed to reducing timber thefts. Before the restructuring, villagers were excluded from managing forests and enjoyed few revenues. Thus, they called collective forests 'cadre forests' and 'government forests' and lacked incentives to report timber thefts. After the restructuring, villagers enjoyed more revenues and were thus more active in monitoring and reporting timber thefts. As one villager said: "If you steal our timber, we will steal yours. Forests are not public; they are our own." It should be noted that the decrease in timber thefts has many reasons. For example, an increasing number of villagers migrated to cities to run snack businesses around 2000. The large-scale out-migration and the income increase also contributed to reducing timber thefts.

Although the revenue distribution within the community improved after the restructuring, the revenue distribution between villagers and outside timber traders worsened. In both villages, FUGs chose to transfer many forests to outside traders within one or two years after the restructuring. Many factors contributed to the large-scale transfer of forests. Some villagers had urgent financial needs and hoped to realize timber values earlier; some fear that the policy might change and the villagers' committee would regain the forests; some argued that commercial timber production requires intensive financial, technical, and entrepreneurial inputs, and they doubted that FUGs were capable for managing forests well. Since villagers lacked the experience of bargaining with timber traders and a unified timber auction platform was absent, many FUGs transferred forests at a low price. Moreover, beyond the expectation of villagers, timber prices soared within a few years after the forest transfer. For example, the price of Chinese fir logs (12 cm) increased from 300 CNY in 2004 to 1200 CNY in 2010, and the premium derived from the timber price increase was earned by outside traders.

The more serious challenge, however, pertains to forest regeneration. Traditionally, after outside traders harvested forests, they would return bare land to FUGs to conduct forest regeneration operations. However, between 2005 and 2015, forest regeneration cost soared, and FUGs thus faced great financial pressure. For example, FUG 3 in X Village transferred a parcel at 15750 CNY/ha, and this parcel was harvested and returned in 2013. The forest regeneration cost around 2013, however, was 18000 CNY/ha, which is even higher than the transfer-out income. Therefore, the premature forest transfer after the restructuring worsened the distribution between villagers and outside traders, and villagers became the losers of the trade.

5.2.3 Economic efficiency

Before the restructuring, in either X Village or B Village the villagers' committee could fulfill basic timber production responsibilities. The committee designated one member to specifically administer timber production. The manager had to follow government orders including afforestation tasks, species selection constraints, technical requirements of timber production operations, and harvest quotas. The county-level forest bureau and the township forest station also provided technical and financial support. Forest regeneration was the key mission of the committee, and conventionally the committee spared 35% of timber revenues for forest regeneration. Certain problems, however, also existed. In particular, since the salaries of village cadres were unrelated to their forest management performances, village cadres often lacked a sense of responsibility. Many villagers in B Village complained that the committee outsourced afforestation operations but poorly conducted the acceptance appraisal work, and the survival rate of samplings was low.

After the restructuring, the economic efficiency of timber production decreased in X Village but increased in B Village and the difference mainly derived from their distinct capacities for arranging forest regeneration activities. Similar to many other villages in Sha County, X Village failed to properly administer forest regeneration because of lacking funds. As mentioned in Section 5.2, after the transferred-out forests were harvested and the bare land was returned to FUGs for reforestation, the forest regeneration cost had soared. To raise funds, some FUGs in X Village tried to borrow loans from banks and seek subsidies from

the government; however, their applications were rejected because FUGs were informal, unregistered organizations and lacked the legal status of persons or corporations. The attempt to raise funds from FUG members also encountered objections. Since the forest regeneration cost had approximated to or even exceeded the income of transferring out forests, many villagers opposed conducting standard forest regeneration operations. The divergent views of FUG members on forest regeneration further dampened the enthusiasm of FUG heads, who organized fund-raising activities in the public interest and received few subsidies for their contributions. These leaders thus lacked incentives to negotiate with group members and organize the collective action of raising funds.

Facing the financial dilemma, FUGs in X Village primarily relied on natural regeneration, which was less costly but had lower future inputs, and later-period management was poorly conducted. With an increasing number of forests harvested and returned, reforestation was pressing. In 2009, the villagers' committee funded a collective share-holding forest farm. The forest farm retrieved the harvested forest parcels from FUGs and took the responsibility of forest regeneration. By 2017, approximately 150 hectares of forestland had been retrieved, indicating the decline of sub-communal FUGs.

Distinct from Xixia, B Village properly fulfilled forest regeneration by carefully designing the forest transfer contract and requiring forest buyers to conduct reforestation. To prevent buyers from breaking the contract, most FUGs in B Village adopted three extra measures. First, they required buyers to pay deposits, which approximately equalled reforestation costs. Second, only FUG members or those intimate with FUG members were eligible for submitting tenders because they hardly defaulted at the cost of their reputations. Third, FUGs rejected surrendering the forest tenure certificate to buyers. Since buyers could not apply for harvest permissions without the certificate, retaining it gave FUGs more power in future negotiations. Most FUGs also reserved part of forest transfer revenues for subsequent tending activities. These measures effectively helped FUGs to finish forest regeneration despite the huge increase in forest regeneration costs. The success of B Village in finishing high-standard forest regeneration was uncommon. Most FUGs in Sha County failed to finish high-standard forest regeneration due to lacking funds and techniques, and some FUGs directly transferred the bare land to outside traders and exited forest management.

The success of B Village was closely related to its location: it is a suburban village. Most villagers ran businesses outside and had a keen market sense. Moreover, because of their proximity to the urban area, villagers' groups in B Village had a large number of property rental incomes and land requisition compensations. These self-generated revenues helped FUGs to make sufficient forest investments even if some challenges emerged. For example, FUG 4 sold 11.7 hectares of standing timber in 2005 and forgot to retain the forest tenure certificate. When the forests were harvested in 2013, total reforestation costs increased to 100000 RMB. The buyer forsook the 30000 CNY reforestation deposit and refused to afforest the bare land. However, FUG 4 still finished high-quality reforestation by diverting revenues from renting out warehouses.

Farmers' perceptions of the changes in forest management costs also differ across two villages. In X Village, many villagers realized that timber production costs increased because of forest parcelization. This problem became more serious after the establishment of the communal forest farm, which retrieved only harvested parcels from FUGs. Since the harvest timing varied across FUGs and parcels, parcels retrieved by the forest farm were fragmented and incurred high management costs. The forest farm manager complained: "Reforestation teams from outside don't want to work for us because our parcels are quite parcelized, making it difficult to burn bare land and create fire belts." Few villagers in B Village agreed on the increase in forest management costs. The reason may be that for most FUGs in B Village, reforestation and harvest, two operations with the largest scale economies, were all conducted by outside timber traders; thus, villagers themselves were less able to feel the changes in costs.

In X Village, ample evidence shows that the restructuring undermines the long-run efficiency of community-based timber production. Since each FUG had limited forests, it lacked incentives to get registered, let alone involve in wood processing. The limited timber revenues also made it impossible for FUGs to hire specialized managers. Similar problems also existed in the FUGs of B Village, which had no interest in developing wood processing. The problem of lacking entrepreneurship, however, was generally absent in B Village. B Village is a suburban village, and its villagers' groups had abundant collective assets. Leaders of FUGs, who were also leaders of villagers' groups, enjoyed subsidies from managing all collective assets including forests.

6 Discussions and conclusions

To explore the generalizability of our findings and to study the efficacy of partitioning forest commons into subgroups under different contexts and restructuring strategies, we compare our findings with relevant

studies based on Mexican evidence. Based on these comparisons, we discuss the theoretical and policy implications of this paper, make final conclusions and propose future research agendas.

6.1 Discussions

Two studies, which provide a total of four cases, explore the outcomes of partitioning forest management rights into sub-communal groups in Mexico (Taylor, 2003; Wilshusen, 2010). We extract information from these cases and make **Table 5**, which compares four Mexican cases with our cases in community characteristics, restructuring approaches, and outcomes. As shown in **Table 5**, six cases considerably vary in community characteristics and forest management contexts. They also vary considerably in restructuring approaches: Chinese cases allocated physical forests to subgroups, while most Mexican cases only allocated timber volumes and harvestable trees; Mexican subgroups were formed by villagers' voluntary grouping, while Chinese cases are based on existing villagers' groups; in two Mexican cases, subgroups experienced multiple sub-divisions and even individualization, while subgroups in other cases overall remained intact.

Despite the huge differences in the community characteristics and restructuring approaches, certain outcomes of the restructuring are surprisingly similar in six cases. In all cases before the restructuring, an elected community-level executive committee dominated community forestry, and villagers were excluded from managing forests. After the restructuring, the community-level committee lost its control over forests. Villagers were highly involved in managing forests and shared more timber revenues. These cases indicate that compared to communal arrangements, sub-communal arrangements tend to enhance

Table 5: Comparing six cases that partitioned forests into subgroups from China and Mexico.

Village name	X Village	B Village	Caoba	Petcacab	Canelas	Santa Marta
Community characteristics						
Village types and region	Administrative villages, Fujian, China		Ejidos, Quintana Roo, Mexico		Agrarian communities, Durango, Mexico	
Tree species	Chinese fir, Masson pine		Mahogany, cedar		pine and oak	
Total area of forests (ha)	1768	459	32500	32500	158000	17000
Number of village members	1640	2906	1535	947	829	630
Characteristics of subgroups and restructuring strategies						
Major driving force	Top-down	Top-down	Bottom-up	Bottom-up	Bottom-up	Bottom-up
Number of subgroups	7	11	7	11	11	4
Subgroups vary in size	NO	NO	YES	YES	YES	YES
Farmers can select group partners	NO	NO	YES	YES	YES	YES
Sub-division of subgroups or even individualization	NO	NO	NO	YES	YES	NO
Transfer of physical forests	YES	YES	NO	NO	YES	NO
Transfer of decision-making power to subgroups	YES	YES	YES	YES	YES	YES
Outcomes of the restructuring						
Participation in community forestry	Increase	Increase	Increase	Mixed	Mixed	Increase
Corruption of village elites	Decrease	Decrease	Decrease	Decrease	Decrease	Decrease
Farmers' access to timber revenues	Increase	Increase	Increase	Increase	Increase	Increase
Equitability of benefit-sharing between community members	Increase	Increase	Increase	Decrease	Decrease	Increase
Long-run economic efficiency	Decrease	Increase	Decrease	Decrease	Decrease	Decrease

the collective actions of managing forest commons and enhance the accountability of community-based forest management to ordinary villagers.

In all cases except B Village, however, the economic efficiency of timber production experienced little improvement. X Village failed to fulfill standard forest regeneration due to the financial dilemma. The forest regeneration dilemma is absent in Mexican cases because they managed natural forests instead of man-made plantations. However, similar to Chinese cases, after the restructuring, Mexican workgroups managed a smaller area of forests and were thus reluctant to take charge of timber harvesting and processing. In addition, due to the lack of funds and expertise, most workgroups were unable to maintain and invest in wood processing machinery, which prevented them from obtaining higher added value. These cases indicate that for commercial timber production, which requires large financial, technical and managerial inputs, partitioning forests into smaller groups may threaten the long-run efficiency of timber production. The decrease in economic efficiency in turn reveals the scale economy characteristic of commercial production. This is because the total output decreases after the community-level timber production unit splits into multiple sub-communal units.

The discussions above contribute to understanding the optimal organizational scale of community forestry. Community forestry may adopt organizational forms moving along the continuum between individual households to sub-communal, communal, or inter-communal organizations (Macqueen, Bolin, Greijmans, Grouwels, & Humphries, 2018). Large-scale organizations may have larger scale economies and higher organizational capacity, while small ones may enhance villagers' democratic participation and equitable benefit-sharing. Therefore, the optimal organizational scale of community forestry depends on the trade-off between various goals. Moreover, the optimal organizational scale varies across communities because of their different socio-economic and biophysical contexts (Antinori & Rausser, 2010). For example, for large communities with abundant forest resources, sub-community arrangements may better balance democratic participation and scale economies than community-level arrangements, while this argument may not hold for small communities with limited forest resources.

This study may help policy-makers and practitioners to restructure community forest management according to local conditions. For example, if forest management suffers from elite capture, partitioning forest commons into sub-communal groups may be promising because it may enhance democratic participation. However, if forest management suffers from limited expertise, capital or entrepreneurship, splitting the group is questionable because it contributes little to the managerial and financial capacities. Finally, for the communities that have already adopted sub-communal arrangements, the forest bureau may provide FUG leaders with management training and government subsidies.

6.2 Conclusions and future research agendas

This study focuses on an innovative approach to restructuring community forest management: partitioning forest commons and devolving them to smaller subgroups. We explore its effects on democratic governance, revenue allocation and economic efficiency based on evidence from two timber production villages in China. Two villages devolved forests from the administrative village to sub-communal FUGs. We find that the smaller and flatter FUGs enabled villagers to directly participate in managing forests and to effectively monitor the behaviours of their leaders; thus, the restructuring contributed to democratic governance. Moreover, by transferring forests to small and autonomous FUGs, the restructuring empowered villagers to allocate timber revenues according to their own needs and thus improved the distribution of timber revenues. However, restructuring threatened the economic efficiency of timber production. FUGs are small, informal, and unregistered, and they have no standing agencies, salaried staff, and the legal status of persons and corporations. Thus, it was challenging for FUGs to obtain external financial and policy supports and to mobilize self-generated resources. The weak organizational capacity and the limited forest holdings prevented FUGs from investing in value-added operations and expanding the production scale.

Many issues still await further investigations, and this paper will serve as a basis for future studies on the restructuring of community forest management. More data is needed to explore the generalizability of our findings and to explore the efficacy of partitioning forest commons into subgroups under different macro-political regimes, community socio-economic settings, and forest management scenarios. In particular, although our tentative comparisons between Chinese cases and Mexican cases imply the similar outcomes of partitioning forests into subgroups, more cross-regional comparisons are needed to investigate how the outcomes of the restructuring vary under different implementation strategies, such as group-clustering approaches, the specific forest management powers that were devolved, and the sub-division of FUGs. Future studies may be performed to explore these issues.

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Competing Interests

The authors have no competing interests to declare.

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