Women as Decision Makers in Community Forest Management: Evidence from Nepal

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Abstract

In many developing countries women are responsible for the collection and management of forest products essential to the daily lives of their household. However, women are often neglected in the decision-making process within community level institutions devoted to the management of natural resources. This paper looks at whether and how an increased participation of women in the the Executive Committee (EC) of Community Forest User Groups (CFUG) in Nepal affects forest protection, specifically the quantity of firewood collected by the households. We account for the potential endogeneity of female participation and exploit an amendment made to the guidelines for CFUG formation that sets a higher threshold for women representation in the EC to evaluate the impact of women on firewood extraction. The results show that higher female participation in the ECs of CFUGs leads to a significant decrease in firewood extraction. These results suggest that in countries with common property resources, the effectiveness of collective action institutions depends also on their gender composition. The recognition of the essential role that women play in forest management can make a difference in terms of forest conservation. Better forest conditions directly affect the livelihood and the welfare of a large part of rural populations who rely on forest resources.

JEL Codes: D71, J16, O13, Q23
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1 Introduction

The management and protection of common property resources such as forests, water or fishing grounds have been central issues in development economic policies in recent years. Increased scarcity of these resources poses serious concerns not only in terms of environmental sustainability but also

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for rural populations reliant on environmental resources for their livelihoods. Over the few decades local level collective action institutions emerged as ways to protect the resources as well as sustain local development. Over the years these institutions were deemed to be successful for environmental resources protection, though more recent concerns started to emerge on their correct functioning. The existence of socio-economic heterogeneity and gender inequality within community institutions may indeed lead to a failure of collective action mechanisms (Adhikari and Lovett, 2006; Baland et al., 2007).

The purpose of this paper is to analyse whether and how an increased participation of women in the decision-making body of local collective action institutions - the Executive Committee (EC) of Community Forest User Groups (CFUGs) in Nepal - affects forest protection, specifically the quantity of firewood collected by the households. Firewood extraction is considered as one of the main causes of deforestation. Therefore, a reduction in the quantity of firewood collected would imply better forest conditions. Our hypothesis is that a higher female representation in ECs of CFUGs contributes to better forest management and hence to forest protection.

Nepal is a particularly suitable country for this analysis. In 1993 the government of Nepal promulgated a Forest Act which established the transfer of national forests to local communities. Since then Community Forest User Groups (FUGs from now on) have been formed for the management and protection of these forests. These groups can autonomously manage the forests and decide on the distribution of benefits deriving from the forest resources. On the basis of 2010 estimates on the Nepalese forest cover, nearly the 44 percent of forest area in Nepal is now covered by FUGs (FAO, 2010). The Executive Committee of each FUG plays a critical role in defining the forest products extraction rules and its composition is therefore crucial for the functioning and effectiveness of these institutions. We use two national representative household surveys, the NLSS 2004 and 2011, and combine them with a census of all FUGs formed in the country. This is a unique feature of our analysis.

This study is motivated by the fact that minimal research has been devoted to exploring gender differences within community-based institutions established for natural resources management. However, women are largely responsible for the collection and use of firewood and other forest products within a household. Despite being important stakeholders in forest management, they are often neglected in the decision-making process that sets out the rules to access and collect forest products within a Community Forest (CF). The recognition of the essential role that women play within community level forest institutions can make a difference in terms of forest conservation and equity in the distribution of benefits.[1]

Why should an increased presence of women in the ECs of FUGs make such a difference? We expect female participation to affect the outcome for one main reason. Women have different and

[1]We concentrate in the present study only on the analysis of the effects of a higher female participation in the ECs of FUGs on the protection of forests (i.e., on the quantity of firewood collected at the household level).

complementary *interests* relative to men within a FUG which stem from the differences in concerns and nature of dependence on forest that women have relative to men (Agarwal, 2000, 2010b). They are the main users of forests, at least of those products which are essential to household daily life. Women have better knowledge than men of certain forest products, on how these products should be extracted and which species should be planted. Given the specific interests of women in certain forest products and particularly in firewood, they thus have the incentive to ensure the availability of these products and ultimately to protect the forests. Women may also have different *preferences* than men (Chattopadhyay and Duflo, 2004). This links to the growing literature on women in leadership positions. They tend to favour redistribution and to support child-related expenditures and outcomes. Women would then have a stronger preference than men to ensure that household's firewood needs are satisfied both in the short and long run.

Therefore, a higher representation of women may increase the effectiveness of FUGs in terms of forest management and protection. However, women face a trade-off as they need to balance sustainable forest protection with their immediate household needs. For the above arguments we argue that, for given forest conditions, women sitting on the ECs may favour decisions that prioritise a sustainable extraction of firewood. We therefore expect a negative sign on the effect of an increased female participation on firewood collection.

We first analyse the relationship between female participation and firewood collection. In order to account for the potential endogeneity of such participation we use a difference-in-difference estimation strategy to exogenously identify the effect of an increase in female participation on firewood collection. In 2009 an amendment to the Community Forest programme's operational guidelines sets at 50 percent the minimum threshold for female representation in the ECs of FUGs. The new provision actually increased female participation within these local institutions. We exploit this exogenous variation in the percentage of women in the Executive Committees of groups formed after 2009 and compare the outcome before and after this change, as an identification strategy. The results show that higher female participation in the ECs of FUGs leads to a decrease in firewood extraction. This evidence is suggestive that women are prioritising conservation to ensure sustainable firewood extraction to satisfy their daily needs.

Agarwal (2009a) is one of the few studies that analyse how the gender composition of community based groups affects forest conservation and management rules. The results reveal that groups with a higher presence of women in the ECs exhibit improvements in forest conditions. However, this existing research focused on relatively narrow geographical areas of Nepal and India using data related to small case studies.

With this paper we contribute to a very limited number of economic studies which assess the role of women within collective action institutions for the management and protection of natural resources. One reason lies in the paucity of good quality data that allows for a rigorous analysis of collective action institutions. This analysis is extremely important in countries where strong

gender division roles exist and where the natural resources are essential to the daily lives of people. The links to the literature on women in decision-making positions at the political level reinforce our arguments and contributions. We show that the recognition of the role of women in natural resource management can be beneficial for the conservation of the resource itself and for the population reliant on it. Furthermore, the combination of national representative household surveys data with the census data gives unique information for the analysis and enables us concentrating on a wider area of Nepal. Finally, we try to account for potential non-random female participation in the ECs, which most of the existing literature ignored.

The paper is structured as follows. Section 2 presents a literature review and the analytical framework. Section 3 provides a background both on the Nepalese context and on the country's forestry policy. Section 4 describes the data, the sample used for the analysis and provides some descriptive statistics of the relevant variables. Section 5 presents the empirical strategy and Section 6 reports the results and provides some robustness checks. Section 7 discusses the results and Section 8 concludes.

2 Literature review and analytical framework

Firewood collection is considered as one of the causes of deforestation and forest degradation. Poverty has been advanced as one of the hypothesis for environmental degradation. Few studies analyse the determinants of firewood collection (Baland et al., 2013, 2010; Edmonds, 2002; Foster and Rosenzweig, 2003) and some of these do not find evidence that poverty is a determinant of deforestation. Understanding the causes of deforestation becomes particularly relevant for determining the ways forests can be protected. The protection of forests and, in general, of common property resources from an overexploitation and hence from depletion as population grows is crucial for defining any developing policy (Wade, 1987). The question is to understand how best these resources can be protected and managed (Baland and Platteau, 1996).

Since the mid-1980s a vast literature on common property arrangements emerged (Agrawal, 2001) claiming for the success of collective action[2] as an effective alternative to private resource management or state regulation of a common resource (Baland and Platteau, 1996; Wade, 1987).[3]

[2]Collective action is "action by more than one person directed toward the achievement of a common goal or the satisfaction of a common interest" (Wade, 1987, p.97).

[3]Past literature highlighted the failure of common property arrangements which generate a mismanagement of these resources and ultimately cause even more rapid degradation. The basic theoretical argument is that individual incentives inevitably lead to the mismanagement of common property resources. The *Tragedy of the Commons* theory (Hardin, 1968) predicts that the private benefit of an overexploitation of a common resource exceeds the private costs of protecting the resource from excessive use because this can be shifted to the whole group. However, the claim for the success of collective action was based on the recognition that the *Tragedy of the Commons* theory holds under the assumption that individuals cannot communicate, which is implausible in many situations (Wade, 1987). As a result voluntary collective action institutions can emerge and be successful in protecting the common interest if effective rules and related sanctions are established within the group.

Since then the belief that local communities through the formation of collective action institutions could successfully manage common property resources and hence contribute to environmental protection and local development became important (Baland and Platteau, 1996; Bardhan, 1993). "Participatory development" and "community driven development" became common themes across countries with natural resources to protect (Hobley and Shakya, 2012).

However, Baland et al. (2007), while proclaiming the potential of small rural communities in achieving the goals of environmental protection and economic development, emphasise that group heterogeneity may lead to a failure of these institutions. Often a failure of collective action institutions in protecting common property resources (e.g., forests) results from inequalities within the groups which prevent them from successfully cooperating. The authors stress the relevance of various dimensions of inequality. In particular, income and asset inequality matters as well as ethnic and social heterogeneity which may influence the well functioning of collective action institutions. Group participation may be lower in localities that are more unequal in terms of income and ethnicity (Alesina and La Ferrara, 2000). Most importantly for the current analysis, gender inequality within groups may affect the level of cooperation. Women are largely excluded from any decision making within community groups. In addition, gender norms and divisions of roles within the household have tended to exclude women at many levels within society. This under-representation together with pre-existing gender inequalities within the household and the society as a whole, poses serious concerns for women who have the primary responsibility for the collection of forest products within the household (Agarwal, 2007). This suggests that the nature of dependence on forest is different between women and men. Women have a higher interest then men in ensuring the availability of firewood and other forest products essential for their daily life. This is also related to the burden associated with a deterioration in forest conditions (Acharya and Gentle, 2006). Environmental degradation and natural resource scarcity affects women and children's time directly, given they have to walk longer distances for the collection of firewood (Cooke, 1998). Similarly, women and children's health may be adversely affected by fuelwood scarcity. Indeed, the use of firewood in an enclosed environment (i.e., a house) is also potentially unhealthy.

Besides having different *interests* than men, women in general may have different *preferences*. Income generated within the FUG could be more equally distributed if more women had power at the decision-making level. Women would also be more prone to favour investments related to their needs and to those of their children (Agarwal, 2010b). This strand of research on women in collective action institutions links to another literature which analyses female representation in public decision-making. Women and men have different policy priorities. This literature demonstrates that women in key political positions tend to favour public goods that emphasise investing more on child-related expenses (Clots-Figueras, 2012). Female political representation also tends to attenuate the gender bias in voter attitudes towards women (Beaman et al., 2009). Chattopadhyay and Duflo (2004) report how the gender of those in key political position affects the type of public good

provided and show that women tend to favour public goods which are more linked to their concerns. Therefore, any surplus income generated within a FUG is likely to be spent disproportionately on goods and outcomes such as health and children's education.

Much of the research which looks at the effects of collective action institutions and of the role of women within local forest groups, concentrate on India and Nepal. The reason for this lies in the recent reforms enacted by the governments to address issues of environmental degradation.[4] Edmonds (2002) is one of the few studies on Nepal which attempts to rigourously evaluate the impact of collective action institutions established for the management of forests on environmental degradation. The results seem to suggest that FUGs in Nepal have been successful in reducing firewood extraction and hence forest degradation. This study focuses on the short term effects of these institutions as it evaluates the effect of the 1993 reform in 1996. Two other recent studies do not find any significant correlation between firewood collection and the presence of FUGs in communities in Nepal (Baland et al., 2010, 2013).[5] The remaining empirical analysis mostly concentrates on relatively small case studies which acknowledge the success of FUGs activities in Nepal in halting deforestation (Kumar, 2002; Hobley and Shakya, 2012). However, these latter studies ignore the potential endogeneity of community group formation on relevant outcomes. Baland et al. (2010) demonstrate that ignoring this potential endogeneity bias may lead to an under-estimation of the benefits of community forest management.

The success of community forestry in Nepal has been challenged in a more recent literature which stresses how most of the benefits accrued to local elites (Thoms, 2008; Malla et al., 2003). Participation in FUGs is found to be higher for more economically advantaged groups (Agrawal and Gupta, 2005). Adhikari et al. (2004) show that richer households benefit more in terms of forest access and distribution of benefits than poorer ones, highlighting the importance of making these groups more inclusive. The exclusion of some sub-groups within these local community institutions may indeed cause failure in terms of both equity and efficiency of these groups (Agarwal, 2001). The success or failure of collective action institutions depends also on their design and characteristics (Baland and Platteau, 1996; Edmonds, 2003; Olson, 1965; Ostrom, 1990; Wade, 1987). For example, many local community groups in Nepal are created with the assistance of donors. Differences between donors in terms of funding or objectives may reflect the attributes of the groups which as a result will have different characteristics (e.g., number of members, area covered). This heterogeneity eventually affects the success or failure of some of these groups and, more generally, of programmes which devolve to local communities the management of natural resources (Edmonds, 2003).

Some recent research focused on explaining why gender matters in environmental collective action and what type of differences women can make to the management of forests (Mai et al., 2011; Agarwal, 2000, 2010b). A higher presence of women may indeed generate different outcomes

[4]We will discuss Nepal forestry policy in the next section.

[5]However the authors claim they are not able to assess any causal effect given the non randomness of group formation.

in terms of forest conditions. Agarwal (2009a) analyse how the gender composition of community based groups affect forest conservation and management rules. The results on Nepal and India reveal that groups with a higher presence of women in the ECs of FUGs show improvements in forest conditions. Sun et al. (2011) look at correlations between the gender composition of a sample of FUGs in Kenya, Uganda, Bolivia and Mexico and property rights and forestry management. They find that groups with a balanced presence of women and men tend to participate more in decision-making processes within the group, but do not find any effect on firewood collection. On the contrary groups where women are the majority (i.e., more than two thirds) tend to collect more firewood, though participating less in decision-making. This result may be attributable to the particular conditions under which groups with a large majority of women are formed as will be discussed later.

Agarwal (2009a) illustrates that one mechanism through which a higher female presence in the groups improves forest conditions is through a better quality of forest protection. Women who take up some responsibilities within the group have the incentive to follow the rules (Bardhan and Dayton-Johnson, 2007) and to bring their concerns into the group's discussions. Female involvement in the decision-making process would also help to spread awareness of the rules among village women, generating an informational flow. The gender composition of the ECs of FUGs may affect differently the type of rules on forest access, resource extraction and the distribution of benefits defined within the groups given different female priorities in terms of resource extraction. Agarwal (2009b) finds in Nepal and India that groups with more women tend to favour stricter rules which in turn favour forest regeneration. The author stresses also that rules which are too strict are difficult to enforce and may favour violations and conflicts. Hence a well balanced strictness of rules may facilitate forest protection giving incentive to FUG members to cooperate. The results show that more women in ECs appear to favour stricter rules which would allow forests to regenerate.

3 Nepal context and forest policy background

3.1 General context

Nepal is an apposite country to analyse as the forest is one of the most important natural resource in the country. In addition, the large majority of the population in the rural areas depends on forest resources for subsistence (CBS, 2004, 2011). Recently, commercial interests over the forest sector started to emerge. These new patterns are increasing the awareness that this shift could potentially lift the population relying on forests out of subsistence (Pokharel et al., 2008). Forestry now represents a productive sector of the economy and is estimated to comprise around 10 percent of Nepal's GDP (Hobley and Shakya, 2012).

The female role in forests is essential in Nepal (Mai et al., 2011). Despite the fact that women

are still largely under-represented at all institutional levels in Nepal, forestry is now the sector where the presence of women in key positions is highest (Pokharel et al., 2008). The attention toward female social inclusion and empowerment in Nepal increased substantially in recent years at different levels within society and in particular in the forestry sector as testified by the recent Gender Equality and Social Inclusion strategy (Pradhan, 2010) and by the Forest Sector Gender and Social Inclusion strategy (MFSC, 2012).

Concerns over forest degradation have emerged in Nepal since the 1980s. According to FAO, in 2010 Nepal forest coverage was estimated at about 3.6 million hectares, which represents nearly 25.4 percent of the total land area of Nepal. Despite the decreasing rate of forest degradation in the last number of years, recent estimates suggest that between 1990-2010 Nepal lost a quarter of its forest cover (FAO, 2010).

Nepal in the past two decades witnessed significant political, social and economic changes. In 1996 a Maoist insurgency initiated a conflict in the country between the Communist Party of Nepal (the Maoist) and government forces. This was triggered by the most marginalised groups (ethnic and low-caste groups) living in rural areas. It started in the western regions but soon extended throughout the country. In 2001 the conflict intensity escalated and ended in 2006 with the signing of a peace agreement. Despite this relatively intense decade of conflict, the Nepalese economy experienced a significant growth over this period. Between 1996 and 2004 poverty rates reduced from 42 to 31 percent, and between 2004 and 2011 the poverty rate further reduced to 25 percent (Hobley and Shakya, 2012).

3.2 Forestry background

The Nepalese forestry sector legislation has gone through many changes since the early 20th century and three main phases can be distinguished (Hobley and Shakya, 2012; Ojha et al., 2008; Chhetri, 2006; Acharya, 2002). After the first two phases of privatisation (pre-1950s) and nationalisation (1957-mid-1970s) of forests, in the late 1970s the failure of centralised arrangements for the protection of forests together with the rising international concerns over Himalayan degradation, influenced the emergence of a third phase of participatory development to oversee forest management.

The recognition of a role for local communities started with the National Forestry Plan in 1976 and with the 25-year Master Plan for the Forestry Sector (MPFS) approved by the government in 1989 (Ojha et al., 2008; Gautam et al., 2004). However, the new forestry legislation which legally established the transfer of all government forest land to local communities was promulgated in 1993 with the Forest Act (HMGN, 1993a). The Act categorised part of the national forests as Community Forests (CF).[6] These are forests collectively managed by local communities who have

[6]Community Forest is only one of six different institutional arrangements of the wider programme in Nepal on Community Based Forest Management (CBFM). See Acharya (2002), Gautam et al. (2004), Kanel (2004) and Ojha

formed a Community Forest User Group subsequent to approval of a local district forest office (Gautam et al., 2004). Once the CF is handed over to the FUG, this can independently manage, conserve and use the forest according to an operational plan while the land ownership remains with the state (Ojha et al., 2007).[7] The Forest Regulation of 1995 (HMGN, 1993b) represented the first operational tool for the implementation of the Forest Act.

Each FUG has the right and responsibility to manage, protect and use forests. All benefits from CF go to the FUG. All management decisions are taken by FUGs and each member should have in principle equal rights over the resources. Each household is recognised as a unit for membership and anyone who is not member of the FUG is excluded from access to the CF. Another important feature of FUGs is that they have no political-administrative boundaries but traditional use rights. This implies that one FUG may cover more than one community and vice versa. Each FUG has two main bodies in its organisational structure: a General Assembly with members drawn from the whole community and an Executive Committee (EC). The EC is the key decision making body which, in conjunction with the General Assembly (and in varying degrees with the forest department) defines the rules for forest use and benefit sharing, the penalties for rule violation, methods of protection and so forth. Forest use rules may restrict access to the forest and these restrictions can range from almost a total ban on extraction of forest products to varying degrees of permitted extraction on firewood, fodder and other forest products (Agarwal, 2010a,b). The benefits derived from FUGs activities should be equally distributed among members, though in practice, as already acknowledged, this has not always happened (Acharya, 2002).

During the 1990s, CF expanded rapidly throughout the country.[8] The objective of CF in Nepal was the protection and management of forests with the clear aim of halting forest degradation in Nepal. A strong focus on learning and exchange between groups was put in place (Hobley and Shakya, 2012). The process of handing forests over to local communities required the assistance and support of both officers from the Department of Forests (DoF) (i.e., District Forest Office (DFO) officers) and international donors. Initially the DFO staff was essential for facilitating and supporting FUG formation (Edmonds, 2002). FUGs formation have also been largely supported by donor-funded projects (Edmonds, 2003).

et al. (2008) for a review of all modalities.

[7]The process of FUG formation is a long process which goes through different steps that eventually end up with the transfer of the forest area to the FUG and to the approval of an Operational Plan by the District Forest Office (MFSC, 2009).

[8]Most of the FUGs started to form in the middle Hills and very few formed initially in the Tarai despite half of the population residing there and with the region including a big proportion of forest land. Still today Tarai is the region with the lowest number of FUGs. One explanation for this lies in the fact that forests in Tarai were more valuable and the government was reluctant to hand over its management to local communities, making also any donor interventions difficult. This area is characterised by higher ethnic heterogeneity than other regions, is more accessible and had significant migration inflows in the 1960s. Multiple interests emerged in this area which hindered the formation of FUGs and pushed the government to implement a different forest policy for Tarai (Hobley and Shakya, 2012; Ojha et al., 2008). Given the very different context and policy framework of the Tarai belt and given that the bulk of FUGs was formed in the Hills and the Mountains, we exclude Tarai from our current analysis.

During the 2000s the expansion of FUGs slowed down. This occurred at the same time as the escalating violence due to the conflict in these years and to a change in attitudes and objectives of CF. While success up to this period in terms of forest conservation was acknowledged, the effects on marginalised and more vulnerable groups were unclear. Problems of elite capture started to emerge. Issues of poverty, equity, inclusiveness and in general of the rebalancing of power were recognised not to have been adequately addressed and hence incorporated within CF objectives. The operational guidelines for FUG formation were revised in 2001 incorporating only part of these new objectives (MFSC, 2001). Not only did the scope of FUGs widen and evolve over these years but the role of government (through the DFOs) and the role of donors also changed. Other actors within the civil society (NGOs, FECOFUN[9]) acquired a more relevant role in facilitating communities to form groups. The decrease in the role of government officials in these years was also coincident with the escalation of the conflict which impeded the free movement of officials around the country (Pokharel et al., 2008). The emergence of a civil society voice also testified to the need for a more democratic push and less intervention of the state through its forest officials. In addition, as a result of the conflict, many donors withdrew their financial support.[10] Despite this, most FUGs continued to function and to rely on their self-generated income for their financial sustainability (Pokharel et al., 2008).

After the end of the conflict in 2006 an increasing emphasis was placed on extreme poverty and inclusiveness of the most marginalised groups. CF evolved from just being a government-supported programme into an extensive system which continues in most of Nepal indipendently of external support. FUGs are now conceived as vehicles for local development, representing in some places the most democratic institutions in the country and acting as a source of cash income, physical infrastructures and other rural development activities. CF have now a strong influence on local democracy and inclusive self-governance (Pokharel et al., 2008).

In 2009, the operational guidelines for FUG formation have been revised for the second time (MFSC, 2009). These new guidelines put a greater emphasis on poor and excluded groups (Dalit, women, indigenous people and ethnic minority groups), including mandatory provisions for representation of all categories of users and equitable distribution of benefits among them. It is also specified that FUGs have to spend 25 percent of their income on forest development activities, an additional 35 percent should be used for programs that target the poor and excluded groups and the remaining amount should be spent on other community development activities (e.g., drinking water supply, schooling infrastructures) (MFSC, 2009; Pokharel et al., 2008). Therefore, surplus income generated within the groups could be spent on initiatives other than protecting the forests.

A specific new provision was introduced for female representation that in particular indicates that there should be at least 50 percent of women representatives in the Executive Committee (EC),

[9]FECOFUN is the Federation of Community Forest Users in Nepal which represents FUGs rights and interests in Nepal and was established in 1996.

[10]Of the six major donors that supported FUGs in most of Nepal's districts only three remained in the country.

the main decison making body of FUGs. Previous guidelines of 2001 only specified that "The Committee should represent men, women and interest groups from each *tole*[11] proportionately" (MFSC, 2001, p.14).

The composition of the committee is a critical issue in terms of decisions about the use of a community forest. In principle the Executive Committee should have representation from all members, and thus its decisions will reflect the needs and desires of all members (Yadav et al., 2008). In practice many groups have been excluded from any decision making process and most of the benefits have been reaped by local elites. The new provisions included in the revised guidelines in 2009 aimed at mitigating these patterns. We exploit the amendment made to the 2009 revised guidelines in terms of female representation in the ECs as identification strategy in the subsequent empirical work.

4 Data, sample and descriptive statistics

4.1 Data

This study uses two main sources of data. As a first source we use two national representative random cross-section household surveys collected by the Central Bureau of Statistics in Nepal (CBS) in collaboration with the World Bank. This data is linked at the village level to a second source of data which is a census of all CFUGs in Nepal. This additional data contains FUG related characteristics necessary for our empirical analysis.[12] Our sample will include only villages which have formed at least one FUG at some point in time.

Specifically we use the 2003/2004 and the 2010/2011 Nepal Living Standards Surveys (2004 NLSS Survey and 2011 NLSS Survey hereafter). They are both nationally representative surveys and their construction follows the standard methodology used by the World Bank in all its Living Standard Measurement Surveys. The first survey was conducted between April 2003 and April 2004 (CBS, 2004). The second was conducted between February 2010 and February 2011 (CBS, 2011). These surveys are respectively the second and third round of the 1995/1996 NLSS Survey conducted to update living standards and social indicators of Nepalese population.[13] Both surveys provide information on a wide range of village, households and individual characteristics. We use for this analysis only village and household level information. For some robustness checks and descriptive statistics we also make use of the 1995/1996 NLSS survey.

[11] A *tole* has a size of a hamlet.

[12] The household surveys also contain FUG related information in the rural community questionnaires. However, not all the data we need for our analysis is available. For example there is no information on the gender composition of the EC. Therefore we are not using this information for our analysis.

[13] In order to look at changes over time in these indicators, some households have been tracked over these three points in time. Therefore panel survey data is also available. However the 2010/2011 NLSS survey panel data was not made available to us yet.

Our second source of data is the FUG Database, a census of all Community Forest User Groups created in Nepal through July 2011 (MFSC, 2011). The FUG Database is maintained by the Department of Forest (DoF) of Nepal. It contains data on every forest user group formed in Nepal up to July 2011. This is the date by which the data has been made available to us. This census contains information on the date of formation,[14] the district and village (i.e., Village Development Committee, VDC) covered, the number of members in the Executive Committee, the number of females in the EC, the area of forest handed over to the FUG and the number of households who participate in the group. All the FUGs related characteristics refer to the time of formation. Therefore, there is no data on changes that may have occurred in the FUGs characteristics over time.[15]

In order to use both sources of data we need to merge them. The FUG Database is at the FUG level. Unfortunately, we do not have information on whether a specific household surveyed in the NLSS is a member of a particular FUG or another. Therefore, we are able to merge the two datasets only at the village level. The NLSS Surveys are at the ward level (*community*/Primary Sampling Unit level) which is a smaller geographical unit than the village (i.e., the VDC). This match may generate a potential bias. However, villages in Nepal are small and quite homogeneous units. In addition, our sample includes only villages which formed at least one FUG and in both NLSS surveys usually one ward per village was sampled. Therefore, any potential bias emerging from this imprecise match should be very small.

4.2 CFUGs in Nepal: female participation in the ECs

According to the FUG database, by July 2011, 17,685 FUGs were formed all over Nepal, covering a total of 1.6 millions hectares of forest land and including 2.2 millions households (MFSC, 2011). The process of forest transfer and group formation occurred gradually over time. However, by the end of the 2004 NLSS Survey in April 2004 and also by July 2011 all districts of Nepal except one[16] had formed at least one FUG. This reflects the importance of FUGs formation in Nepal. A rough calculation on the basis of 2010 estimates on the Nepalese forest cover (FAO, 2010) suggests that the 44 percent of forest area in Nepal is now covered by FUGs.

Table 1 reports some characteristics of FUGs according to the census. Consistent with the fact that the area where most FUGs formed over these years is the Hill belt, by 2011, 74 percent of FUGs were formed in this area. Another 14 percent were formed in the Mountains and 12 percent in Tarai. On average, the percentage of women in the Executive Committee of FUGs is 33 percent.

[14] This date is referred formally to the Operational Plan approval date.

[15] We believe however that this does not substantially limit our analysis. Indeed once formed, the ECs of FUGs normally do not change for many years (Agarwal, 2009a). In addition, even if in 2009 some FUGs may have changed their EC composition through the increase in the percentage of women, our estimates would represent a lower bound of the true effect.

[16] The missing district is Mustang. This was an independent Kingdom within Nepal until 2008.

The number of observations in Table 1 reveal that some information on these variables is missing. The percentage of missing observations on the proportion of women is nearly nine percent. We have looked at the average characteristics of the FUGs for these observations to see if they are largely comparable to those in Table 1. Summary statistics in Table A.1 of the Appendix show that some differences emerge.[17] However, as the percentage of missing observations is quite limited, it is unlikely that the results will be substantially affected by this. In addition, as we will explain in subsequent sections, in part of our empirical strategy we are not using the variable related to the percentage of women. Hence, the related estimate should not contain any bias related to this missing information.

For the purpose of our analysis, we plot the years of formation of FUGs against the average percentage of women in the ECs and we notice an increasing trend with a peak from 2010 (Figure 1).[18] This pattern is consistent with the fact that in 2009 the operational guidelines for FUG formation were changed (see Section 3 above) and incorporated a new provision for female representation in the ECs of FUGs. The figure shows that FUGs created after 2009 exhibit a higher percentage of women in their ECs. We test whether the increase in female participation in FUGs formed after 2009 is significant. We regress the percentage of women in the ECs of FUGs on a trend and on a dummy which indicates whether a FUG was created after 2009 (i.e., in 2010 or 2011). The results in Table A.2 in the Appendix show that there is a positive and increasing trend in female participation over time. The results also reveal that FUGs created after 2009 have a significantly higher percentage of women above the trend by 3.5 percentage points. We also regress the percentage of women in ECs of FUGs on a set of dummies on the year of FUGs formation. Table A.3 in the Appendix reports that across all model specifications in which we use the 2009, 2008, 2007 and 2006 year of formation respectively as reference category, groups formed in 2010 and 2011 have a significantly higher percentage of women relative to those formed in earlier years. In order to further assess whether FUGs formed after 2009 have a higher percentage of women relative to those formed before we show in Table 2 a breakdown of the percentage of women by different dates of formation of FUGs. The first column shows that most of the groups have a proportion of women in the ECs below the 50 percent. There is a 7.8 percent of groups with a percentage of women in the ECs above 50 percent and a 5.6 percent with all women in the ECs. It is visible from

[17] Table A.1 of the Appendix shows that there is a higher proportion of FUGs for which there is missing information on the percentage of women in the Far Western region. This region is one of the least accessible and this may also explain why some information is not available. Also these groups are characterised, on average, by a lower area of land. We have checked whether this missing information is mostly related to FUGs created early on or to more recent ones and we find it is related to early FUGs. As will be shown below, FUGs created earliest had a lower percentage of women in the ECs of FUGs. We may therefore advance the hypothesis that the FUGs for which the information on the number of women is not available are those with a lower proportion of them. Hence, if we think that the missing observations reflect a lower percentage of women we expect the average in the percentage of women for the available observations to be slightly higher than what it should be.

[18] To note that we exclude from the following descriptive statistics all FUGs created in the Tarai as it is not part of this analysis as outlined in note 8.

the table that as we move towards the latest years of formation the proportion of groups with a higher percentage of women is larger.[19] For example, the 45 percent of groups formed in 2010-2011 have women between the 33 and the 50 percent threshold in the ECs relative to a 41 percent of those formed between 2007 and 2009. Similarly, another 21 percent of groups formed in 2010 and 2011 has a proportion of women in ECs above the 50 percent compared to seven percent for those formed between 2007 and 2009. These patterns will be used in subsequent sections as a basis for our identification strategy.

We note also that there is a negative relationship between the area of forest handed over and the percentage of women in the ECs as groups start to have larger numbers of women (Figure 2). Interestingly groups where the ECs are composed by the one hundred percent of women, manage much smaller areas of forests. This pattern is consistent with the literature on female-dominated FUGs in Nepal (Ray-Paudyal and Buchy, 2004; Agarwal, 2010b). Indeed, in many districts women-only FUGs have been established as a result of a pressure to include women in the decision-making process of these institutions. However, these groups were usually allocated more degraded forests and smaller areas which made them even more marginalised. A similar relationship is visible between the number of households and the percentage of women. So groups with a one hundred proportion of women in the ECs on average seem to be characterised by a smaller area transferred and a lower number of households in the group. We have checked further this relationship and noticed that the average area of forest handed over to women-only groups is much lower for groups formed before or in 2009 than for those formed after 2009. This may suggest for a shift in attitudes toward the role of women after 2009.

4.3 Sample

In order to merge the FUG census to the NLSS surveys to obtain the sample used for our analysis, we select from the FUG Census only villages that have been sampled in the NLSS surveys. The FUG Database covers all villages in which FUGs have been formed, while the NLSS data are nationally representative surveys in which only a sample of villages and households have been randomly selected. Therefore, from the 17,685 FUGs in the census we end up with a sample of villages, that excludes the Tarai belt, which include 2,047 FUGs. To note that the NLSS surveys despite being representative of villages and households have not been designed to be representative of FUGs. We have checked that the characteristics and patterns are similar between all the FUGs in the census and this selected sample of villages. Table A.4 in the Appendix shows that most of the characteristics are similar to those shown in Table 1.[20] We have also plotted the average percentage

[19] As a robustness check we have looked at the same summary statistics but using a three-years grouping. The patterns look very similar to the ones shown in Table 2. The results are available upon request.

[20] To note that the sample of villages we are considering does not include the Tarai belt. Therefore some regional differences between this table and table 1 may be due to this.

of women in the ECs of FUGs against the FUG time of formation. Figure A1 in the Appendix shows a pattern mostly similar to Figure 1 above. There is, however, a bigger variation where peaks and troughs are more accentuated due to the smaller sample size. As a result the pattern is less smooth. Table A.5 in the Appendix shows, similarly to Table 2, that there is a higher proportion of groups formed in 2010 and 2011 which have a percentage of women between the 33 and 50 percent and above the 50 percent relative to those formed in earlier years.

We construct FUGs related variables at the village level as there can be more than one FUG in a village. Specifically, we create a variable for the number of FUGs in a village and we calculate the village average of other FUG characteristics (i.e., percentage of women in the ECs, area of forest handed over and number of households in the FUGs) over all FUGs formed in each village up to the end of each survey period (i.e., April 2004 and February 2011).

We can then merge at the village level, the FUG Database to the NLSS surveys from which we exclude urban and Tarai villages. Out of the 127 and the 183 villages surveyed in the 2004 and 2011 NLSS rural surveys, five and nine villages respectively did not form any FUG according to the FUG census. As a result the 95 percent of the surveyed villages in the Hills and Mountains formed at least one FUG by July 2011. As FUGs formation did not occur randomly around Nepal (Edmonds, 2002), our sample includes only villages which have formed at least a FUG at some point in time. Hence we exclude from our sample these 14 villages that did not form any FUG by July 2011. We nonetheless check whether the characteristics of villages and households in these villages are different relative to those that we select for our sample. Table A.6 in the Appendix reports these descriptive statistics. The results are consistent with the non existence of FUGs in these villages.[21]

We also exclude from our sample two villages (one from the 2004 and one from the 2011 NLSS surveys, corresponding to 24 households in total) which according to the FUG Database did form some FUGs, but only after 2009. These may be quite different villages as the process of FUG formation started in 1993. We did however a robustness check including these two villages and the results are not altered.[22]

The number of households surveyed in the two NLSS surveys in the Hills and Mountains belts are respectively 1,524 and 2,196. After excluding the villages with no FUGs according to the census and with no FUGs formed before 2010, we are left with 1,452 and 2,076 households in the sample respectively for the 2004 and 2011 NLSS surveys. We need to further reduce our sample to those

[21]Indeed, a lower percentage of households report having used firewood in the past 12 months and use firewood as a cooking fuel. Consistently a higher percentage of households use gas, oil or kerosene as a primary source of cooking fuel, which are superior type of fuels. Also there is a lower percentage of these households which collect firewood from the community forest and a higher proportion that collect from government forests. There is a higher proportion of these households which use electricity as light source and that have higher per capita nominal expenditures. Also these households appear to own or cultivate a lower number of hectares of land and own a lower number of livestock. These statistics may suggest that these households are possibly richer on average than those we consider and less dependent on forest products and agriculture for their subsistence.

[22]Results not shown and available upon request.

households that use and collect firewood in the past 12 months. These households represent the 97 and 96 percent of households respectively for the 2004 and 2011 surveys and confirms a high dependency on this resource.

There are 16 households for which the quantity of firewood is not available for the 2011 NLSS survey and these are excluded from the analysis. Finally we do not include in our analysis the four observations in the 2011 NLSS survey which have a value above 1000 for firewood collection. Looking at the distribution of the quantity of firewood collected, these values appear to be outliers. We have estimated our model including these observations and the results are not materially affected.[23] Our final sample includes 3,252 households (1,361 correspondent to the 2004 NLSS and 1,891 correspondent to the 2011 NLSS in 121 and 172 villages respectively).

4.4 Descriptive statistics

We report in Table 3 summary statistics on household and community level characteristics for the 2004 and 2011 NLSS survey samples as defined above. The average annual amount of firewood collected by the households decreased by eight percent between 2004 and 2011 which may suggest for a reduction in forest depletion.[24] Firewood is measured in bhari which is defined as roughly a bundle of wood whose size/weight depends on the person carrying it.[25]

We note that in both samples most of the households use firewood as main cooking fuel, which implies a high forest dependency. On the contrary, the proportion of households which use gas, oil or kerosene as a primary source of cooking fuel is just the 2.4 and 3.1 percent for the 2004 and 2011 surveys respectively. This implies that the use of fuels of superior quality is quite rare in this sample of rural households. The survey provides information on the place where households collect firewood and in particular whether they collect it in their own land, in community forests or in government forests. We note that the percentage of households that collect firewood in community forests is quite high and in 2011 is higher than the percentage of those that collect it in government forests. We also looked at the same descriptive statistics using the 1996 NLSS survey and we could notice that the majority of the households were collecting firewood in government forests (60 percent) and a minority in community forest (14 percent). This is a reflection of the gradual implementation of the Forestry Act in 1993. Although informative, this variable provides only imperfect information on whether households in our sample are members of FUGs.

The surveys provide some information on forest conditions and in particular survey respondents

[23] Results not shown but available upon request.

[24] We are not able to distinguish between the collection of fallen twigs (which may not imply forest degradation) and the cutting of drywood from the trees (which may generate actual forest depletion). However we use firewood collection as a measure of forest degradation consistently with the existing literature (Baland et al., 2013, 2010; Edmonds, 2002; Foster and Rosenzweig, 2003). In addition, the advantage of looking at firewood collection as a measure of forest degradation is that it is directly related to women as they are the primary collectors of this resource.

[25] For women or children carrying it, it usually corresponds to a headload.

have to say whether the area under forest decreased in the past five years and whether the time taken to collect firewood increased over the same period.[26] These variables seem to indicate that forest conditions have deteriorated between the two surveys as a higher proportion of villages seems to show a decrease in the area of forest and an increase in the time to collect firewood. We also note that the average time to collect firewood at the household level, increased by 14 percent between 2004 and 2011. However, the distance of the ward to the forest appears to have decreased. This may be interpreted as an improvement of the forest conditions in 2011 relative to 2004 as it may mean that forests partly regenerated and are now closer. In addition, the increase in collection times may also be consistent with the presence of FUGs in the villages which has imposed restrictions in access to the forests. Finally, there is a higher proportion of wards where trees have been planted by the community relative to those planted by the government or privately in both surveys. This also testifies to the role of FUGs in these villages. A lower proportion of households seem to have trees planted by the community or privately in 2011 relative to 2004. This may either indicate that the forests are in better condition and hence there is less need to replant trees or it can indicate that less efforts are put toward forest regeneration. Both interpretations are equally valid with the available information. Recent forest estimates of Nepal appear to show that despite forest conditions deteriorating in the past two decades, between 2005 and 2010 the total forest cover remained constant (FAO, 2010). This is an indication that, if anything, at least the forest conditions did not deteriorate over this period.

5 Empirical strategy

5.1 Female participation in Executive Committees and firewood collection

The objective of our analysis is to examine the effect of an increase in female participation in the ECs of FUGs on firewood collection at the household level. Therefore, we are interested in estimating the following specification:

$$Y_{hjdt} = \alpha + \beta Women_{jdt} + X_{hjdt}^{'}\delta + F_{jdt}^{'}\gamma + distr_d + distr_d * nlss2011_t + yform_{jt} + e_{hjdt} \quad (1)$$

where Y_{hjdt} is the outcome of interest (i.e., quantity of firewood at the household level) for household h living in village j of district d and surveyed in year t. $Women_{jdt}$ is the average percentage of women in ECs of FUGs formed in village j of district d up to year t and β is the estimated coefficient of interest. The term X_{hjdt} represents a set of household characteristics for household

[26] As these are subjective measures, they might not measure precisely forest conditions. For example, current and historical satellite data would be more informative about forest conditions. However, we have not been able to obtain these data for the current analysis and have to rely on the available data to account for forest conditions.

h living in village j of district d surveyed in year t. F_{jdt} are village characteristics and village level FUGs related characteristics. Specifically, we include some variables which account for forest conditions. We also include the percentage of high caste households in the community and dummies for whether there are user groups other than FUGs in the ward and whether there are development projects. These variables should partly account for the economic conditions of the village. Edmonds (2002) finds that areas more accessible, located close to markets, to forestry offices, with a higher presence of user groups other than forestry ones, with presence of agricultural technical assistance, were more likely to form groups earlier on. Finally, among the FUG related characteristics, we include the average number of FUGs in the village, the village average area of forest handed over to FUGs and the village average number of household members of FUGs. We also include district fixed effects, $distr_d$ and $distr_d * nlss2011_t$, to account for any difference across districts and a set of village level dummies which control for the year of FUGs formation, $yform_{jt}$. As areas that formed groups earlier on could have different characteristics than those that formed groups in later years, the inclusion of these dummies should account for differences between villages that formed groups earlier or later.

We assume the error term e_{hjdt} to be independent between villages but not necessarily within villages. As we anticipate observations within each village to be correlated and potentially not robust to heteroscedasticity, we estimate robust standard errors and cluster them at the village level. The above equation is estimated using an OLS model.

Identification concerns may emerge from the estimates of equation (1) as the percentage of women on the ECs of FUGs may not be exogenous to the outcome. Indeed there may be unobserved characteristics which could predict both female participation in ECs of FUGs and firewood collection. This may lead to biased estimates of equation (1). A higher participation of women in ECs of FUGs may reflect systematic characteristics of villages where the FUGs have been formed which may also have affected firewood collection. Unobserved characteristics could jointly determine female participation and firewood collection. One example of a potentially unobserved characteristic is the level of social capital within the village which may imply a general positive gender attitude accompanied by a higher awareness toward forest conservation (Agarwal, 2009a). We expect this to be positively correlated with the presence of women in the ECs of FUGs but negatively correlated with firewood collection if higher social capital changes also the attitudes toward forest protection and ultimately toward firewood collection in a way that people collect less. OLS estimates may therefore be downwardly biased if this unobservable is ignored. In order to address the potential endogeneity of female participation in ECs, we need a source of exogenous variation in the percentage of women in ECs of FUGs.

5.2 Difference-in-difference estimation strategy

In order to identify the causal effect of an increased representation of women in the Executive Committees of FUGs on firewood collection, we exploit the introduction in 2009 of the new guidelines and the fact that we can observe the outcomes before and after this change (i.e., in 2004 and in 2011).

Our identification strategy is based on the observation that the 2009 FUGs new operational guidelines, by including a new specific provision for female representation in the ECs (i.e., at least 50 percent of women should be part of the ECs),[27] increased substantially the proportion of women in groups formed after 2009 (see Figure 1). As a remark, we are not claiming here that groups formed after 2009 have 50 percent of women in the ECs of FUGs. We are only stating that as a result of the introduction of the new guidelines in 2009, which put more emphasis on female representation in these institutions, the percentage of women actually increased in groups formed after this date. Tables 2 and A.5 are also consistent with this pattern.

We exploit this source of variation for our identification strategy. The estimation framework that we propose follows a difference-in-difference (DD) identification strategy. More specifically, we compare the change in outcomes between 2004 and 2011 for households living in villages where some FUGs formed after the introduction of the new guidelines in 2009 (treated villages) to the change in outcomes over the same period for households living in villages where FUGs formed only before 2009 or in 2009 (control villages). As both treated and control villages include at least one FUG formed since the start of the programme in 1993, these villages should be comparable in many of their relevant characteristics. Therefore, the first difference compares treated to control villages. Villages in the control group are those that have formed FUGs in 2009 or in the years preceding the introduction of the new guidelines but none after 2009. While villages in the treatment group have formed FUGs after 2009 but could have also formed FUGs before. Thus, all villages in the sample may have formed FUGs in various years since the start of the programme in 1993. What distinguishes the treated villages is the fact that these villages may have *also* formed FUGs after 2009 and this is what allows us to define them as treated villages. According to our sample the percentage of treated villages is 16 percent, corresponding to 532 households out of 3,252 and to 47 villages out of 293. The second difference comes from comparing the outcome before (i.e.,2004) and after (i.e.,2011) the policy change. This allows us to control for systematic differences between treatment and control groups.

The baseline difference-in-difference specification, that we estimate using an OLS model, is of the following form:

$$Y_{hjdt} = \alpha + \beta after2009_j + \gamma nlss2011_t + \delta(after2009 * nlss2011)_{jt} + \epsilon_{hjdt} \quad (2)$$

[27] See section 3.2.

Where Y_{hjdt} is the outcome of interest (i.e., quantity of firewood collected) for household h living in village j of district d and surveyed in year t. The variable $after2009_j$ is a dummy which equals 1 if in the village FUGs were formed also after 2009 (so in 2010 and 2011) and 0 if FUGs were formed only before 2009 or in 2009. The $nlss2011_t$ variable is a dummy equal to 1 for 2011 NLSS observations and 0 otherwise. ϵ_{hjdt} defines the error term. The parameter δ is the reduced-form estimate of the effect of an increase in female participation on firewood collection (i.e., the DD coefficient). Our hypothesis is that firewood demand would decrease as a result of an increased representation of women in the ECs. We test if this is present in the data.

The underlying assumption of the identification strategy is that trends in firewood collection would have been the same in both treatment and control groups in the absence of the treatment (i.e., the treatment induces a deviation from the common trend). Indeed the existence of omitted factors correlated to both whether villages formed groups after 2009 and firewood collection, would represent a threat for our strategy. In order to account for time-invariant differences in firewood collection levels across districts we include district fixed effects. We also include district fixed effects interacted with the NLSS 2011 dummy to allow for any difference between districts for 2011 and 2004 observations. These should account for much of the time-variant unobserved heterogeneity at the district level. The inclusion of district fixed effects accounts among other things for differences in conflict intensity across Nepal over the years. Unfortunately, we do not have information on conflict exposure at a lower level than the district. However, in our sample there are, on average, three villages per district and villages are well spread across districts. Therefore, we are confident that by including district fixed effects we are accounting for most of the conflict exposure. District fixed effects should also account for donor presence. Traditionally, donors have focused their interventions at the district level (Edmonds, 2003).

However, pre-existing differential trends in firewood collection could still explain part of the results. In order to account for differences between districts over time, we should include district level trends. However, as we had to collapse the FUG census data at the village level, we do not have any variable that permits us to specify a trend. As an alternative to the inclusion of district specific trends to account for the possibility of time varying confounders, we have conducted a series of placebo experiments which we will discuss in a later section. The results from these experiments are reassuring for the validity of our identification strategy.

As discussed above, villages which formed groups in earlier years just after the reform of 1993 may be quite different from those that formed groups in more recent ones. To account for these differences, we control for whether a village formed at least one FUG in a particular year from 1993 up to 2011. We include therefore one dummy for each year of formation. We also control for the total number of FUGs formed in each village, for the village average area of forest handed over to FUGs and for the village average number of households members of FUGs.

Finally, we also estimate a specification that includes a set of other village and household controls

as in equation (1). The inclusion of these terms besides increasing precision in our estimates should also account for as much observed heterogeneity of households and villages as possible.

The *richest* specification we estimate is therefore defined as follows:

$$Y_{hjdt} = \alpha + \beta after2009_j + \gamma nlss2011_t + \delta(after2009 * nlss2011)_{jt} + \\ distr_d + distr_d * nlss2011_t + yform_{jt} + X_{hjdt}^{'}\theta + F_{jdt}^{'}\gamma + \epsilon_{hjdt} \tag{3}$$

Where all terms are defined as in equation (1). Specifically, $distr_d$ are district fixed effects, $distr_d * nlss2011_t$ are district-specific effects for each survey year, $yform_{jt}$ are a set of village dummies that equal one if in village j surveyed in year t at least one FUG was created in a particular year between 1993 and 2011. Finally, X_{hjdt} are household characteristics. F_{jdt} are village characteristics and FUGs characteristics at the village level. We assume the error term ϵ_{hjdt} to be independent between villages but not necessarily within villages. As we expect observations within each village to be correlated and not necessarily robust to heteroscedasticity, we estimate robust standard errors and cluster them at the village level.

6 Results

We present the results on the estimation of equation (1) above in Table 4. The results do not show any significant correlation between female participation in ECs of FUGs and firewood collection. Indeed, despite exhibiting a negative sign, none of the specifications yield coefficients on the village average percentage of women in ECs significantly different from zero. Therefore, these estimates seem to indicate that a higher female participation in ECs of FUGs is not related to household firewood collection. The lack of any correlation between the participation of women and firewood collection may be due to the fact that a greater participation of women in the ECs of FUGs does not necessarily imply that they actually have more power and consequently that they are able to affect outcomes (Agarwal, 2010a). A recent study does not find any persistent effect of increasing female representation on their participation in local decision making (Casey et al., 2012). A possible explanation lies in the fact that communities may be pushed toward more inclusion without actually challenging the elites who hold power (Acemoglu and Robinson, 2008). However, the reported estimates might be biased as the estimated model ignores the potential endogeneity problems of female participation in FUGs.

We report the results from our difference-in-difference estimates in table 5. The coefficient on the DD term (δ) is negative and significant across all specifications. Despite altering across specifications, the magnitude remains broadly invariant to the addition of more controls. These results tell us that between 2004 and 2011, the firewood collection of households living in villages which formed FUGs also after 2009, decreased on average by 21.4 bharis per year, as compared

to those living in villages which formed FUGs only before or in 2009. As one bhari is a bundle of firewood, the results suggest that this effect is quite large. If we think that one bundle can be one round trip, this corresponds to a bit more than 20 round trips. In order to give an interpretation of the results in percentage terms, we divide the DD coefficient of column 5 by the average firewood collection in the control villages in the pre-treatment year (i.e., in 2004) which is 90 bhari per year. The decline in household firewood collection is on average 24 percent, which represents a substantial reduction. These results therefore indicate that in villages where FUGs have a higher representation of women in the ECs, household firewood collection decreases sharply. We recall from Table 4 that the coefficients on the participation of women are not statistically significant from zero. Therefore, ignoring the possibility that there could be unobservables which may correlate with both the percentage of women in ECs of FUGs and firewood collection, would lead to downwardly biased estimates as argued in Section 5.1.

It is interesting to note that all other explanatory variables in column 5 of Table 5 are very similar in signs, significance and magnitude to those in Table 4. The coefficients on these variables provide some insights on what correlates to household firewood collection. Our results are mostly consistent with Baland et al. (2013) and Baland et al. (2010) who analyse the determinants of firewood collection and specifically the effects of increasing living standards on forest degradation. Poorer households collect less than richer ones, but at the top income level firewood collection starts to decrease. Despite consumption growth appearing to accelerate deforestation, an increase in education, non-agricultural occupations and access to other sources of fuelwood may reduce this pressure on forests, highlighting the importance of distinguishing between sources of growth when looking at the effects of poverty on environmental degradation. In particular, the wealth and substitution effects have to be distinguished to clearly establish in which direction an improvement of the economic conditions affects firewood collection and thus environmental degradation (Baland et al., 2013). Column 5 of Table 4 and Table 5 reports results which include a set of controls that try to account for the economic conditions of the households and their remoteness.[28] We also include some village level characteristics which should control for forest conditions in the year of the surveys, whether the village had natural disasters, the proportion of high caste in the village, the presence of other user groups and of development projects. These two latter variables should control for the accessibility of the village to donors and NGOs. Finally we include some FUGs characteristics.

Household size is positively associated with firewood collection. This suggests that as household size increases, the demand for firewood is higher as there is an increasing need within the household for firewood. This may also suggest that an increasing number of persons in the household, lowers the opportunity cost of firewood collection as more individuals in the household are available for

[28] We are not including household consumption as a measure of wealth of the household not only for its potential endogeneity but also because its inclusion does not allow to assess the effects of different sources of wealth and opportunity.

this task. We have decomposed the household size variable between number of children, male and female adults (results not shown). The coefficients on these terms all remain positive and significant with the biggest size of the coefficients reserved for female adults. This is consistent with the fact that women are those mostly responsible for firewood collection within the household.

Also a higher level of education of the household head relative to having no education decreases firewood collection. This may be consistent with the idea that, controlling for other sources of wealth, more educated households should be more concerned about forest degradation and hence collect less. On the other hand, households which own more livestock and more hectares of land collect a higher quantity of firewood. Baland et al. (2013) also show that an increase in livestock is associated with an increase in the quantity of firewood collected. The positive sign on the livestock coefficient reflects both the fact that livestock is a source of wealth (positive income effect) and the fact that livestock is also a productive asset, which is thus complementary to firewood collection (grazing). These two effects generate an increase in firewood collection. The positive effect on land may suggest a prevailing wealth effect. Households which use electricity as a light source collect more firewood. The availability of electricity should partly reduce the dependency on firewood. Hence these households may have less concerns over forest protection and demand more firewood. Alternatively it captures an income effect whereby as households become richer they consume more firewood.[29] A higher distance of the village to the forest is negatively correlated with the quantity of firewood collected at the household level. This is consistent with the fact that if forests are more distant, people would collect less as the opportunity cost of collecting is higher. Alternatively, larger distance to the forest may simply reflect more depleted forests which still would be negatively correlated with firewood collection. A higher percentage of high caste households in the community decreases firewood collection. This is partly consistent with Agarwal (2001) who finds that a higher percentage of high caste (i.e., Brahmins) members in the ECs improves forest conditions. Finally, a higher number of FUGs in the village and a higher average area of forest transferred to the FUGs is associated with more firewood collection. This may suggest that the presence of more FUGs and larger areas of forest distributed may have rendered firewood more available. Hence, households can thus extract more firewood.

These results offer some interesting insights on the determinants of firewood collection which are mostly consistent with other findings in the literature (Baland et al., 2013). We exploit part of this evidence in the discussion of our results.

In summary, these results seem to indicate that an increase in female participation in the ECs of FUGs decreases household's firewood collection, which is consistent with our hypothesis. Hence a higher percentage of women in decision-making position seems to prioritise sustainable extraction and thus forest conservation to satisfy their daily needs. We discuss further these results in section

[29]These explanations, consistently with the findings of Baland et al. (2013), would be in contrast to the Poverty Environment Hypothesis which predicts that an increase in wealth should be associated with a decrease in deforestation.

7.

6.1 Robustness and validity checks: placebo tests

Our identification strategy is valid only if trends in firewood collection were parallel before 2009. We have tested the validity of our identification strategy through a set of placebo tests.

In a first set of placebo experiments we estimate the same DD specification as outlined in equations (2) and (3), defining treated villages as those that are not part of our original treatment villages (i.e., villages in which no FUGs were formed in 2010 and 2011). Hence we still compare the change in outcomes between 2004 and 2011 between households living in villages where FUGs were formed only *before* the introduction of the new guidelines in 2009. Some of these villages are defined as placebo treatment villages and some as control. None of them should have experienced any policy change in terms of female representation in the ECs. If we find that the coefficients on the placebo DD terms are not significantly different from zero, we may conclude that there was no pre-treatment trend in firewood collection systematically correlated with subsequent female participation in ECs of FUGs. This would therefore reassure on the validity of our identification strategy.

Specifically, we have constructed four different placebo treatment groups by progressively excluding villages that formed groups in more recent years. The first placebo treatment group includes villages which have formed FUGs in 2008 and 2009. The control group includes villages which have formed groups only before 2008. Villages which have formed FUGs in 2010 and 2011 (our actual treatment group) are excluded from the sample. The second placebo group includes villages which have formed groups in 2007 and 2008 and the control includes those formed only before 2007. The third placebo group includes villages that formed FUGs in 2006 and 2007 and the control group includes villages which have formed groups only before 2006. Villages which have formed FUGs in 2008 or in later years are excluded from the sample. Finally, the fourth placebo treatment group includes villages which formed FUGs also in 2005 and 2006 and the control is comprised of those formed only before 2005. All other villages which formed groups in later years are excluded from the sample.

We have estimated the same specifications as in equations (2) and (3) for all regressions. The results are shown in Table 6. We do not report the coefficients on other control variables as in the main regression results, as the signs and significance are very similar and do not provide any additional information. One remark is the decreasing number of observations as we gradually exclude villages from the sample. The results show that none of the coefficients on the placebo terms (in the specification that includes all controls) is statistically significant with the exception of column 5 of Panel B where the coefficient on the DD term is significant at the 10 percent. These results are quite reassuring for our identification strategy. They suggest that by looking at the same

change in firewood collection between 2004 and 2011 but comparing villages that did not actually experience any treatment (i.e, did not form any FUG after 2009), no pre-treatment differentials in trends in firewood collection were dectected.

In order to further test the validity of our strategy we implement an alternative placebo test. For this purpose we make use of the 1996 NLSS survey and drop the 2011 NLSS from this analysis. Basically we compare the change in outcomes between 1996 and 2004 for households living in villages where some FUGs formed after 2009 to the change in outcomes over the same period for households living in villages where FUGs formed only before 2009. So here we look at the change across two years during which there has not been any policy change in terms of female participation in FUGs while mantaining the original treatment and control groups. Indeed, the treated and control villages remain the same as in our specifications of equations (2) and (3). The results in Table 7 show that the point estimate for the placebo interaction term is positive but not significantly different from zero.

7 Discussion of the results

Our estimates from the difference-in-difference model, indicate that an increase in female participation in the ECs of FUGs, identified by villages where groups formed also after 2009, decreases household's firewood collection. A higher presence of women affects the decision making process within the ECs of FUGs in a way that limits firewood extraction and ultimately improves forest conservation and regeneration. Women sitting on the ECs seem to prioritise forest conservation to ensure the satisfaction of their daily need for firewood. This result is consistent with our hypothesis and with the argument that "women often seem to have a more responsible attitude towards the forest than men because it is more important in their daily lives. They can be motivated by the thought of the additional hardship they and their children would face as a result of depleted forest reserves"(Agarwal, 2000, p.299).

The mechanisms through which a higher presence of women in the ECs may affect the quantity of firewood collected at the household level are various. The presence of more women may condition the choice of stricter or more lenient rules which define the access to forests and the extraction of firewood (Agarwal, 2009a). The quality of protection may improve, hence limiting rule violations. A higher female participation may also facilitate the spread of information around the community and hence render women more cooperative and empowered and ultimately more concerned about forest conservation. Agarwal (2000, p.289) similarly notes that "...[women] spread awareness among women of the need to conserve forests, monitor forest use, and exert social pressure on women who violate usage rules." Unfortunately, our data do not allow an exploration as to which of these mechanisms plays a bigger role.

Alternative arguments can be advanced to explain the substantial reduction in firewood collec-

tion. We discuss here reasons in support of our findings and that allow us to exclude alternative channels. First, for a given effect that the presence of FUGs may have already had on the forests, the effect we are identifying should only relate to the change in female participation in the ECs of FUGs. As our sample includes only villages which have formed at least one FUG at some point in time, we are able to control for any effect that these institutions may have had at the local level. The extent of these effects is accounted for by the inclusion of the year of formation of all FUGs created in the villages in our sample. Second, our results also hold when controlling for both the quantity of forest under the FUG managament (i.e., the area of forest transferred) and the quality of the forest (i.e., forest conditions). The area of forest that FUGs manage informs on the amount of land which users can dispose of and hence partly control for the supply of forest products. Holding the number of households members of FUGs constant, the bigger the area the higher the products available. Indeed, we obtain a positive sign on the coefficient that controls for the area of forest transferred. In addition, we control for forest conditions including the variables that inform on whether the forest decreased in the past five years and whether the time to collect firewood increased in the past five years. We already acknowledged that these variables may capture forest conditions in an imprecise way, but believe that they partly control for the quality of the forests. In addition, the distance of the community to the forest captures not only the opportunity cost of collecting firewood but also forest conditions. The more degraded the forest, the lower the amount of firewood that can be collected.

However, there is still the possibility that forest conditions and the area of forest under FUG management are not adequately controlled for. There could be an unobserved portion of these characteristics which is correlated with both female participation and firewood collection. The resulting estimates would be biased and would not reflect a causal effect of an increase in the representation of women in the ECs of FUGs on firewood collection. We acknowledged earlier a negative correlation between the area of forest and female participation in ECs of FUGs and showed also that the average area of forest transferred is substantially lower for groups which have one hundred percent of women in the ECs. The existing literature suggested that these groups have been traditionally allocated smaller areas of forest which were also more degraded. Therefore, a higher presence of women in the ECs of FUGs may simply reflect smaller and more degraded forests. As a result of this, firewood collection would decrease simply because the supply of forest products is lower. Hence, if the percentage of women is negatively correlated with the area of forest handed over and the expected sign on the area coefficient is positive (i.e., an increase in the area positively correlated with firewood collection), our estimate can be downward biased if part of this variation is left unexplained. Therefore our estimates, if biased, represent a lower bound of the true effect. Similarly, we expect also a downward bias in our estimates if we are not controlling properly for forest conditions (i.e., the quality of the forest). Indeed, we expect a negative correlation between forest condition and female participation and a positive coefficient of forest condition on firewood

collection as better forest condition would lead to a higher demand for firewood. Nonetheless, as the percentage of groups with a dominant presence of women is small, we argue that the potential bias should be small in this case.

Third, our results may simply reflect the economic and social conditions of villages where women are more represented in the ECs of FUGs. We have checked the correlations between female participation in the ECs of FUGs and some household and village conditions. Interestingly, we find that the participation of women seems to be higher in villages and households that are on average worse-off. Our richest specification includes various household and village characteristics. Therefore we should control for village and household economic status which would reflect in the demand for firewood. Our results are invariant to the inclusion of these types of variable.

Fourth, our results may just show the effect of a shift from the use of firewood to other fuels. In Table 3 we have shown that most of the households in our sample use firewood as the main cooking fuel. A negligible amount of households use dung or leaves as cooking fuels (i.e., inferior fuels) and a very small percentage of them use gas, oil or kerosene as cooking fuel (i.e., superior fuels). Therefore, we expect these channels to have no influence on our results. Furthermore, as a robustness check we have included in our richest specification also controls for the use of these types of fuels and none of the coefficients appeared to be significant in the model.[30]

Finally, the use of mud, smokeless or biogas stoves as opposed to fireplace stoves which need the use of more firewood, might drive part of our results. As shown in the descriptive statics, a small percentage of households in our sample use biogas stoves. We have included a dummy in our specification for the use of mud/smokeless stoves and for the use of biogas stoves and our results are substantially unaltered by the inclusions of these terms.[31]

8 Concluding remarks

This paper looks at the effects of an increase in female participation in the ECs of FUGs on household firewood collection in Nepal. The study is motivated by the observation that women are often neglected in the decision-making process within community level institutions devoted to the management of natural resources. However, women have a fundamental role in the management of environmental resources and forestry in particular.

We address the potential endogeneity of female participation exploiting the 2009 new provision for female representation in the EC of FUGs. This change in the guidelines increased the share of women in the ECs of groups formed after 2009. The results from our difference-in-difference model show that an increase in the average village level participation of women in ECs of FUGs, identified by villages where groups formed also after 2009, decreases the collection of firewood at the

[30] Results not shown but available upon request.
[31] Results not shown but available upon request.

household level. This result is suggestive that women are prioritising conservation and hence once in a decision-making position they favour decisions which tend to ensure a sustainable extraction of firewood. This important finding suggests that a greater focus should be put on the role of women in forestry and in general in collective action institutions.

The current analysis makes important contributions to this largely ignored, though extremely relevant, topic. This is the first study that examine the role of gender within collective action institutions looking at a vast area of Nepal and accounting for the potential endogeneity of female representation within FUGs. We contribute to a small economic literature recognising that an increase in female participation within local collective action institutions may improve the outcomes of community groups in terms of their effectiveness for the protection and management of the resource. In addition, aside from the context of forest management and more generally of natural resources, we contribute also to the growing literature on women in policy-making positions. Consistently with the findings in this literature, our results suggest that giving more voice to women can have positive consequences on outcomes related to their concerns.

The importance of the role of women in natural resource management suggests for further research on this under-researched topic. Future research should be devoted to explore the mechanisms through which a higher female participation in the Executive Committees affects the decisions and ultimately the outcomes. Interesting additional aspects that also merit attention for future research are the analysis of the effect of an increased female participation on equity in the distribution of benefits within local collective groups and on how the excess income generated within the groups is spent locally.

We deem this topic and our research question extremely important not only for the specific setting of Nepal but for any developing country which has natural resources to manage and protect that are essential to the daily lives of people. Our results indicate indeed that in countries with common property resources, the effectiveness of collective action institutions depends also on which provisions are made for the functioning of these groups, specifically in terms of the gender composition of the decision-making bodies. In addition, in countries where strong gender division roles exist, the recognition that women and men may have different preferences and interests can make a substantial difference in terms of public good provisions and ultimately in terms of household welfare.

References

Acemoglu, D. and J. A. Robinson (2008). Persistence of power, elites, and institutions. *American Economic Review 98*(1), 267–93.

Acharya, K. (2002). Twenty-four years of community forestry in nepal. *International Forestry Review 4*(2), 149–156.

Acharya, K. and P. Gentle (2006). Improving the effectiveness of collective action: sharing experiences from community forestry in nepal. Capri working papers no. 54, CGIAR Systemwide Program on Collective Action and Property Rights (CAPRi) c/o International Food Policy Research Institute, Washington DC: USA.

Adhikari, B., S. Di Falco, and J. C. Lovett (2004). Household characteristics and forest dependency: evidence from common property forest management in nepal. *Ecological Economics 48*(2), 245–257.

Adhikari, B. and J. Lovett (2006). Institutions and collective action: Does heterogeneity matter in community-based resource management? *The Journal of Development Studies 42*(3), 426–445.

Agarwal, B. (2000). Conceptualising environmental collective action: why gender matters. *Cambridge Journal of Economics 24*, 283–310.

Agarwal, B. (2001). Participatory exclusions, community forestry, and gender: An analysis for south asia and a conceptual framework. *World Development 29*(10), 1623–1648.

Agarwal, B. (2007). Gender inequality, cooperation and environmental sustainability. In J. Baland, P. Bardhan, and S. Bowles (Eds.), *Inequality, Cooperation and Environmental Sustainability*, pp. 274–313. Princeton: Princeton University Press.

Agarwal, B. (2009a). Gender and forest conservation: The impact of women's participation in community forest governance. *Ecological Economics 68*(11), 2785–2799.

Agarwal, B. (2009b). Rule making in community forestry institutions: The difference women make. *Ecological Economics 68*(8-9), 2296–2308.

Agarwal, B. (2010a). Does women's proportional strength affect their participation? governing local forests in south asia. *World Development 38*(1), 98–112.

Agarwal, B. (2010b). *Gender and Green Governance: The Political Economy of Women's Presence Within and Beyond Community Forestry*. Oxford University Press.

Agrawal, A. (2001). Common property institutions and sustainable governance of resources. *World Development 29*(10), 1649–1672.

Agrawal, A. and K. Gupta (2005). Decentralization and participation: The governance of common pool resources in nepal's terai. *World Development 33*(7), 1101 – 1114.

Alesina, A. and E. La Ferrara (2000). Participation in heterogeneous communities. *The Quarterly Journal of Economics 115*(3), 847–904.

Baland, J., P. Bardhan, and S. Bowles (2007). *Inequality, cooperation, and environmental sustainability*. Princeton: Russell Sage Foundation, Princeton University Press.

Baland, J.-M., 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.

Baland, J.-M., P. Bardhan, S. Das, D. Mookherjee, and R. Sarkar (2010). The environmental impact of poverty: Evidence from firewood collection in rural nepal. *Economic Development and Cultural Change 59*(1), 23–61.

Baland, J.-M., F. Libois, and D. Mookherjee (2013). Firewood collections and economic growth in rural nepal 1995-2010: Evidence from a household panel. CEPR Discussion Paper Series 9394, Centre for Economic Policy Research (CEPR).

Baland, J.-M. and J.-P. Platteau (1996). *Halting Degradation of Natural Resources: Is There a Role for Rural Communities?* Oxford University Press.

Bardhan, P. (1993). Symposium on management of local commons. *Journal of Economic Perspectives 7*(4), 87–92.

Bardhan, P. and J. Dayton-Johnson (2007). Inequality and the governance of water resources in mexico and south india. In J. Baland, P. Bardhan, and S. Bowles (Eds.), *Inequality, Cooperation and Environmental Sustainability*, pp. 97–130. Princeton: Princeton University Press.

Beaman, L., R. Chattopadhyay, E. Duflo, R. Pande, and P. Topalova (2009). Powerful women: Does exposure reduce bias? *The Quarterly Journal of Economics 124*(4), 1497–1540.

Casey, K., R. Glennerster, and E. Miguel (2012). Reshaping institutions: Evidence on aid impacts using a preanalysis plan. *The Quarterly Journal of Economics 127*(4), 1755–1812.

CBS (2004). Nepal living standard survey 2003/2004. Statistical report, volume one, Central Bureau of Statistics, National Planning Commission Secretariat His Majesty's Government of Nepal, Kathmandu.

CBS (2011). Nepal living standard survey 2010/2011. Statistical report, volume one, Central Bureau of Statistics, National Planning Commission Secretariat Government of Nepal, Kathmandu.

Chattopadhyay, R. and E. Duflo (2004, 09). Women as policy makers: Evidence from a randomized policy experiment in india. *Econometrica 72*(5), 1409–1443.

Chhetri, R. B. (2006). From protection to poverty reduction: A review of forestry policies and practices in nepal. *Journal of Forest and Livelihood 5*(1), 66–77.

Clots-Figueras, I. (2012). Are female leaders good for education?: Evidence from india. *American Economic Journal: Applied Economics 4*(1), 212–244.

Cooke, P. A. (1998). Intrahousehold labor allocation responses to environmental good scarcity: A case study from the hills of nepal. *Economic Development and Cultural Change 46*(4), 807–30.

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

Edmonds, E. V. (2003). Development assistance and the construction of government-initiated community institutions. *Economic Development and Cultural Change 51*(4), pp. 897–928.

FAO (2010). Global forest resources assessment 2010 nepal. Country report, Food and Agriculture Organization, Rome.

Foster, A. D. and M. R. Rosenzweig (2003). Economic growth and the rise of forests. *The Quarterly Journal of Economics 118*(2), 601–637.

Gautam, A. P., G. P. Shivakoti, and E. L. Webb (2004). A review of forest policies, institutions, and changes in the resource condition in nepal. *International Forestry Review 6*(2), 136–148.

Hardin, G. (1968). The tragedy of the commons. *Science 162*, 1243–1248.

HMGN (1993a). Forest act, 1993. His Majesty's Government of Nepal (HMGN)/USAID, Ministry of Forest and Soil Conservation, Forestry Development Project.

HMGN (1993b). Forest regulation, 1995. His Majesty's Government of Nepal (HMGN)/USAID, Ministry of Forest and Soil Conservation, Forestry Development Project.

Hobley, M. and D. Shakya (2012). Persistence and change: Review of 30 years of community forestry in nepal. Volume 4 national case study/literature review, HURDEC Nepal, Mary Hobley and ERI.

Kanel, K. (2004). Twenty-five years of community forestry: Contribution to millennium development goals. In K. R. Kanel, P. Mathema, B. Kandel, D. Niraula, A. Sharma, and M. Gautam (Eds.), *Twenty-five Years of Community Forestry: Proceedings of the Fourth National Workshop on Community Forestry*, pp. 4–18. Kathmandu: Community Forestry Division, Department of Forests.

Kumar, N. (2002). The challenges of community participation in forest development in nepal. Report, The World Bank Operations Evaluation Department, The World Bank, Washington DC.

Mai, Y., E. Mwangi, and M. Wan (2011). Gender analysis in forestry research: looking back and thinking ahead. *International Forestry Review 13*(2), 245–258.

Malla, Y., H. Neupane, and P. Branney (2003). Why aren't poor people benefiting more from community forestry? *Journal of Forests and Livelihoods 3*(1), 78–91.

MFSC (2001). Guidelines for community forestry development programme, revised edition 2058. His Majesty's Government of Nepal (HMGN), Ministry of Forests and Soil Conservation (MFSC), Department of Forests, Community Forestry Division, Babar Mahal, Kathmandu.

MFSC (2009). Guidelines for community forestry development programme, second revision 2009. Government of Nepal, Ministry of Forests and Soil Conservation (MFSC), Department of Forests, Community Forest Division, Babar Mahal, Kathmandu.

MFSC (2011). Cfug database. Government of Nepal, Ministry of Forests and Soil Conservation (MFSC), Department of Forests, Community Forest Division, Babar Mahal, Kathmandu.

MFSC (2012). Forest sector gender and social inclusion strategy. Report, Ministry of Forest and Soil Conservation, Singhadurbar, Kathmandu.

Ojha, H., D. R. Khanal, N. Sharma, H. Sharma, and P. Bharati (2007). Federation of community forest user groups in nepal: An innovation in democratic forest governance. Proceedings: International Conference on Poverty Reduction and Forests, September, Bangkok.

Ojha, H. R., N. P. Timsina, C. Kumar, M. R. Banjade, B. Belcher, R. Chhetri, and A. Nightingale (2008). Community-based forest management programmes in nepal: An overview of contexts, policies, practices and issues. In H. R. Ojha, , N. P. Timsina, C. Kumar, M. R. Banjade, and B. Belcher (Eds.), *Communities, Forests and Governance: Policy and Institutional Innovations from Nepal*, pp. 15–43. New Delhi: Adroit.

Olson, M. (1965). *The Logic of Collective Action: Public Goods and the Theory of Groups*. Cambridge: Harvard University Press.

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

Pokharel, B. K., P. Branney, M. Nurse, and Y. B. Malla (2008). Community forestry: Conserving forests, sustaining livelihoods and strenghtening democracy. In H. R. Ojha, , N. P. Timsina,

C. Kumar, M. R. Banjade, and B. Belcher (Eds.), *Communities, Forests and Governance: Policy and Institutional Innovations from Nepal*, pp. 44–80. New Delhi: Adroit.

Pradhan, G. D. (2010). Gender equality and social inclusion strategy. Report, UNDP, Comprehensive Disaster Risk Management Programme (CDRMP).

Ray-Paudyal, B. and M. Buchy (2004). Institutional exclusion of women in community forestry. is women-only strategy a right answer? In 25 Years of Community Forestry. Proceedings of the 4th National Workshop on Community Forestry, 4-6 August. Community Forestry Division, Department of Forest, Kathmandu, Nepal.

Sun, Y., E. Mwangi, and R. Meinzen-Dick (2011). Is gender an important factor influencing user groups' property rights and forestry governance? empirical analysis from east africa and latin america. *International Forestry Review 13*(2), 205–219.

Thoms, C. (2008). Community control of resources and the challenge of improving local livelihoods: A critical examination of community forestry in nepal. *Geoforum 39*(3), 1452–1465.

Wade, R. (1987). The management of common property resources: Collective action as an alternative to privatisation or state regulation. *Cambridge Journal of Economics 11*(2), 95–106.

Yadav, B. D., H. Bigsby, and I. MacDonald (2008). Who are controlling community forestry user groups in nepal? scrutiny of elite theory. Paper presented at the New Zealand Agricultural and Resource Economics Society Conference. August 28-29, 2008, Nelson, New Zealand.

Figures

Figure 1: Percentage of women in ECs of FUGs by year of FUGs formation

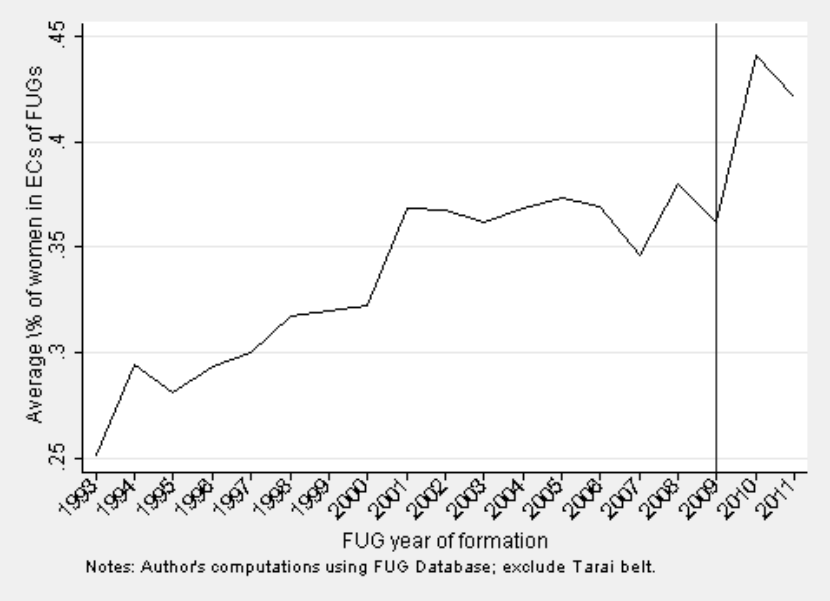
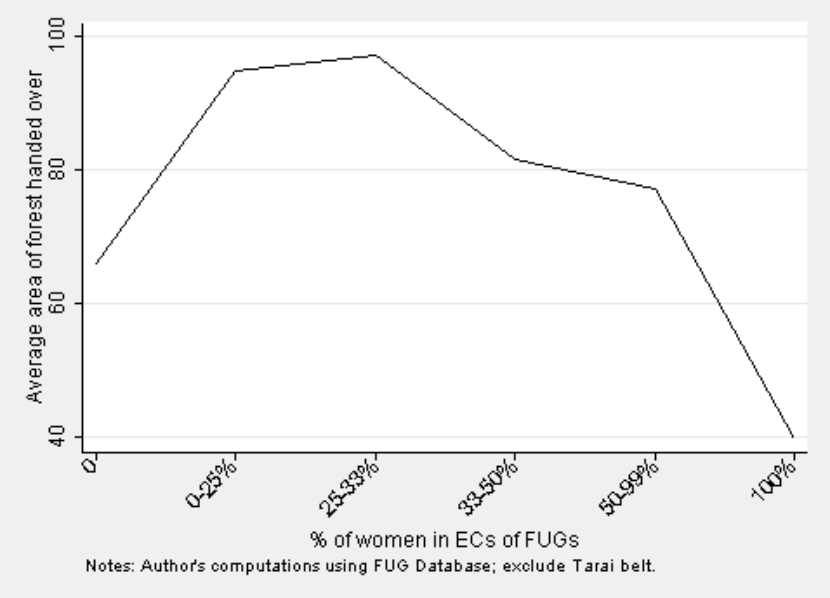


Figure 2: Percentage of women in ECs of FUGs and area of forest handed over



Tables

Table 1: FUGs characteristics - Census data

	Obs.	Mean	St.Dev.	Min	Max
Eastern region	17685	0.175	0.380	0	1
Central region	17685	0.223	0.416	0	1
Western region	17685	0.261	0.439	0	1
Mid Western region	17685	0.216	0.412	0	1
Far Western region	17685	0.125	0.331	0	1
Mountains	17685	0.142	0.349	0	1
Hills	17685	0.743	0.437	0	1
Tarai	17685	0.116	0.320	0	1
Forest handed over (Ha)	17675	92.144	164.542	0	5698
Number of households in the group	17660	123.322	148.858	0	4690
Number of EC members	17181	11.584	2.747	0	39
Percentage of women in EC	16108	0.333	0.226	0	1

Notes: Author's computations using FUG Database.

Table 2: Average percentage of women in ECs of FUGs - Census data

	All	1993-2000	2001-2006	2007-2009	2010-2011
% women in ECs=0	0.018	0.023	0.009	0.009	0.008
% women in ECs between 0-25%	0.396	0.474	0.310	0.230	0.117
% women in ECs between 25-33%	0.182	0.177	0.188	0.225	0.141
% women in ECs between 33-50%	0.271	0.213	0.332	0.410	0.454
% women in ECs between 50-99%	0.078	0.066	0.081	0.071	0.212
% women in ECs =100%	0.056	0.046	0.080	0.056	0.068
Observations	13814	8747	2922	1420	725

Notes: Author's computations using FUG Database; Exclude Tarai belt.

Table 3: Summary statistics for rural household and village characteristics

	2004				2011			
	Mean	St.Dev.	Min	Max	Mean	St.Dev	Min	Max
Quantity firewood collected (Bhari/year)	91.007	52.424	12	360	83.555	60.599	0	600
Time to collect firewood (Hours/bhari)	3.471	1.669	0	12	3.910	1.876	1	10
Use firewood past 12 months	1.000	0.000	1	1	1.000	0.000	1	1
Collect firewood past 12 months	1.000	0.000	1	1	1.000	0.000	1	1
Collect firewood in own land	0.270	0.444	0	1	0.257	0.437	0	1
Collect firewood in community forest	0.345	0.476	0	1	0.468	0.499	0	1
Collect firewood in government forest	0.342	0.475	0	1	0.234	0.424	0	1
Collect firewood in other forest	0.043	0.203	0	1	0.041	0.198	0	1
Electric light source	0.216	0.412	0	1	0.481	0.500	0	1
Gas,Oil,Kerosene light source	0.681	0.466	0	1	0.309	0.462	0	1
Use firewood as cooking fuel	0.971	0.167	0	1	0.964	0.186	0	1
Use dung/leaves as cooking fuel	0.005	0.071	0	1	0.005	0.068	0	1
Gas,Oil,Kerosene as cooking fuel	0.024	0.152	0	1	0.031	0.174	0	1
Fireplace stove	0.560	0.497	0	1	0.471	0.499	0	1
Mud/Smokeless stove	0.407	0.491	0	1	0.485	0.500	0	1
Kerosene/gas stove	0.034	0.180	0	1	0.045	0.206	0	1
HH size	5.109	2.219	1	17	4.823	2.144	1	15
HH head female	0.227	0.419	0	1	0.283	0.451	0	1
HH head married	0.835	0.371	0	1	0.860	0.347	0	1
HH head age	46.336	14.650	14	91	47.070	14.461	14	95
HH head migrated	0.317	0.466	0	1	0.259	0.438	0	1
HH head any compl edu	0.656	0.475	0	1	0.558	0.497	0	1
HH head completed primary education	0.167	0.373	0	1	0.239	0.426	0	1
HH head completed secondary/higher education	0.177	0.382	0	1	0.204	0.403	0	1
Own any land	0.956	0.205	0	1	0.971	0.167	0	1
Hectares land owned/cultivated	0.768	0.741	0	10	0.709	0.793	0	17
Land size very small (0-0.2 ha)	0.120	0.325	0	1	0.125	0.331	0	1
Land size small (0.2-1 ha)	0.611	0.488	0	1	0.651	0.477	0	1
Land size medium (1-2 ha)	0.191	0.393	0	1	0.175	0.380	0	1
Land size large (>2 ha)	0.059	0.236	0	1	0.035	0.184	0	1
Own any livestock	0.956	0.205	0	1	0.966	0.183	0	1
Number of livestocks owned	12.145	10.132	0	83	12.377	9.833	0	89
Number of big livestocks owned	7.046	5.691	0	42	6.905	5.662	0	52
Hindu	0.800	0.400	0	1	0.808	0.394	0	1
Buddhist	0.141	0.348	0	1	0.113	0.317	0	1
Paved Road less than 1 hour away from HH	0.132	0.339	0	1	0.190	0.392	0	1
Paved Road 1-2 hours away from HH	0.111	0.314	0	1	0.163	0.369	0	1
Paved Road 2-4 hours away from HH	0.160	0.367	0	1	0.246	0.431	0	1
Paved Road 4-12 hours away from HH	0.259	0.438	0	1	0.194	0.395	0	1
Paved Road more than 12 hours away from HH	0.338	0.473	0	1	0.208	0.406	0	1
% of high caste hh in ward above 50%	0.505	0.500	0	1	0.460	0.499	0	1
Distance of ward to forest(hours)	1.347	1.139	0	5	1.168	1.179	0	10
Area Under Forest Decreased past 5 years	0.265	0.442	0	1	0.358	0.480	0	1
Time Taken to collect avg Bhari increased past 5 years	0.380	0.486	0	1	0.504	0.500	0	1
Trees planted privately past 5 years	0.234	0.424	0	1	0.092	0.289	0	1
Trees planted by community past 5 years	0.498	0.500	0	1	0.253	0.435	0	1
Trees planted by government past 5 years	0.063	0.243	0	1	0.036	0.187	0	1
Any user group in ward	0.669	0.471	0	1	1.000	0.000	1	1
Any development project in ward	0.720	0.449	0	1	0.955	0.207	0	1
Any natural disaster past 5 years	0.513	0.500	0	1	0.348	0.476	0	1
Ward population	789.278	746.009	104	4817	786.256	595.535	0	5000
Observations	1361				1891			

Notes: Author's computations using 2004 and 2011 NLSS surveys; the sample excludes Tarai belt and includes only villages with at least one FUG that have been sampled in the NLSS surveys; it includes only households which use and collect firewood.

Table 4: Determinants of quantity of firewood collected and female participation

	(1)	(2)	(3)	(4)	(5)
Village average % of women in ECs of FUGs	-16.523	-28.189	-16.489	-19.454	-8.870
	(15.648)	(18.940)	(17.349)	(17.112)	(16.367)
Nlss 2011		-5.616	-74.274***	-73.993***	-82.099***
		(3.622)	(6.077)	(5.866)	(9.871)
HH size					5.798***
					(0.493)
HH head migrated					-2.297
					(2.261)
HH head completed primary education					-4.594*
					(2.394)
HH head completed secondary/higher education					-1.974
					(2.391)
Electric light source					10.602***
					(3.417)
Number of livestocks owned					0.632***
					(0.133)
Hectares land owned/cultivated					2.638*
					(1.389)
Paved Road less than 1 hour away from HH					-1.511
					(6.720)
Paved Road 1-2 hours away from HH					1.504
					(6.468)
Paved Road 2-4 hours away from HH					2.966
					(5.698)
Paved Road 4-12 hours away from HH					2.051
					(4.649)
Distance of ward to forest(hours)					-3.687***
					(1.420)
Area Under Forest Decreased past 5 years					4.197
					(4.179)
Time Taken to collect avg Bhari increased past 5 years					-4.474
					(4.094)
% of high caste hh in ward above 50%					-9.780***
					(3.166)
Any user group in ward					-2.664
					(5.926)
Any development project in ward					-4.231
					(5.911)
Any natural disaster past 5 years					-3.272
					(3.071)
Number of FUGs in village					0.821*
					(0.425)
Village average FUGs area					0.034***
					(0.012)
Village average FUGs number of households					-0.008
					(0.019)
District FE	No	Yes	Yes	Yes	Yes
District FE * Nlss 2011	No	No	Yes	Yes	Yes
FUG year of formation	No	No	No	Yes	Yes
Obs.	3205	3205	3205	3205	3205
R-squared	0.001	0.090	0.166	0.184	0.274

Notes: Author's computations using 2004, 2011 NLSS surveys and FUG Database. Dependent variable: quantity of firewood (bhari/year). All columns show estimates with robust standard errors in parenthesis clustered at the village level. Reference categories: HH head with no education; paved road more than 12 hours away from HH. * p<0.10, ** p<0.05, *** p<0.01.

Table 5: Determinants of quantity of firewood collected and female participation: difference-in-difference estimates

	(1)	(2)	(3)	(4)	(5)
After 2009*Nlss 2011	-20.965*	-17.843*	-25.282*	-25.692**	-21.354**
	(12.689)	(10.660)	(13.723)	(12.044)	(10.790)
Nlss 2011	-2.532	-3.536	-73.348***	-74.173***	-83.653***
	(4.007)	(3.778)	(6.098)	(5.478)	(9.970)
After 2009	6.368	13.763	23.087*	16.796	12.212
	(11.253)	(11.132)	(12.156)	(14.108)	(12.915)
HH size					5.855***
					(0.485)
HH head migrated					-2.365
					(2.195)
HH head completed primary education					-4.237*
					(2.382)
HH head completed secondary/higher education					-1.490
					(2.424)
Electric light source					10.265***
					(3.420)
Hectares land owned/cultivated					2.490*
					(1.399)
Number of livestocks owned					0.620***
					(0.132)
Paved Road less than 1 hour away from HH					-0.154
					(6.580)
Paved Road 1-2 hours away from HH					2.205
					(6.263)
Paved Road 2-4 hours away from HH					3.272
					(5.551)
Paved Road 4-12 hours away from HH					1.148
					(4.672)
Distance of ward to forest(hours)					-3.765***
					(1.335)
Area Under Forest Decreased past 5 years					4.659
					(4.142)
Time Taken to collect avg Bhari increased past 5 years					-3.803
					(4.040)
% of high caste hh in ward above 50%					-9.995***
					(3.184)
Any user group in ward					-1.771
					(5.468)
Any development project in ward					-4.425
					(5.308)
Any natural disaster past 5 years					-4.356
					(2.951)
Number of FUGs in village					0.872**
					(0.422)
Village average FUGs area					0.037***
					(0.011)
Village average FUGs number of households					-0.013
					(0.017)
District FE	No	Yes	Yes	Yes	Yes
District FE * Nlss 2011	No	No	Yes	Yes	Yes
FUG year of formation	No	No	No	Yes	Yes
Obs.	3252	3252	3252	3252	3252
R-squared	0.009	0.091	0.169	0.185	0.275

Notes: Author's computations using 2004, 2011 NLSS surveys and FUG Database. Dependent variable: quantity of firewood (bhari/year). All columns show estimates with robust standard errors in parenthesis clustered at the village level. Reference categories: HH head with no education; paved road more than 12 hours away from HH. * p<0.10, ** p<0.05, *** p<0.01.

Table 6: Placebo regressions for determinants of quantity of firewood collected (1)

	(1)	(2)	(3)	(4)	(5)
Panel A					
After 2007*Nlss 2011	4.595	2.604	2.028	0.415	8.405
	(9.013)	(9.233)	(9.286)	(9.175)	(10.452)
Nlss 2011	-3.537	-3.905	-73.348***	-71.464***	-81.471***
	(4.580)	(4.234)	(6.115)	(6.255)	(9.259)
After 2007	-5.873	-0.768	0.230	-20.689	-17.278
	(5.862)	(7.790)	(6.852)	(13.785)	(16.916)
District FE	No	Yes	Yes	Yes	Yes
District FE * Nlss 2011	No	No	Yes	Yes	Yes
FUG year of formation	No	No	No	Yes	Yes
Controls	No	No	No	No	Yes
Obs.	2720	2720	2720	2720	2720
R-squared	0.001	0.080	0.165	0.177	0.274
Panel B					
After 2006*Nlss 2011	-5.153	-3.517	10.674	11.615	17.533*
	(9.384)	(9.982)	(9.335)	(9.637)	(9.558)
Nlss 2011	-2.974	-3.886	-73.348***	-71.357***	-82.413***
	(4.830)	(4.491)	(6.121)	(6.870)	(9.807)
After 2006	-0.320	-2.560	-7.915	-19.908	-21.008
	(6.037)	(8.459)	(5.925)	(12.238)	(14.550)
District FE	No	Yes	Yes	Yes	Yes
District FE * Nlss 2011	No	No	Yes	Yes	Yes
FUG year of formation	No	No	No	Yes	Yes
Controls	No	No	No	No	Yes
Obs.	2511	2511	2511	2511	2511
R-squared	0.002	0.086	0.173	0.186	0.284
Panel C					
After 2005*Nlss 2011	5.162	15.977	16.080	17.163	7.409
	(11.356)	(13.423)	(10.494)	(11.087)	(10.000)
Nlss 2011	-3.938	-5.804	-73.348***	-67.361***	-70.965***
	(4.988)	(4.554)	(6.133)	(7.909)	(10.265)
After 2005	-8.914	-11.373	-7.008	-11.495	3.917
	(7.385)	(10.161)	(5.985)	(14.415)	(14.563)
District FE	No	Yes	Yes	Yes	Yes
District FE * Nlss 2011	No	No	Yes	Yes	Yes
FUG year of formation	No	No	No	Yes	Yes
Controls	No	No	No	No	Yes
Obs.	2263	2263	2263	2263	2263
R-squared	0.002	0.101	0.180	0.198	0.300
Panel D					
After 2004*Nlss 2011	20.439	28.251	23.289	32.469*	21.563
	(15.166)	(19.292)	(14.210)	(16.740)	(15.679)
Nlss 2011	-5.165	-7.365	-73.348***	-69.360***	-74.127***
	(4.994)	(4.520)	(6.143)	(7.710)	(9.646)
After 2004	-10.779	-14.058	-5.621	-35.776	58.139
	(7.436)	(12.198)	(5.922)	(22.162)	(37.479)
District FE	No	Yes	Yes	Yes	Yes
District FE * Nlss 2011	No	No	Yes	Yes	Yes
FUG year of formation	No	No	No	Yes	Yes
Controls	No	No	No	No	Yes
Obs.	2076	2076	2076	2076	2076
R-squared	0.004	0.119	0.198	0.214	0.316

Notes: Author's computations using 2004, 2011 NLSS surveys and FUG Database. Dependent variable: quantity of firewood (bhari/year). Results are obtained using difference-in-difference estimation strategy. All columns show estimates with robust standard errors in parenthesis clustered at the village level. * p<0.10, ** p<0.05, *** p<0.01.

Table 7: Placebo regressions for determinants of quantity of firewood collected (2)

	(1)	(2)	(3)	(4)	(5)
After 2009*Nlss 2004	6.488	6.057	5.879	13.283	17.549
	(16.813)	(15.111)	(15.247)	(16.561)	(14.002)
Nlss 2004	-15.511***	-17.480***	-16.940	-17.682	-22.549
	(5.041)	(3.902)	(20.302)	(20.804)	(17.982)
After 2009	-0.120	11.223	17.208*	12.108	-8.178
	(12.486)	(11.465)	(9.135)	(12.408)	(10.485)
District FE	No	Yes	Yes	Yes	Yes
District FE * Nlss 2004	No	No	Yes	Yes	Yes
FUG year of formation	No	No	No	Yes	Yes
Controls	No	No	No	No	Yes
Obs.	2643	2643	2643	2643	2580
R-squared	0.016	0.202	0.305	0.319	0.432

Notes: Author's computations using 1996, 2004 NLSS surveys and FUG Database. Dependent variable: quantity of firewood (bhari/year). Results are obtained using difference-in-difference estimation strategy. All columns show estimates with robust standard errors in parenthesis clustered at the village level. * p<0.10, ** p<0.05, *** p<0.01.

A Appendix

Figure A1: Percentage of women in ECs of FUGs by year of FUGs formation

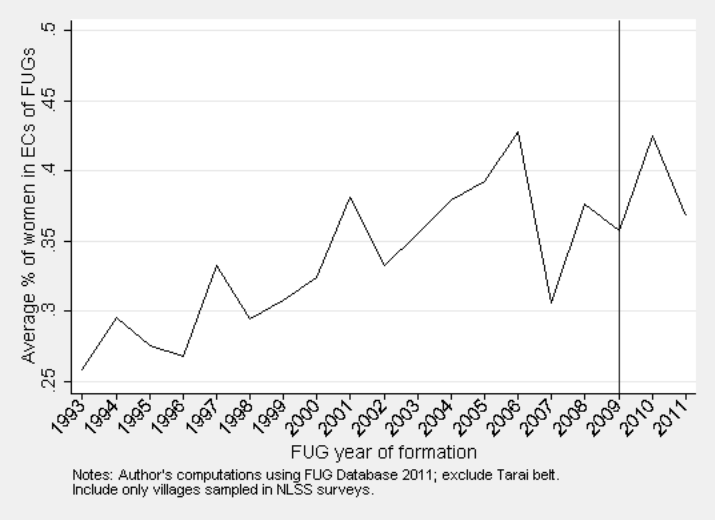


Table A.1: FUG characteristics on observations with missing information on women in ECs - Census data

	Obs.	Mean	St.Dev.	Min	Max
Eastern region	1577	0.098	0.297	0	1
Central region	1577	0.201	0.401	0	1
Western region	1577	0.238	0.426	0	1
Mid Western region	1577	0.188	0.391	0	1
Far Western region	1577	0.275	0.447	0	1
Mountains	1577	0.101	0.301	0	1
Hills	1577	0.741	0.438	0	1
Tarai	1577	0.159	0.365	0	1
Forest handed over (Ha)	1573	77.868	137.852	0	2591
Number of households in the group	1570	130.662	198.497	0	4334
Number of EC members	1073	11.027	2.949	0	27

Notes: Author's computations using FUG Database. Include only observations with missing information on percentage of women in ECs.

Table A.2: Test on whether the percentage of women is significantly above trend (1)

	(1)	(2)
Trend	0.008***	0.007***
	(0.000)	(0.000)
FUG formed after 2009		0.035***
		(0.009)
Obs.	13814	13814
R-squared	0.034	0.035

Notes: Author's computations using FUG Database.
* p<0.10, ** p<0.05, *** p<0.01

Table A.3: Test on whether the percentage of women is significantly above trend (2)

	(1)	(2)	(3)	(4)
Year of formation=1993	-0.110***	-0.128***	-0.095***	-0.117***
	(0.010)	(0.011)	(0.012)	(0.015)
Year of formation=1994	-0.067***	-0.085***	-0.052***	-0.074***
	(0.010)	(0.011)	(0.012)	(0.015)
Year of formation=1995	-0.080***	-0.098***	-0.065***	-0.087***
	(0.009)	(0.011)	(0.012)	(0.014)
Year of formation=1996	-0.068***	-0.086***	-0.053***	-0.076***
	(0.010)	(0.011)	(0.012)	(0.014)
Year of formation=1997	-0.062***	-0.080***	-0.047***	-0.069***
	(0.010)	(0.011)	(0.012)	(0.015)
Year of formation=1998	-0.044***	-0.062***	-0.029**	-0.052***
	(0.010)	(0.012)	(0.013)	(0.015)
Year of formation=1999	-0.042***	-0.059***	-0.027**	-0.049***
	(0.011)	(0.012)	(0.013)	(0.015)
Year of formation=2000	-0.039***	-0.057***	-0.024*	-0.046***
	(0.011)	(0.012)	(0.013)	(0.015)
Year of formation=2001	0.006	-0.012	0.021	-0.001
	(0.012)	(0.013)	(0.014)	(0.016)
Year of formation=2002	0.006	-0.012	0.021	-0.001
	(0.013)	(0.014)	(0.015)	(0.017)
Year of formation=2003	0.000	-0.018	0.015	-0.007
	(0.013)	(0.014)	(0.015)	(0.017)
Year of formation=2004	0.007	-0.011	0.022	-0.000
	(0.013)	(0.014)	(0.015)	(0.017)
Year of formation=2005	0.012	-0.006	0.027	0.004
	(0.015)	(0.016)	(0.017)	(0.018)
Year of formation=2006	0.007	-0.011	0.022	
	(0.015)	(0.016)	(0.017)	
Year of formation=2007	-0.015	-0.033**		-0.022
	(0.013)	(0.014)		(0.017)
Year of formation=2008	0.018		0.033**	0.011
	(0.012)		(0.014)	(0.016)
Year of formation=2010	0.079***	0.061***	0.094***	0.072***
	(0.012)	(0.013)	(0.014)	(0.016)
Year of formation=2011	0.059***	0.041**	0.074***	0.052***
	(0.017)	(0.017)	(0.018)	(0.020)
Year of formation=2009		-0.018	0.015	-0.007
		(0.012)	(0.013)	(0.015)
Obs.	13814	13814	13814	13814
R-squared	0.040	0.040	0.040	0.040

Notes: Author's computations using FUG Database; Reference categories: in column 1 is year formation=2009, in column 2 is year of formation=2008, in column 3 is year formation=2007, in column 4 is year formation=2006; p<0.10, ** p<0.05, *** p<0.01.

Table A.4: FUG characteristics - Census data (include only villages sampled in NLSS surveys)

	count	mean	sd	min	max
Eastern region	2047	0.166	0.372	0	1
Central region	2047	0.282	0.450	0	1
Western region	2047	0.271	0.444	0	1
Mid Western region	2047	0.189	0.392	0	1
Far Western region	2047	0.093	0.290	0	1
Mountains	2047	0.154	0.361	0	1
Hills	2047	0.846	0.361	0	1
Number of FUGs per village	2047	11.693	7.032	1	36
Forest handed over (Ha)	2045	88.439	167.604	0	4500
Number of households in the group	2046	115.600	91.357	0	1209
Number of EC members	2006	11.621	2.601	0	25
% of women in EC	1905	0.326	0.213	0	1

Notes: Author's computations using FUG Database. Exclude Tarai belt. Include only villages sampled in NLSS surveys.

Table A.5: Average percentage of women in ECs of FUGs - Census data (include only villages sampled in NLSS surveys)

	All	1993-2000	2001-2006	2007-2009	2010-2011
% women in ECs=0	0.024	0.032	0.009	0.020	0.010
% women in ECs between 0-25%	0.376	0.468	0.257	0.239	0.163
% women in ECs between 25-33%	0.205	0.187	0.226	0.269	0.184
% women in ECs between 33-50%	0.277	0.221	0.357	0.343	0.429
% women in ECs between 50-99%	0.062	0.049	0.068	0.080	0.143
% women in ECs=100%	0.056	0.044	0.083	0.050	0.071
Observations	1905	1140	456	201	98

Notes: Author's computations using FUG Database. Exclude Tarai belt. Include only villages sampled in NLSS surveys

Table A.6: Comparison of average household and village characteristics between villages with and without FUGs

	2004			2011		
	With FUGs	Without FUGs	Diff.	With FUGs	Without FUGs	Diff.
Eastern	0.207	0.200	0.007	0.214	0.111	0.103**
Central	0.306	0.200	0.106	0.260	0.556	-0.295***
Western	0.240	0.400	-0.160*	0.214	0.222	-0.008
Mid-west	0.165	0.200	-0.035	0.185	0.111	0.074*
Far-west	0.083	0.000	0.083***	0.127	0.000	0.127***
hills	0.760	0.600	0.160*	0.844	0.889	-0.045
Quantity firewood collected (Bhari/year)	90.996	95.750	-4.754	84.884	104.263	-19.379*
Time to collect firewood (Hours/bhari)	3.526	4.104	-0.578*	3.889	4.501	-0.612
Use firewood past 12 months	0.974	0.817	0.157**	0.965	0.611	0.354***
Collect firewood past 12 months	0.963	0.980	-0.017	0.954	0.879	0.075
Collect firewood in own land	0.263	0.208	0.055	0.250	0.362	-0.112
Collect firewood in community forest	0.337	0.167	0.170**	0.475	0.293	0.182**
Collect firewood in government forest	0.357	0.583	-0.226**	0.235	0.310	-0.075
Collect firewood in other forest	0.043	0.042	0.002	0.040	0.034	0.005
Electric light source	0.242	0.383	-0.142*	0.496	0.713	-0.217***
Gas,Oil,Kerosene light source	0.652	0.383	0.269***	0.297	0.148	0.149***
Use firewood as cooking fuel	0.944	0.817	0.128*	0.921	0.556	0.365***
Use dung/leaves as cooking fuel	0.008	0.000	0.008***	0.006	0.028	-0.022
Gas,Oil,Kerosene as cooking fuel	0.048	0.183	-0.136**	0.074	0.417	-0.343***
HH size	5.046	4.367	0.679**	4.761	4.111	0.650**
HH head female	0.223	0.250	-0.027	0.281	0.167	0.114**
HH head married	0.824	0.783	0.041	0.857	0.815	0.043
HH head age	46.663	43.367	3.296	46.824	48.370	-1.546
HH head migrated	0.318	0.500	-0.182**	0.289	0.343	-0.054
HH head any compl edu	0.647	0.717	-0.070	0.536	0.500	0.036
HH head completed primary education	0.164	0.133	0.031	0.233	0.148	0.085*
HH head completed secondary/higher education	0.189	0.150	0.039	0.231	0.352	-0.121*
Own any land	0.941	0.833	0.107*	0.948	0.722	0.226***
Hectares land owned/cultivated	0.757	0.736	0.021	0.698	0.376	0.322***
Land size very small (0-0.2 ha)	0.118	0.267	-0.148*	0.126	0.287	-0.161***
Land size small (0.2-1 ha)	0.602	0.383	0.219**	0.630	0.352	0.278***
Land size medium (1-2 ha)	0.186	0.100	0.086*	0.171	0.111	0.059
Land size large (¿2 ha)	0.059	0.100	-0.041	2076	0.009	0.028**
Own any livestock	0.935	0.767	0.168**	0.928	0.593	0.336***
Number of livestocks owned	11.870	12.467	-0.597	11.789	5.694	6.095***
Number of big livestocks owned	6.824	5.783	1.040	6.568	2.750	3.818***
Hindu	0.802	0.450	0.352***	0.810	0.750	0.060
Buddhist	0.141	0.450	-0.309***	0.109	0.194	-0.085*
Paved Road less than 1 hour away from HH	0.145	0.300	-0.155*	0.223	0.454	-0.231***
Paved Road 1-2 hours away from HH	0.110	0.067	0.043	0.150	0.102	0.048
Paved Road 2-4 hours away from HH	0.160	0.033	0.127***	0.234	0.111	0.123***
Paved Road 4-12 hours away from HH	0.233	0.000	0.233***	0.188	0.111	0.077*
Paved Road more than 12 hours away from HH	0.351	0.600	-0.249***	0.205	0.222	-0.018
% of high caste hh in ward above 50%	0.521	0.400	0.121	0.474	0.778	-0.304***
Distance of ward to forest(hours)	1.337	1.350	-0.013	1.192	1.056	0.136
Area Under Forest Decreased past 5 years	0.281	0.200	0.081	0.364	0.111	0.253***
Time Taken to collect avg Bhari increased past 5 years	0.397	0.800	-0.403***	0.526	0.444	0.082
Trees planted privately past 5 years	0.231	0.200	0.031	0.092	0.222	-0.130**
Trees planted by community past 5 years	0.496	0.400	0.096	0.266	0.111	0.155***
Trees planted by government past 5 years	0.074	0.000	0.074***	0.040	0.222	-0.182***
Any user group in ward	0.669	0.400	0.269***	1.000	1.000	0.000
Any development project in ward	0.719	0.800	-0.081	0.954	1.000	-0.046***
Any natural disaster past 5 years	0.529	0.400	0.129	0.341	0.222	0.119**
ward population	794.709	760.000	34.709	895.890	1058.667	-162.776
Observations	1452	60		2076	108	

Notes: Author's computations using 2004, 2011 NLSS surveys and FUG Database.* p<0.10, ** p<0.05, *** p<0.01.