



# Women participation in formal decision-making: Empirical evidence from participatory forest management in Ethiopia

Goytom Abraha Kahsay<sup>a,\*</sup>, Anna Nordén<sup>b</sup>, Erwin Bulte<sup>c</sup>

<sup>a</sup> Department of Food and Resource Economics, University of Copenhagen, Denmark

<sup>b</sup> Jönköping International Business School, Jönköping University, Sweden

<sup>c</sup> Development Economics Group, Wageningen University, Netherlands

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## ABSTRACT

Amid growing emphasis on community-based approaches to natural resource management, there are concerns about the lack of women participation in communal decision-making. We analyze the association between participation of women in decision-making of forest user groups in Ethiopia and several forest management outcomes. We combine longitudinal survey, administrative and forest inventory data and find that participation of women in executive committees (i.e., formal decision-making) is associated with greater forest benefits, and an improved (perceived and actual) condition of the forest. Alternatively, the association between women participation in group-level meetings and outcomes is not robust. This implies that women participation in formal decision-making is required to reach forest conservation and livelihood gains.

## 1. Introduction

Policy makers increasingly delegate responsibility for natural resource management to local communities. This trend extends to the management of forests (Faguet, 2014). Approximately one-third of the forests in developing countries are currently managed under some form of participatory forest management, typically by so-called forest user groups or FUGs (Blackman et al., 2017). However, there are concerns about governance aspects of these groups, including leadership capacity and elite capture (e.g., Agrawal and Gupta, 2005; Persha and Andersson, 2014; García-López, 2019; Kahsay and Medhin, 2020) and lack of women participation in decision-making (e.g., Agarwal, 2001; Mai et al., 2011; Coleman and Mwangi, 2013; Leisher et al., 2016). These concerns are important in the generation and distribution of forest benefits, and the promotion of forest conservation (Persha and Andersson, 2014; Leisher et al., 2016; García-López, 2019). For instance, women participation in decision-making is found to improve natural resource governance (Leisher et al., 2016), decrease disruptive conflicts (Coleman and Mwangi, 2013) and improve conservation outcomes (Agarwal, 2009a, 2009b; Leone, 2019).

There are differences between men and women in terms of forest use

and management (Agarwal, 2009b; Sunderland et al., 2014). While men focus on high-value forest products for sale, women tend to be more involved in extraction of forest products for immediate household use such as firewood (Cavendish, 2000). By using cross-country data across the developing world, Sunderland et al. (2014) find evidence that supports these distinct gender roles in forest management, but these are also found to be context-specific. For instance, women in Africa depend more than men on unprocessed forest products and contribute more to forest income when they are closer to forests and poor, in contrast to women in Latin America (Sunderland et al., 2014). However, despite their dependence on forest products both for sale and consumption, women are often excluded from decision-making (Agarwal, 2001). This is a missed opportunity. Involving women in decision-making could contribute to sustainable forest management given their direct incentives (e.g., Agarwal, 2009b; Leone, 2019). Women are often directly affected by forest degradation, for instance by increasing the walking distance to collect firewood (Cooke, 1998; Agarwal, 2001). This dependency can explain why women tend to have more “conservationist preferences” than men (e.g., Agarwal, 2010; Ray et al., 2017; Umaerus et al., 2019). Women are, on average, also more cooperative and egalitarian in distributing benefits (Eckel and Grossman, 1998; Dufwenberg

\* Corresponding author at: University of Copenhagen, Department of Food and Resource Economics, Denmark.

E-mail addresses: [goytom@ifro.ku.dk](mailto:goytom@ifro.ku.dk) (G.A. Kahsay), [anna.norden@ju.se](mailto:anna.norden@ju.se) (A. Nordén), [erwin.bulte@wur.nl](mailto:erwin.bulte@wur.nl) (E. Bulte).

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**Table 1**  
Descriptive statistics.

	Total number of observations	Mean	Std. Dev.	Min	Max
<i>Women participation and decision-making</i>					
Share of female members who attend meetings	2437	0.156	0.13	0	0.5
Number of female EC members	2437	0.189	0.485	0	3
<i>Members' characteristics</i>					
Age	2387	48.24	14.97	0	100
Gender of respondent	2437	0.824	0.381	0	1
Literacy	2409	0.495	0.5	0	1
Household size	2423	8.729	3.648	1	35
Land holding	2434	8.071	11.318	0	326
Livestock holding	2414	22.176	14.366	0	162
Meeting participation	2444	0.929	0.257	0	1
EC participation	2444	0.323	0.468	0	1
Training/advice	2437	0.625	0.325	0	1
<i>Group characteristics</i>					
Altitude	264	2.229	0.652	1	3
Year of establishment	264	2005.732	3.458	1999	2011
Total members	264	27.691	4.104	11	30
Share of female members	264	0.208	0.116	0	0.727
Distance to market	264	2.62	3.42	0.43	30.78
Forest extraction rules	264	0.909	0.289	0	1
Forest monitoring rules	264	0.909	0.289	0	1
Clan fractionalization index	264	0.497	0.217	0	0.844
Distance to road	244	3.185	11.404	0.095	108.383
<i>Forest management outcomes</i>					
Forest benefits (ETB)	2437	11366.398	9672.205	0	66783.281
Perception of forest condition	2437	0.509	0.417	0	1
Potential Crop Trees/ha	224	42.688	32.512	0.23	161.22
Mature Trees/ha	224	40.164	33.912	2.12	423

Note: Distance to markets is measured in number of walking hours. Year of establishment refers to the year the group was formed. Literacy referees to whether a member reads and writes. Land holding is measured in timad (a local measure) and one timad is approximately 0.25 ha. The gender of respondent has a value of 1 if male, 0 otherwise. The value of altitude ranges from 1 (2200–2700 m above sea level) to 3 (3000–3500 m above sea level). Forest extraction and monitoring rules have a value of 1 if groups have these rules, 0 otherwise. Clan fractionalization index captures socio-cultural (clan) heterogeneity and is calculated following [Poteete and Ostrom \(2004\)](#). 1 USD = ~22 ETB at the time of the survey. EC membership refers to whether the household is a member of the group EC (1 if yes, 0 otherwise) while meeting participation refers to whether the household participates in general assembly meeting (1 if yes, 0 otherwise). Training and advice refers to whether the household received training or advice from government or NGO on development projects (1 if yes, 0 otherwise). Distance to road is measured in walking hours (one way).

**Table 2**  
Women participation in decision-making and forest management outcomes, FEs model.

	Forest benefits		Perceived forest condition	
	(1) Meeting participation	(2) EC participation	(3) Meeting participation	(4) EC participation
Women participation and decision- making	-2280.586	844.009***	0.375**	0.149***
	(1683.169)	(267.544)	(0.156)	(0.018)
Controls Yes	Yes	Yes	Yes	Yes
Constant	9578.040***	8983.172***	0.423***	0.465***
	(987.757)	(943.222)	(0.080)	(0.075)
R <sup>2</sup>	0.666	0.668	0.215	0.239
Observations	2333	2333	2333	2333

Notes: Clustered (at FUG level) standard errors in brackets. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . Included control variables at member (household) level: age, literacy, household size, land holding, livestock holding and governance intervention (whether the members were in a group which was part of one of the governance interventions).

and Muren, 2006; Croson and Gneezy, 2009). However, preferences are context-dependent, and women's preferences perhaps even more so than those of men, which makes their decisions more variable (Croson and Gneezy, 2009). Barrero-Amórtegui and Maldonado (2021) find that conservation behavior is not gendered but rather a construction that

**Table 3**  
The impact of women participation in decision-making on forest cover, FEs model.

	Potential crop trees		Mature trees	
	(1) Meeting participation	(2) EC participation	(3) Meeting participation	(4) EC participation
Women participation and decision- making	-42.573	12.487***	-366.074	2.815
	(28.819)	(4.570)	(255.772)	(3.893)
Controls Yes	Yes	Yes	Yes	Yes
Constant	55.529	7.307	413.889*	58.684*
	(43.060)	(30.637)	(243.691)	(30.109)
R <sup>2</sup>	0.078	0.151	0.289	0.085
Observations	203	203	203	203

Notes: Robust standard errors in brackets. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . Included control variables at FUG level: average age of members, share of literate members, average household size, average land holding, average livestock holding and governance intervention (whether the group was part of one of the governance interventions).

depends on the context of the natural resource. Their findings suggest that it is the combination of the genders that matters, where groups consisting of both genders are more likely to reach decisions consistent with conservation.

Empirical evidence in the domain of forest management and

**Table 4**

The impact of women participation in decision-making on forest management outcomes, DiD model.

	Forest benefits		Perceived forest condition		Potential crop trees		Mature trees	
	(1) Meeting participation	(2) EC participation	(3) Meeting participation	(4) EC participation	(5) Meeting participation	(6) EC participation	(7) Meeting participation	(8) EC participation
No women empowerment (reference group)								
Increasing women empowerment	2231.170*** (795.958)	1243.570 (759.049)	-0.143*** (0.039)	0.016 (0.041)	26.689** (11.623)	9.328 (8.728)	49.523 (36.896)	-5.773 (6.726)
Constant women empowerment	2028.610*** (455.275)	842.294 (958.185)	0.062** (0.027)	-0.310*** (0.017)	6.486 (6.558)	32.935 (20.639)	-5.799 (5.483)	-6.973 (7.903)
Decreasing women empowerment	-790.676 (528.243)	220.353 (519.811)	0.046 (0.042)	0.382*** (0.031)	25.153*** (9.488)	-2.226 (8.092)	7.156 (10.768)	-16.787** (8.262)
Year	2666.077*** (488.825)	2207.171*** (188.644)	0.291*** (0.030)	0.311*** (0.026)	-7.117 (6.835)	-11.919** (5.882)	0.977 (6.747)	-6.867 (6.960)
Increasing women empowerment × year	-2237.705* (1319.759)	-161.256 (733.312)	0.181*** (0.055)	-0.011 (0.057)	-12.055 (16.025)	2.393 (14.216)	-35.675 (36.953)	9.857 (10.188)
Constant women empowerment × year	-1533.815** (769.769)	2712.977*** (882.920)	-0.084** (0.036)	0.396*** (0.057)	-8.550 (9.154)	4.356 (25.584)	-1.652 (8.022)	21.499 (15.643)
Decreasing women empowerment × year	-2307.842** (982.019)	-1456.736*** (458.632)	0.113** (0.054)	-0.325*** (0.041)	-5.459 (15.692)	-16.283* (9.726)	-10.368 (12.549)	-1.336 (9.497)
Controls Yes	6055.106*** (809.598)	7657.167*** (778.068)	0.298*** (0.041)	0.238*** (0.037)	12.819 (26.387)	22.172 (25.965)	94.912*** (21.624)	86.865*** (18.505)
Constant	0.287 (809.598)	0.450 (778.068)	0.149 (0.041)	0.201 (0.037)	0.202 (26.387)	0.232 (25.965)	0.136 (21.624)	0.061 (18.505)
R <sup>2</sup>	0.287	0.450	0.149	0.201	0.202	0.232	0.136	0.061
Observations	2332	2332	2332	2332	202	202	202	202

Notes: Robust standard errors in brackets. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . Included control variables at member (household) level: age, literacy, household size, land holding, livestock holding and governance intervention (whether the members were in a group which was part of one of the governance interventions).

**Table 5**

. Women participation in decision-making and forest management outcomes, IV model.

	Forest benefits		Perceived forest condition		Potential crop trees		Mature trees	
	Meeting participation (1)	EC participation (2)	Meeting participation (3)	EC participation (4)	Meeting participation (5)	EC participation (6)	Meeting participation (7)	EC participation (8)
<b>Second stage results</b>								
Women participation and decision-making	17890.948** (7995.734)	3925.752** (1941.342)	1.139 (0.734)	0.250* (0.142)	148.547*** (47.056)	37.129*** (13.934)	-24.386 (28.407)	-6.095 (7.174)
Controls Yes	870141.033*** (298106.365)	919317.927*** (348547.015)	-78.633*** (19.705)	-75.502*** (20.139)	12835.445*** (1680.253)	13211.113*** (2057.672)	8109.041*** (1256.673)	8047.369*** (1278.966)
R <sup>2</sup>	0.275	0.165	0.338	0.324	0.542	0.364	0.566	0.557
Observations	121	121	121	121	99	99	99	99
<b>First stage results</b>								
Distance to Kebelle Admin	-0.003*** (0.001)	-0.014*** (0.003)	-0.003*** (0.001)	-0.014*** (0.003)	-0.003*** (0.001)	-0.012*** (0.003)	-0.003*** (0.001)	-0.012*** (0.003)
Controls Yes	-11.994 (7.227)	-67.186** (29.540)	-11.994 (7.227)	-67.186** (29.540)	-10.957 (8.236)	-53.739* (29.205)	-10.957 (8.236)	-53.739* (29.205)
F (1,103)	17.585	19.475	17.585	19.475				
F (1,81)					17.259	18.551	17.259	18.551
R <sup>2</sup>	0.415	0.422	0.415	0.422	0.441	0.402	0.441	0.402
Observations	121	121	121	121	101	101	101	101

Notes: Robust standard errors in brackets. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . Included control variables at member (household) level: age, literacy, household size, land holding, livestock holding, altitude, year of establishment, group size, whether the group has extraction rules (1 if yes, 0 otherwise), whether the group has monitoring rules (1 if yes, 0 otherwise), clan fractionalization index, distance to road, share of group members who received training and advice from government or NGO on development projects, share of group members who are members of the EC and share of group members who participate in group meetings.

decision-making is still relatively weak, ambiguous, and under-studied (e.g., [Leisher et al. \(2016\)](#)). Using data from Nepal and India, [Agarwal \(2009a\)](#) finds that FUGs with a greater proportion of women in their executive committees (ECs) manage forests that are in better condition.

This may be due to stricter implementation of rules, and more frequent reporting of illegal logging of trees ([Agarwal, 2009b](#)). In contrast, [Suna et al. \(2011\)](#), find that the gender composition of FUGs does not matter for forest protection in Kenya, Uganda, Bolivia and Mexico. A recent

paper by Leone (2019) finds that female representation in ECs in FUGs reduces firewood extraction in Nepal. However, increased conservation likely means decreased resource extraction, possibly at the expense of households' livelihoods. Thus, there is a need to evaluate the impact of women participation in decision-making on a broader set of forest management outcomes, including forest condition and forest-based benefits.

The main objective of this paper is to analyze how women participation in decision-making is associated with forest management outcomes. We use two measures of participation: the number of female members of the group's executive committee (EC), and the share of female members participating in General Assembly meetings of the group. We proxy forest management outcomes by a measure of tangible forest-based benefits for group members, a subjective measure of forest condition as perceived by members, and an objective measure of forest cover based on field measurements.

Most studies focusing on gender in relation to communal forest management are based on cross-section correlations. An exception to this is Leone (2019), who goes a long way towards credible identification of a causal relationship by exploiting exogenous variation in women participation due to a natural experiment. Identifying causal effects of women participation in cross-section research designs is challenging. We take one step towards causal identification by exploiting the panel nature of our data, and also by estimating an instrumental variable model. The paper's contribution to the literature further follows from the richness of our data set, which allows studying the association between our two complementary measures of women participation and a measure of forest-based benefits as well as an objective measure of tree cover. This extends the literature, which until now mainly focused on the impact of women participation on firewood extraction (Leone, 2019) or subjective measures of forest quality.

We find that women participation in EC is positively associated with forest-based income for group members, and with both subjective and objective measures of forest condition. Results for women participation in meetings are much weaker and not robust across our alternative models. These results suggest that women empowerment should extend beyond simply inviting women to discussions—empowering them with a formal position of authority is necessary for positive effects to eventuate.

## 2. Background and context

Ethiopia is one of the countries most affected by deforestation and forest degradation. At the turn of the twentieth century, some 40% of Ethiopia was covered by forest (Von Breitenbach, 1961; Wood, 1991; Yirdaw, 1996). Forest cover fell to 16% in 1950s and to 3% in 1990s (Dessie and Christiansson, 2008). Important proximate causes of forest loss are collection of firewood and charcoal, and agricultural expansion. Underlying causes are population growth, poor agricultural practices and governance, and the country's land tenure system (Getahun et al., 2013; Assefa and Bork, 2014).

In collaboration with international organizations, the Ethiopian government initiated a Participatory Forest Management (PFM) program in early 1990s. Local communities were given exclusive user rights in return for the promise of sustainable forest management. While FUGs are allowed to extract forest resources for sale and consumption, they should limit conversion of forests into agricultural land, and ban livestock grazing inside the forest. In addition, they should pay an annual rent based on total forest extraction.

One of the earliest PFM programs in Ethiopia was implemented in the Adaba and Dodola districts of West Arsi zone, Oromia regional state. Currently, 132 FUGs manage 50,500 ha of forest in the Adaba-Dodola PFM program. The Oromia Forest and Wildlife Enterprise (OFWE) is a government organization responsible for managing forest and wildlife resources, and implements and monitors the PFM program in Oromia region. Before the establishment of the FUGs, OFWE together with

village representatives identified three criteria (settlement proximity to the forest area, permanent residence in a village, and customary use right) for households to be eligible to join FUGs. These criteria were later approved by all village members through a series of village general assembly meetings. This was followed by the establishment of FUGs with a maximum group size of 30 households. Membership was organized on the basis of neighborhoods, i.e., eligible neighbor households within the same village became members of the same FUG until the group size reached 30. Supported by OFWE, newly-created FUGs drafted their own bylaws, detailing forest use and governance of the group. OFWE provided a sample bylaw to the groups to help them draft forest use and management rules. This sample bylaw explicitly suggested FUGs to include women in the group's EC. Nowadays, a "typical FUG" has a general assembly, consisting of all members, an executive committee (EC) of five members, and a few supportive committees (e.g., forest product marketing, forest rent determining, and forest development committees). Members of the EC and supportive committees are 'elected democratically' by the group's general assembly. Only 14% of the groups have at least one female EC member, despite the fact that the great majority of the FUGs (93%) have at least one female group member. The suggestion of OFWE regarding women participation, in other words, has typically been ignored.

Elites often dominate the FUG Executive Committee. Elites have, on average, higher income and consumption levels. They are also more educated and wealthy, and often have a role as religious leader or clan leader (Kahsay and Bulte, 2021). Tesfaye et al. (2015) identified key challenges with the functioning of FUG ECs, including the marginalization of women and youths in decision-making, lack of accountability regarding financial flows, and unfair distribution of benefits and responsibilities. They suggest that quota for women participation in the EC may improve group governance and subsequently forest management outcomes. The effect of such quota is likely dependent on the extent to which women can actually influence group-level decision-making (and are not merely reduced to "token participants").

While the Adaba-Dodola PFM program is generally regarded as successful, and it is responsible for reducing deforestation and forest degradation (compared to government-managed forests, see Ameha et al., 2016), there is substantial heterogeneity among FUGs in terms of forest protection and livelihood outcomes. To explain this heterogeneity, earlier studies emphasize the role of leadership (Kosfeld and Rustagi, 2015), cooperative preferences among group members (Rustagi et al., 2010), leader turnover (Kahsay and Medhin, 2020), and monitoring (Kahsay and Bulte, 2021). Gender aspects have so far been overlooked.

## 3. Data description

This paper is based on two data sources. The first data set is based on household surveys conducted among 132 FUGs in the Adaba-Dodola PFM program in March-April 2017 (baseline data) and September-December 2018 (endline data). We interviewed the selected sample twice, at baseline and endline periods. In total, we have 1222 baseline observations and 1215 endline observations. The slight drop in the number of observations at the endline period is due to the absence of the respondents during the data collection period. Given the small attrition rate (<1%), we disregard this in the analysis below. Survey data include socio-demographic characteristics, economic indicators, measures of forest extraction and governance, social capital and network indicators, and distance to institutions. Our sample is homogeneous in terms of ethnicity and religion: more than 95% are Muslim and belong to Oromo ethnic group.

Women participation in decision-making is measured with two variables: (i) the share of female members who attend general assembly meetings (referred to as "passive participation" by Agarwal, 2001); and (ii) the number of female EC members (referred to as "active participation"). The latter proxy is the most obvious and unambiguous measure of women leadership in the group, and refers to situations where women

are formally endowed with a position of authority. The share of female members who attend general assembly meetings is measured as total number of female members attending FUG general assembly meetings divided by total number of female members in the group. On average, female EC members are slightly older, own more livestock and land, are more literate and have larger family size than the rest of the group members. This is consistent with Agarwal (2010), who points out the importance of women's economic class and status for active participation in decision-making.

Forest benefits are measured at the member level and expressed in Ethiopian Birr (ETB) (1 USD  $\approx$  22 ETB at the time of data collection). They are the sum of income from tree-based and non-tree products. Members were asked to indicate the quantities of processed and unprocessed tree products, which are commonly extracted in the study area. These products include firewood, poles, tree bark, lianas and vines, bamboo, tree branches, logs, saw log, smoothed splits, and different furniture types. Similarly, members were asked to indicate the extraction quantity of common non-tree products such as honey, thatch grass, and wild vegetables. Extracted quantities were multiplied by village-product-level market prices to calculate forest-based income of members. On average, forest-based income accounts for about 25% of household income.

We also asked members how, according to their view, the forest condition had changed in recent years. They could choose one of three responses: no change, improved or degraded. We created a binary forest condition variable which takes the value of 1 if the response is 'improved', 0 otherwise. We collected geographic variables such as altitude and distance to market and key institutions; whether groups have forest extraction and monitoring rules; clan group membership; and socio-demographic and economic variables, such as age, gender, education, household size, livestock and land holdings. Table 1 presents descriptive statistics of our variables.

The second data source are administrative data from OFWE. This includes, among others, information on the year of group establishment, group size and composition, areas of forest blocks, and extensive forest inventory data. The latter are counts of so-called Potential Crop Trees (PCTs/ha) and Mature Trees (MTs/ha). Forest stock data were collected in 2004 (baseline data) for 117 FUGs, and again in 2019 for 109 FUGs. These administrative data are also summarized in Table 1.

#### 4. Econometric method and identification strategy

We aim to identify the impact of women participation in decision-making on forest management outcomes by exploiting the panel nature of our data. Based on the two waves of survey data, we first estimate the following member-level model:

$$\text{Forest management outcome}_{it} = \alpha_i + \beta_1 \text{women decision}_{gt} + \beta_2 X_{it} + \varepsilon_{it} \quad (1)$$

where *Forest management outcome<sub>it</sub>* refers to forest benefits and perceived forest condition by member *i* at time *t*, which is at member level. The key explanatory variable, *women decision<sub>gt</sub>*, is a FUG-level variable, and refers to women participation in decision-making in group *g* at time *t*. As described in section 3, this variable is measured by (i) the share of female members attending General Assembly meetings and (ii) the number of female ECs members in the FUG. *X<sub>it</sub>* refers to a vector of time-variant member-level controls,  $\alpha_i$  refers to member spe-

cific intercepts (fixed effects) capturing unobserved time-invariant member-level characteristics, and  $\varepsilon_{it}$  is the error term. Standard errors are clustered at the FUG level.

To identify the impact of women participation in decision-making on OFWE-measured forest cover variables (potential crop trees and mature trees per hectare), we also estimated the following fixed effects model at the FUG-level.

$$\text{Forest cover}_{gt} = \alpha_g + \beta_1 \text{women decision}_{gt} + \beta_2 X_{gt} + \varepsilon_{gt} \quad (2)$$

where *Forest cover<sub>gt</sub>* refers to potential crop trees and mature trees per ha for group *g* at time *t* while *women decision<sub>gt</sub>*, again, stands for the proxies of women participation in decision-making for group *g* at time *t*. *X<sub>gt</sub>* now represents a vector of group-level time-variant controls for group *g* at time *t*,  $\alpha_g$  refers to FUG specific intercepts (fixed effects), which capture unobserved time-invariant FUG-level characteristics and  $\varepsilon_{gt}$  is the error term.

As in other papers based on observational data, we face the challenge that our proxies for women participation in decision-making may be endogenous in the regression models that we estimate. The literature on determinants of women participation in meetings and decision-making points to factors such as women's individual characteristics (e.g., education and wealth) and social norms (e.g., Agarwal, 2000; Westermann et al., 2005). If we fail to control for these factors, and they are also correlated with our forest management outcome variables, then the estimated correlations should not be interpreted as causal effects. Compared to many of the existing papers, we have the advantage that we can access panel data, as our fixed effect captures all time-invariant variables. Many of the relevant unobservables, such as social norms, ethnicity and religion, market access, etc., are slow to change over time so are absorbed by the fixed effects.

However, other variables may vary over time. In an effort to mitigate the effect of unobservable individual or group attributes that are associated with both forest outcomes and women participation in decision-making, we respond by (i) estimating a difference-in-differences model (DiD), and (ii) estimating an instrumental variable (IV) model. Turning to the DiD model first, we exploited the variation in women participation in EC between the baseline and endline periods and created 4 groups: (i) FUGs without female EC members at baseline but with female EC members at endline, 'increasing women empowerment'; (ii) FUGs without female EC members at both baseline and endline, 'no women empowerment'; (iii) FUGs with female EC members at both baseline and endline, 'constant women empowerment'; and (iv) FUGs with female EC members at baseline, but not at endline, 'decreasing women empowerment'. Similarly, we created 4 groups based on variation in women participation in group meetings between the two periods: (i) FUGs with meeting participation below the median level of women meeting participation at baseline but above median level at endline, 'increasing women empowerment'; (ii) FUGs with below median level of women meeting participation at both baseline and endline, 'no women empowerment'; (iii) FUGs with above median level of women meeting participation at both baseline and endline, 'constant women empowerment'; and (iv) FUGs with above median level of women meeting participation at baseline, but not at endline, 'decreasing women empowerment'.

We estimate the following DiD model with all four groups included.

$$\text{Forest management outcome}_{it} = \beta_0 + \beta_{1j} \sum_{j=1}^3 WE_j + \beta_2 Post + \beta_{3j} \sum_{j=1}^3 WE_j * Post + \beta_4 X_{it} + \varepsilon_{it} \quad (3)$$



where  $WE_j$  is a vector of dummies for women empowerment  $j$  with ‘no women empowerment’ as the reference group. *Post* indicates a dummy for the follow-up data. Our main interest is  $\beta_{3j}$  which captures the effect of women empowerment  $j$ . To verify whether the parallel trends assumption is satisfied, we use the pre-survey forest inventory data (117 FUGs in 2004 and 49 FUGs in 2012). While this sample is small, we tested whether the implication of parallel trends assumption holds or not. Results reported in Appendix Table A4 suggest that we cannot reject the assumption that all four groups followed parallel trends in terms of tree cover before the baseline period.

Next, turn to our IV model. We instrument women participation in decision-making by *distance to Kebele administration*—the distance between a FUG and the relevant Kebele administration office. This results in a system of two equations, estimated jointly:

$$\text{Women decision}_g = \rho_0 + \rho_1 D_g + \beta_2 X_g + \alpha_z + \epsilon_g \quad (4)$$

$$\text{Forest management outcome}_g = \beta_0 + \beta_1 \text{women decision}_g^* + \beta_2 X_g + \alpha_z + \epsilon_g \quad (5)$$

where  $D$  is the instrument (*distance to Kebele administration*) and  $\text{women decision}_g^*$  indicates predicted women participation in decision-making. Because our IV is time-invariant, we run a cross-section model for the 2017 data only (which has fewer missing observations than the 2018 data). We now control for as many observables as we can (as the fixed effects are dropped).

To be a valid instrument, our distance variable should be exogenous, explain variation in women participation in decision-making among FUGs, and should not affect forest management outcomes directly or via alternative channels. *Distance to Kebele administration* is exogenous, since groups were formed by OFWE based on the neighborhood (which obviously has not changed over the years). Moreover, we expect *distance to Kebele administration* to be correlated with women participation. Most Kebele administrations have a branch aiming to promote women participation and empowerment across a range of activities and domains. FUGs closer to the administrative center are more likely to be visited by Kebele representatives, and subject to scrutiny and “suggestions” by civil servants. We explore whether this affects the propensity of groups to follow the OFWE suggestion to include women in decision-making.

Our IV should also satisfy the exclusion restriction assumption, which implies that *distance to Kebele administration* should not affect forest management outcomes directly or via alternative channels. While we cannot test this assumption econometrically, based on our experience with the local context and the data at our disposal, we believe there is some evidence to support this claim. Firstly, the OFWE branch, which is responsible for overseeing the PFM program is located in Dodola town and has no Kebele-level branches. Thus, *distance to Kebele administration* is less likely to be correlated with forest management outcomes via channels such as forest-related trainings, expert support, and external monitoring for which OFWE is responsible. Secondly, *distance to Kebele administration* is not synonymous with market access. Markets where forest products are traded are mainly located in the two district centres (Adaba and Dodola towns)—not the seat of the Kebele administration.

Finally, one can argue that groups that are farther from the Kebele administration are more likely to be generally remote and thus affects forest outcome through channels, for instance lack of road connection or other participatory programs, other than women participation in decision making. To mitigate this concern, we control for *altitude*, which is the best proxy for remoteness in our study area, *distance to roads*, and whether group members receive training or advice on proxies of participatory development projects (such as agriculture, agro-processing, marketing, livestock production, saving and finance and health) by the government or NGO. Overall, while we believe that *distance to Kebele administration* is less likely to affect forest management outcomes directly or through other channels, these results need to be

verified using more rigorous studies.

## 5. Results and discussion

Table 2 presents estimation results on the conditional association between women participation in decision-making and our survey-based proxies of forest outcomes. Column (1) and (2) present results for forest benefits at the group-member level, for the two explanatory variables. Column (1) summarizes results for the variable capturing women participation in meetings and column (2) presents results for the formal leadership variable (the number of female EC members). Columns (3) and (4) present corresponding estimation results using perceived forest condition as the dependent variable. We report full estimation results, including all controls, in Appendix Table A1 and A2. Estimation results with additional control variables (household’s attendance in general assembly meetings and involvement in EC) are reported in Appendix Table A3.

While both proxies of women participation in decision-making are positively and significantly associated with our subjective measure of forest condition, we find that only women participation in EC (number of female EC members) is positively correlated with our measure of members’ forest benefits. The estimated coefficients for the number of female EC members imply that one more female EC member is associated with an average increase in forest benefits of households by 844 ETB ( $p < 0.01$ ), i.e., around 7% average increase in forest benefits of households considering the mean level of forest benefits reported in Table 1. Moreover, an additional female EC member improves the perceived forest condition by 15% ( $p < 0.01$ ). The estimated coefficient for women participation in meetings suggest that a 20% increase in the share of women participating in the general assembly meeting is associated with only a 7.5% ( $p < 0.05$ ) increase in perceived forest condition. The finding that women participation matters for decision-making is in line with Agarwal (2009a, 2009b) and Leone (2019), who also find that the number of female EC members is positively correlated with the condition of the forest. Our results extend those by Leone (2019) because we look at the economic implications for group members. We document a robust positive association between women participation in EC and income from timber products and non-timber products for group members.

Table 3 summarizes our results for the association between women participation in decision-making and our objective measures of forest cover—the counts of potential crop trees per ha (columns (1) and (2)) and mature trees per ha (columns (3) and (4)). The number of female EC members is positively and significantly associated with the potential crop trees count: one more female EC members is associated with an average increase in the number of potential crop trees per hectare by 12.5 ( $p < 0.01$ ), i.e., around 29% increase in potential crop trees per ha considering the mean level of forest benefits in Table 1.

Interestingly, the potential crop tree variable is considered the best measure of group performance, as mature trees cannot be extracted without the help of machinery (Rustagi et al., 2010; Kosfeld and Rustagi, 2015). Groups therefore manage for potential crop trees, not mature trees. The variable measuring female attendance at general assembly meetings is, again, insignificant. This result is consistent with Agarwal’s (2001; 2009a), who argues that passive participation of women is not sufficient to have an impact on group management. Instead, active participation is necessary, or women should be formally endowed with a position of authority to steer group performance.

To probe the robustness of these findings we now turn to the DiD and IV results. The DiD results combining the baseline and endline data are summarized in Table 4. Full estimation results, including all controls, are reported in Appendix Table A5. While we do not find statistically significant effects for some of the groups, we consistently find that decreasing women empowerment decreases forest benefits, perceived forest condition and objective forest cover. On average, members in ‘decreasing women empowerment’ FUGs have 1457 ETB ( $p < 0.01$ ) less

forest benefits, 33% ( $p < 0.01$ ) less perceived forest condition, and 16 ( $p < 0.10$ ) less potential crop trees per ha compare to ‘no women empowerment’ FUGs when women empowerment is measured by EC participation. This supports the positive roles of women empowerment in better natural resource governance, livelihood and conservation outcomes reported in the literature as well as supports our earlier results.

Estimation results for the IV model, including all controls, are reported in Table 5. Full estimation results, including all controls, are reported in Appendix Table A6. Overall, the IV results confirm our earlier findings. Indeed, they are strengthened somewhat. Both participation measures are now positively and significantly associated with forest benefits and the potential crop trees count. Perceived forest condition is positively and significantly associated with the number of female EC members only. An increase in number female EC members by 1 increases average group forest benefits by 3926 ETB ( $p < 0.05$ ), average group perceived forest condition by 25% ( $p < 0.10$ ) and number of potential crop trees per hectare a by about 37 ( $p < 0.01$ ). An increase in the share of female members participating in general assembly meetings by 10% increases average group forest benefits by about 1789 ETB ( $p < 0.05$ ) and number of potential crop trees per hectare by about 15 ( $p < 0.01$ ).

The first stage results in the second panel of Table 5 confirm that *distance to Kebele administration* is negatively and significantly associated with our two measures of women participation in decision-making. The closer the FUG is located to the Kebele administration, the higher is the number of female EC members in a group and the likelihood of female members attending General Assembly meetings. The partial F-statistic values are greater than 10, in agreement with Stock et al. (2002) requirement. However, since we cannot test whether the exclusion restriction is satisfied, we believe that these results should be interpreted with some caution. Nevertheless, it is encouraging to find consistent patterns across the different models that we estimate.

## 6. Conclusions

In recent years, the decentralization of forest management to local communities has been emphasized as a solution to remedy unsustainable extraction. At the same time, concerns are growing about leadership capacity constraints, elite capture and the lack of women participation in decision-making. In the forest domain, there are gaps in the empirical evidence on the effect of increased participation of women in forest management groups. In this paper, we combine two panel data sources and several fixed effects models to conclude that: (i) women representation in group leadership is associated with increased forest benefits and forest cover; and (ii) active participation is necessary, women should be formally endowed with a position of authority to steer group performance in a more sustainable direction.

Our results contribute to the limited empirical evidence on the effect of women participation in formal decision making in the forest domain. Further, we bring insights to the discussion regarding tradeoffs between environmental targets and local development, showing that these can be complements. Sustainability and poverty alleviation need not be inconsistent or mutually exclusive. Consistent with the earlier literature we also document an important asymmetry between membership in the executive committee and participating in meetings more generally. While women representation in the executive committee is robustly associated with increased forest benefits and (potential crop) tree cover, less direct measures of women participation (such as attendance of meetings) does not seem to matter.

Our findings suggest that policies to increase women in formal leadership positions can contribute to sustainability and a more equitable distribution of the gains from extraction (i.e. benefits accruing to other members than simply the elite). We interpret this as preliminary evidence that policy should try to intervene by encouraging women’s participation in executive committees—for example through quota

setting. For instance, a non-binding guideline that at least 50 percent of FUGs’ executive members are female increased the number of female EC members in Nepal (Leone, 2019). Auxiliary analysis of our own data also reveals that more stringent monitoring by government officials positively affects women participation in group-level decision-making (results not shown here). In other words, women leadership to some extent can be “chosen” by policy makers. Our results suggest that efforts to promote women leadership in group-level decisions will positively affect forest management outcomes.

However, quota alone may not be sufficient to enhance women decision making. It is easy to imagine that sometimes women are merely included in the group’s executive committees to meet quota requirements, without actually influencing group decisions. Supplementary interventions may then be necessary, possibly including information campaigns, government monitoring, leadership training for female members, and conditional support for groups depending on levels of women involvement in decision-making. However, it is important to emphasize that cultural norms determine the extent to which women can speak their mind during meetings, and such norms may change only slowly under outside pressures (but see Bursztyjn et al., 2020, for evidence of rapidly changing social norms in the context of women empowerment).

It is important that future research verifies the robustness of these findings elsewhere, using more rigorous identification approaches such as field experiments. Especially since previous research has shown that forest dependence and gender roles in forest management are context-dependent, more empirical results from different contexts are needed. In the context of this research, forest user groups are small in size, consisting of around 30 households, and the average executive committees consisted of less than 0.2 female members (out of 5 members). This limits our possibilities to, for instance, explore optimal gender compositions which could be investigated in more experimental settings or in contexts with larger variation in women participation in decision making.

## CRedit authorship contribution statement

**Goytom Abraha Kahsay:** Conceptualization, Formal analysis, Writing - original draft, Writing - review & editing, Funding acquisition.  
**Anna Nordén:** Conceptualization, Writing - review & editing.  
**Erwin Bulte:** Conceptualization, Writing - review & editing.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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## Appendix A

**Table A1**

The impact of women participation in decision-making on forest management outcomes, FEs model.

	Forest benefits		Forest condition	
	(1) Meeting participation	(2) EC participation	(3) Meeting participation	(4) EC participation
Women participation and decision-making	-2280.586 (1683.169)	844.009*** (267.544)	0.375** (0.156)	0.149*** (0.018)
Age	-37.625*** (13.693)	-34.886*** (13.353)	0.000 (0.001)	0.000 (0.001)
Literacy	-303.805 (408.264)	-253.272 (410.427)	0.020 (0.034)	0.027 (0.034)
Household size	0.373 (51.119)	-8.194 (51.058)	-0.003 (0.004)	-0.005 (0.004)
Land holding	-41.696*** (8.918)	-42.733*** (9.033)	-0.001 (0.001)	-0.001 (0.001)
Livestock holding	25.361* (13.758)	25.940* (13.626)	-0.003** (0.001)	-0.002** (0.001)
Governance intervention	10606.205*** (268.541)	10584.282*** (266.293)	0.302*** (0.019)	0.303*** (0.018)
Constant	9578.040*** (987.757)	8983.172*** (943.222)	0.423*** (0.080)	0.465*** (0.075)
R <sup>2</sup>	0.666	0.668	0.215	0.239
Observations	2333	2333	2333	2333

Notes: Clustered (at FUG level) standard errors in brackets. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .**Table A2**

Women participation in decision-making and forest cover, FEs model.

	Potential crop trees		Mature trees	
	(1) Meeting participation	(2) EC participation	(3) Meeting participation	(4) EC participation
Women participation and decision-making	-42.573 (28.819)	12.487*** (4.570)	-366.074 (255.772)	2.815 (3.893)
Average age	0.080 (0.454)	0.065 (0.415)	-0.704 (0.680)	-0.202 (0.420)
Average literacy	8.787 (11.380)	3.280 (10.646)	-12.369 (16.777)	-31.118 (28.224)
Average household size	-0.464 (1.551)	-0.699 (1.452)	-2.557 (2.534)	1.546 (2.235)
Average land holding	0.596* (0.308)	0.547* (0.324)	0.961 (0.593)	1.001 (0.802)
Average livestock holding	-0.326 (0.280)	-0.428 (0.268)	-0.444 (0.437)	-0.806 (0.597)
Governance intervention	2.069 (2.652)	1.813 (2.595)	-5.006 (4.968)	-2.443 (3.793)
Constant	55.529 (43.060)	7.307 (30.637)	413.889* (243.691)	58.684* (30.109)
R <sup>2</sup>	0.078	0.151	0.289	0.085
Observations	203	203	203	203

Notes: Robust standard errors in brackets. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .



**Table A3**

The impact of women participation in decision-making on forest management outcomes, FEs model.

	Forest benefits		Perceived forest condition		Potential crop trees		Mature trees	
	(1) Meeting participation	(2) EC participation	(3) Meeting participation	(4) EC participation	(5) Meeting participation	(6) EC participation	(7) Meeting participation	(8) EC participation
Women participation and decision-making	-1780.846 (1700.552)	861.164*** (275.608)	0.329** (0.156)	0.133*** (0.019)	-24.031 (29.842)	10.432** (5.252)	-406.386 (267.352)	-0.688 (4.500)
Age	-38.214*** (13.670)	-35.726*** (13.326)	-0.000 (0.001)	0.000 (0.001)	-0.020 (0.452)	-0.000 (0.428)	-0.759 (0.636)	-0.317 (0.444)
Literacy	-308.852 (408.699)	-250.555 (410.809)	0.015 (0.034)	0.022 (0.033)	5.458 (11.456)	3.433 (11.113)	-16.300 (17.083)	-30.434 (23.530)
Household size	-2.730 (51.149)	-13.579 (51.195)	-0.002 (0.004)	-0.004 (0.004)	-1.621 (1.583)	-1.602 (1.509)	-1.996 (2.215)	-0.124 (1.540)
Land holding	-42.390*** (8.957)	-43.494*** (9.009)	-0.001 (0.001)	-0.001 (0.001)	0.563* (0.285)	0.526* (0.304)	1.000 (0.617)	0.961 (0.746)
Livestock holding	26.783* (13.789)	27.358** (13.685)	-0.002** (0.001)	-0.002** (0.001)	-0.323 (0.273)	-0.383 (0.257)	-0.525 (0.461)	-0.719 (0.497)
Governance intervention	10569.280*** (269.389)	10530.398*** (266.683)	0.312*** (0.019)	0.313*** (0.018)	0.400 (2.800)	0.365 (2.795)	-2.859 (4.328)	-5.176 (5.807)
EC membership	262.109 (379.655)	63.717 (390.641)	0.119*** (0.029)	0.085*** (0.030)	24.207* (12.241)	12.706 (13.456)	11.387 (14.931)	21.478 (14.640)
Meeting participation	-734.212 (657.680)	-942.018 (646.087)	0.094** (0.043)	0.102** (0.043)	-13.728 (12.455)	-14.469 (13.335)	33.821 (29.138)	-27.961 (39.065)
Constant	10144.912*** (1174.575)	9920.087*** (1153.802)	0.296*** (0.088)	0.335*** (0.084)	58.544 (43.851)	28.449 (34.623)	412.816* (239.999)	98.775* (51.366)
R <sup>2</sup>	0.667	0.669	0.230	0.248	0.123	0.168	0.304	0.099
Observations	2333	2333	2333	2333	203	203	203	203

Notes: Clustered (at FUG level) standard errors in brackets. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . EC membership refers to whether the household is a member of the EC (1 if yes, 0 otherwise) while meeting participation refers to whether the household participates in general assembly meeting (1 if yes, 0 otherwise).

**Table A4**

The impact of women participation in decision-making on forest management outcomes, DiD model (parallel trend).

	Potential crop trees	
	(1) Meeting participation	(2) EC participation
No women empowerment		
Increasing women empowerment	24.982** (11.518)	6.290 (8.334)
Constant women empowerment	4.031 (7.031)	28.950 (20.983)
Decreasing women empowerment	18.902** (8.917)	-4.545 (8.759)
Year	7.161 (9.794)	-2.264 (10.820)
Increasing women empowerment × year	-13.219 (15.876)	-3.839 (12.653)
Constant women empowerment × year	28.842 (17.811)	8.414 (29.475)
Decreasing women empowerment × year	5.231 (14.599)	15.505 (18.705)
Age	-0.385 (0.517)	-0.708 (0.587)
Literacy	37.588*** (14.070)	30.099** (14.265)
Household size	-0.126 (1.812)	-0.743 (1.770)
Land holding	0.216 (0.269)	0.019 (0.369)
Livestock holding	-0.255 (0.376)	-0.209 (0.341)
Governance intervention	-7.271 (12.090)	7.891 (12.476)
Constant	40.616 (31.565)	70.891** (32.735)
R <sup>2</sup>	0.199	0.164
Observations	138	138

Notes: Robust standard errors in brackets. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

**Table A5**

The impact of women participation in decision-making on forest management outcomes, DiD model.

	Forest benefits		Perceived forest condition		Potential crop trees		Mature trees	
	(1) Meeting participation	(2) EC participation	(3) Meeting participation	(4) EC participation	(5) Meeting participation	(6) EC participation	(7) Meeting participation	(8) EC participation
<b>No women empowerment (reference group)</b>								
Increasing women empowerment	2231.170*** (795.958)	1243.570 (759.049)	-0.143*** (0.039)	0.016 (0.041)	26.689** (11.623)	9.328 (8.728)	49.523 (36.896)	-5.773 (6.726)
Constant women empowerment	2028.610*** (455.275)	842.294 (958.185)	0.062** (0.027)	-0.310*** (0.017)	6.486 (6.558)	32.935 (20.639)	-5.799 (5.483)	-6.973 (7.903)
Decreasing women empowerment	-790.676 (528.243)	220.353 (519.811)	0.046 (0.042)	0.382*** (0.031)	25.153*** (9.488)	-2.226 (8.092)	7.156 (10.768)	-16.787** (8.262)
Year	2666.077*** (488.825)	2207.171*** (188.644)	0.291*** (0.030)	0.311*** (0.026)	-7.117 (6.835)	-11.919** (5.882)	0.977 (6.747)	-6.867 (6.960)
Increasing women empowerment × year	-2237.705* (1319.759)	-161.256 (733.312)	0.181*** (0.055)	-0.011 (0.057)	-12.055 (16.025)	2.393 (14.216)	-35.675 (36.953)	9.857 (10.188)
Constant women empowerment × year	-1533.815** (769.769)	2712.977*** (882.920)	-0.084** (0.036)	0.396*** (0.057)	-8.550 (9.154)	4.356 (25.584)	-1.652 (8.022)	21.499 (15.643)
Decreasing women empowerment × year	-2307.842** (982.019)	-1456.736*** (458.632)	0.113** (0.054)	-0.325*** (0.041)	-5.459 (15.692)	-16.283* (9.726)	-10.368 (12.549)	-1.336 (9.497)
Age	-22.010* (11.358)	-30.544*** (10.517)	-0.000 (0.001)	0.000 (0.001)	0.343 (0.429)	0.257 (0.436)	-0.553* (0.311)	-0.493* (0.298)
Literacy	154.620 (371.410)	-186.356 (322.274)	0.022 (0.017)	0.042** (0.017)	45.316*** (11.338)	42.972*** (11.601)	-18.700 (12.411)	-18.531* (11.137)
Household size	99.798** (50.218)	52.492 (40.773)	0.004* (0.002)	0.003 (0.002)	-0.266 (1.515)	-0.161 (1.465)	-1.883* (1.060)	-0.769 (1.145)
Land holding	-22.656 (14.303)	-26.649*** (7.186)	0.001 (0.001)	0.001** (0.001)	0.024 (0.278)	-0.089 (0.376)	0.714 (0.886)	0.288 (0.706)
Livestock holding	21.707* (12.621)	26.831** (10.597)	0.001 (0.001)	0.001 (0.001)	-0.678** (0.308)	-0.625** (0.275)	-0.400 (0.632)	-0.111 (0.487)
Governance intervention	9254.658*** (515.179)	8625.762*** (315.053)	0.015 (0.024)	0.039 (0.024)	12.281* (7.155)	15.106*** (5.663)	-1.509 (6.604)	-1.215 (6.065)
Constant	6055.106*** (809.598)	7657.167*** (778.068)	0.298*** (0.041)	0.238*** (0.037)	12.819 (26.387)	22.172 (25.965)	94.912*** (21.624)	86.865*** (18.505)
R <sup>2</sup>	0.287	0.450	0.149	0.201	0.202	0.232	0.136	0.061
Observations	2332	2332	2332	2332	202	202	202	202

Notes: Robust standard errors in brackets. \* p &lt; 0.10, \*\* p &lt; 0.05, \*\*\* p &lt; 0.01.

**Table A6**

Women participation in decision-making and forest management outcomes, IV model.

	Forest benefits		Perceived forest condition		Potential crop trees		Mature trees	
	Meeting participation (1)	EC participation (2)	Meeting participation (3)	EC participation (4)	Meeting participation (5)	EC participation (6)	Meeting participation (7)	EC participation (8)
<b>Second stage results</b>								
Women participation and decision-making	17890.948** (7995.734)	3925.752** (1941.342)	1.139 (0.734)	0.250* (0.142)	148.547*** (47.056)	37.129*** (13.934)	-24.386 (28.407)	-6.095 (7.174)
Average age	-146.317* (75.181)	-156.443** (73.358)	0.006 (0.006)	0.005 (0.006)	-0.030 (0.457)	0.020 (0.566)	-0.558** (0.267)	-0.566** (0.266)
Average literacy	-868.671 (2248.694)	-2317.345 (2077.912)	0.192 (0.175)	0.099 (0.172)	21.880 (17.203)	12.727 (16.713)	-14.555 (14.810)	-13.052 (14.687)
Average household size	134.648 (319.019)	93.687 (280.668)	0.057** (0.028)	0.054** (0.025)	2.850 (2.453)	2.939 (2.861)	-0.864 (1.110)	-0.878 (1.153)
Average land holding	-3.994 (60.065)	26.104 (60.138)	0.000 (0.004)	0.002 (0.005)	-0.194 (0.309)	-0.100 (0.287)	-0.088 (0.194)	-0.104 (0.211)
Average livestock holding	10.456 (36.421)	-16.331 (39.944)	0.001 (0.004)	-0.001 (0.004)	-0.379 (0.285)	-0.564 (0.356)	-0.109 (0.195)	-0.079 (0.192)
Altitude	3115.546*** (653.815)	2847.501*** (711.589)	-0.127*** (0.049)	-0.144*** (0.052)	14.995*** (4.904)	12.614** (4.909)	-7.282*** (2.736)	-6.891** (2.755)

(continued on next page)

Table A6 (continued)

	Forest benefits		Perceived forest condition		Potential crop trees		Mature trees	
	Meeting participation (1)	EC participation (2)	Meeting participation (3)	EC participation (4)	Meeting participation (5)	EC participation (6)	Meeting participation (7)	EC participation (8)
Year of establishment	-432.469*** (148.987)	-456.578*** (174.260)	0.039*** (0.010)	0.037*** (0.010)	-6.390*** (0.845)	-6.575*** (1.033)	-3.987*** (0.628)	-3.957*** (0.639)
Group size	76.691 (78.118)	21.623 (76.054)	-0.009 (0.008)	-0.012 (0.008)	-0.161 (0.502)	-0.465 (0.617)	-0.653 (0.548)	-0.604 (0.531)
Share of female members	3025.219 (3557.270)	6240.904** (2996.635)	-0.194 (0.333)	0.011 (0.256)	-74.625*** (23.894)	-54.539** (26.322)	26.495* (15.288)	23.197 (14.145)
Forest extraction rules	857.589 (2606.516)	149.464 (2648.654)	0.178* (0.101)	0.133 (0.120)	-18.392 (11.921)	-29.400** (11.773)	-3.864 (7.127)	-2.057 (7.198)
Forest monitoring rules	936.193 (2676.483)	2195.524 (2756.087)	-0.010 (0.094)	0.070 (0.121)	3.873 (11.467)	11.815 (11.131)	10.543 (7.715)	9.239 (7.297)
Clan fractionalization index	-922.446 (1675.526)	2742.278 (1850.513)	-0.075 (0.182)	0.158 (0.141)	-11.573 (14.252)	22.297 (15.224)	3.443 (10.170)	-2.118 (8.547)
Distance to road	-0.615** (0.299)	-0.745** (0.353)	-0.000** (0.000)	-0.000** (0.000)	-0.004 (0.002)	-0.005* (0.003)	0.002* (0.001)	0.002* (0.001)
Training and advice	-292.937 (1149.029)	-194.846 (1277.459)	-0.022 (0.100)	-0.016 (0.100)	-1.391 (7.324)	0.227 (9.031)	-24.833*** (6.705)	-25.098*** (6.795)
EC membership	3929.941 (2511.115)	-4716.902 (3715.581)	0.769*** (0.200)	0.219 (0.347)	-2.216 (18.589)	-75.382*** (28.261)	-2.156 (10.628)	9.856 (14.153)
Meeting participation	-4293.908 (2815.913)	946.212 (2821.818)	0.300 (0.270)	0.633*** (0.232)	-21.651 (19.697)	13.250 (20.333)	8.993 (17.179)	3.264 (14.555)
Constant	870141.033*** (298106.365)	919317.927*** (348547.015)	-78.633*** (19.705)	-75.502*** (20.139)	12835.445*** (1680.253)	13211.113*** (2057.672)	8109.041*** (1256.673)	8047.369*** (1278.966)
R <sup>2</sup>	0.275	0.165	0.338	0.324	0.542	0.364	0.566	0.557
Observations	121	121	121	121	99	99	99	99
<b>First stage results</b>								
Distance to Kebele Admin	-0.003*** (0.001)	-0.014*** (0.003)	-0.003*** (0.001)	-0.014*** (0.003)	-0.003*** (0.001)	-0.012*** (0.003)	-0.003*** (0.001)	-0.012*** (0.003)
Average age	-0.001 (0.002)	-0.002 (0.008)	-0.001 (0.002)	-0.002 (0.008)	-0.002 (0.002)	-0.007 (0.009)	-0.002 (0.002)	-0.007 (0.009)
Average literacy	-0.073 (0.053)	0.037 (0.202)	-0.073 (0.053)	0.037 (0.202)	-0.123** (0.056)	-0.251 (0.233)	-0.123** (0.056)	-0.251 (0.233)
Average household size	-0.011 (0.007)	-0.040 (0.036)	-0.011 (0.007)	-0.040 (0.036)	-0.005 (0.007)	-0.021 (0.038)	-0.005 (0.007)	-0.021 (0.038)
Average land holding	0.002 (0.001)	-0.001 (0.007)	0.002 (0.001)	-0.001 (0.007)	0.002 (0.001)	0.004 (0.006)	0.002 (0.001)	0.004 (0.006)
Average livestock holding	0.002 (0.001)	0.014* (0.008)	0.002 (0.001)	0.014* (0.008)	0.001 (0.002)	0.011 (0.007)	0.001 (0.002)	0.011 (0.007)
Altitude	0.016 (0.018)	0.141 (0.085)	0.016 (0.018)	0.141 (0.085)	0.012 (0.021)	0.108 (0.077)	0.012 (0.021)	0.108 (0.077)
Year of establishment	0.006* (0.004)	0.033** (0.015)	0.006* (0.004)	0.033** (0.015)	0.005 (0.004)	0.027* (0.015)	0.005 (0.004)	0.027* (0.015)
Group size	-0.001 (0.002)	0.009 (0.009)	-0.001 (0.002)	0.009 (0.009)	-0.002 (0.002)	0.001 (0.009)	-0.002 (0.002)	0.001 (0.009)
Share of female members	0.265*** (0.089)	0.387 (0.338)	0.265*** (0.089)	0.387 (0.338)	0.220** (0.097)	0.346 (0.350)	0.220** (0.097)	0.346 (0.350)
Forest extraction rules	0.019 (0.050)	0.268 (0.185)	0.019 (0.050)	0.268 (0.185)	0.018 (0.051)	0.361 (0.220)	0.018 (0.051)	0.361 (0.220)
Forest monitoring rules	-0.028 (0.051)	-0.448** (0.199)	-0.028 (0.051)	-0.448** (0.199)	-0.019 (0.054)	-0.289 (0.221)	-0.019 (0.054)	-0.289 (0.221)
Clan fractionalization index	0.169*** (0.045)	-0.163 (0.172)	0.169*** (0.045)	-0.163 (0.172)	0.206*** (0.046)	-0.071 (0.196)	0.206*** (0.046)	-0.071 (0.196)
Distance to road	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)
Training and advice	-0.015 (0.029)	-0.091 (0.132)	-0.015 (0.029)	-0.091 (0.132)	0.002 (0.030)	-0.017 (0.126)	0.002 (0.030)	-0.017 (0.126)
EC membership	-0.082 (0.066)	1.828*** (0.452)	-0.082 (0.066)	1.828*** (0.452)	-0.115 (0.072)	1.580*** (0.499)	-0.115 (0.072)	1.580*** (0.499)
Meeting participation	0.231*** (0.068)	-0.284 (0.444)	0.231*** (0.068)	-0.284 (0.444)	0.301*** (0.104)	0.313 (0.319)	0.301*** (0.104)	0.313 (0.319)
Constant	-11.994 (7.227)	-67.186** (29.540)	-11.994 (7.227)	-67.186** (29.540)	-10.957 (8.236)	-53.739* (29.205)	-10.957 (8.236)	-53.739* (29.205)
F (1,103)	17.585	19.475	17.585	19.475		18.551	17.259	18.551
F (1,81)					17.259	18.551	17.259	18.551
R <sup>2</sup>	0.415	0.422	0.415	0.422	0.441	0.402	0.441	0.402
Observations	121	121	121	121	101	101	101	101

Notes: Robust standard errors in brackets. \* p &lt; 0.10, \*\* p &lt; 0.05, \*\*\* p &lt; 0.01.

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