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Gender quotas increase the equality and effectiveness of climate policy interventions

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SUPPLEMENTARY INFORMATION FOR: GENDER QUOTAS INCREASE THE EQUALITY AND EFFECTIVENESS OF CLIMATE POLICY INTERVENTIONS

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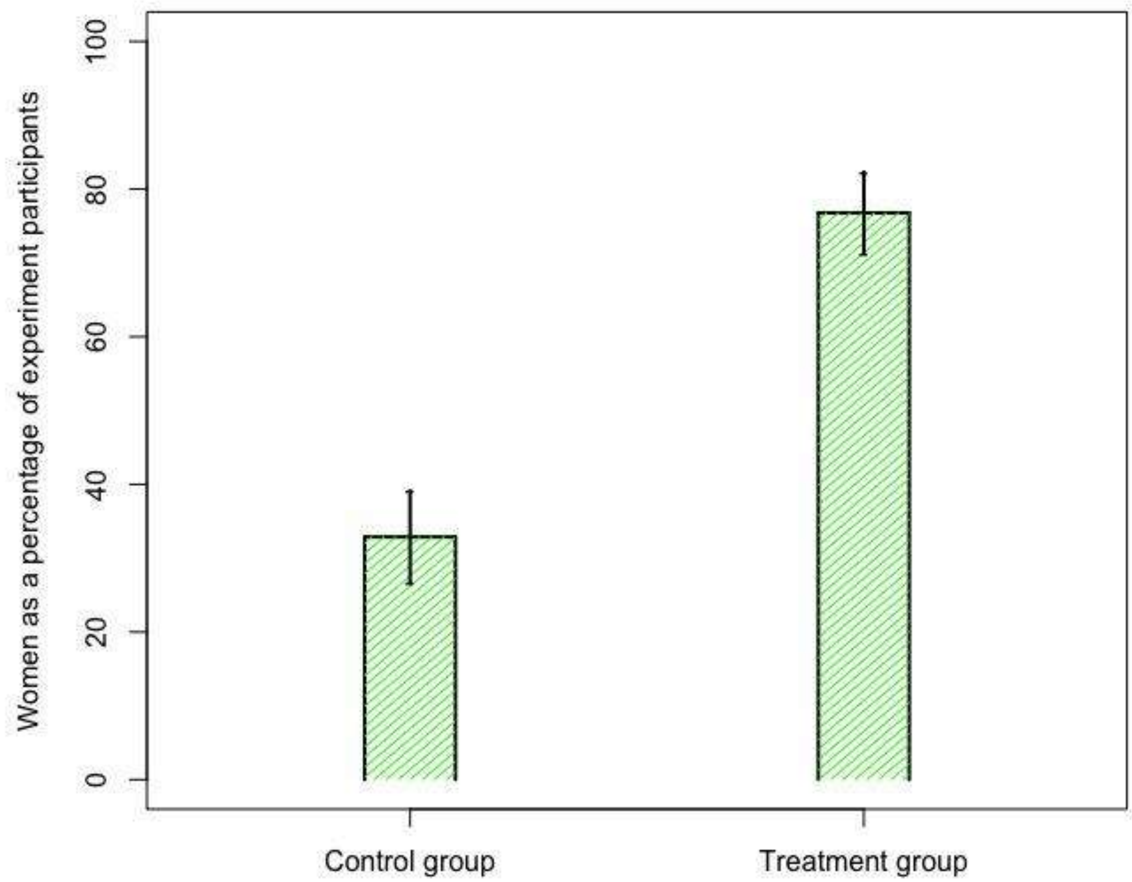
Supplementary Note 1. Gender differences between treatment and control groups

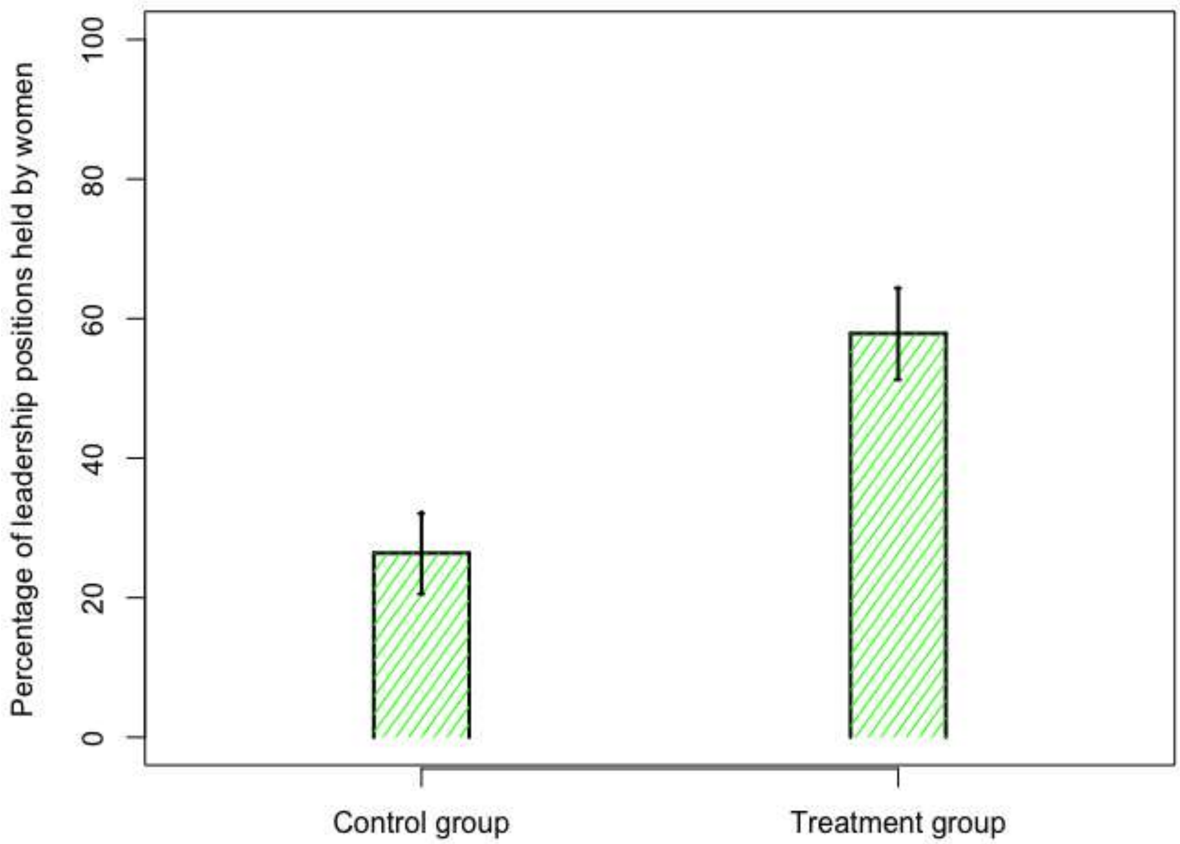
Under the gender quota treatment, our field team ensured that at least 50% of the participants in each group assigned to the treatment condition were women. This procedure resulted in a gender composition of approximately 33% female under the control condition and 76% female under the treatment condition (Supplementary Figure 1; Supplementary Table 1).

Our experimental procedure did not require or encourage participants to consider gender as they chose the group leader for each round. Nonetheless, it is reasonable to expect that groups with more women would be more likely to choose female leaders. The results presented in Supplementary Figure 2 and Supplementary Table 1 corroborate this expectation, indicating that groups under the treatment condition were significantly more likely to choose female leaders compared to the control group ($p < 0.001$). Under the control condition, less than 30% of leadership positions were awarded to women. Under the treatment condition, almost 60% of leadership positions were awarded to women (Supplementary Figure 2).

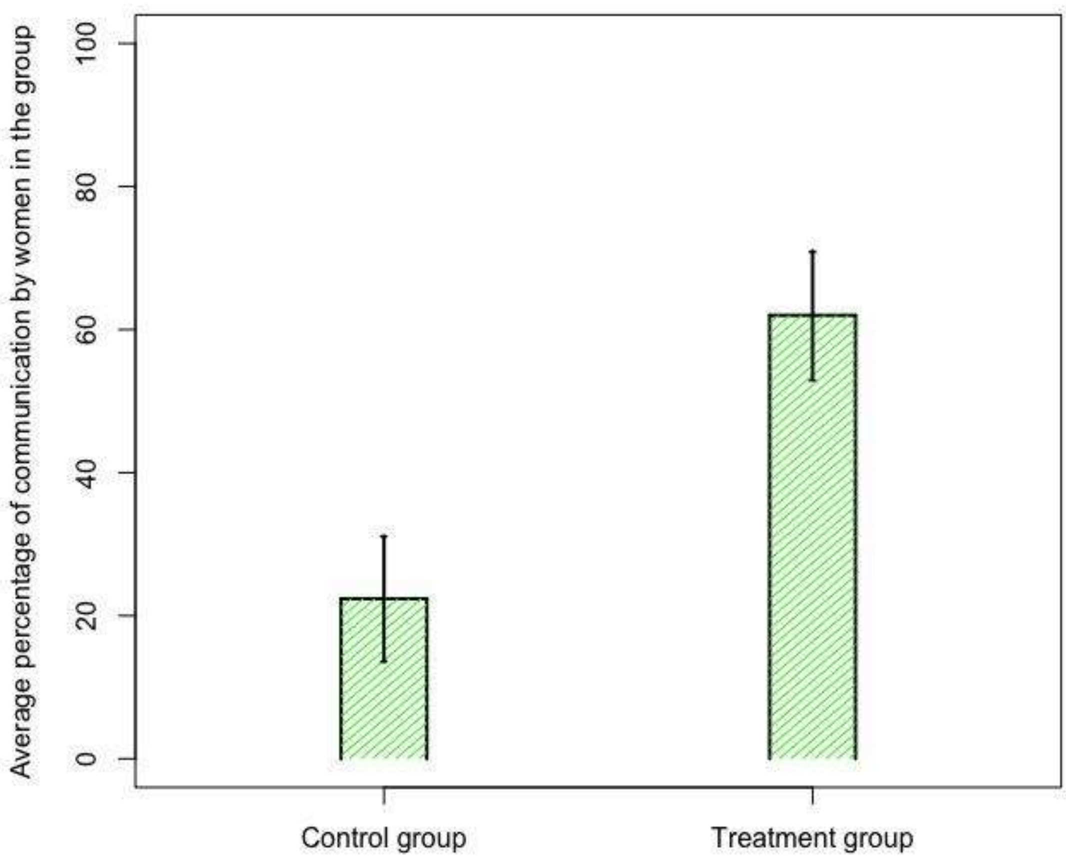
The experiment moderators observed and coded the proportion of communication done by each participant in each group. We also find that women accounted for a greater share of communication during the experiment in the groups treated with the gender quota ($p < 0.001$, Supplementary Table 1). Under the control condition, women were responsible for less than 30% of the communication observed by the experiment moderators. Under the treatment condition, women were responsible for more than 60% of the communication (Supplementary Figure 3).



Supplementary Figure 1: Gender composition by treatment assignment. Vertical axis shows women as a percentage of experiment participants, separated based on treatment assignment. 95% confidence bounds.



Supplementary Figure 2: Percentage of leadership positions held by women, by treatment assignment. A leader was elected in each group of eight participants at each round, during rounds 9-16. Vertical axis shows the percentage of rounds in which a woman occupied the leadership position, separated based on treatment assignment. 95% confidence bounds.



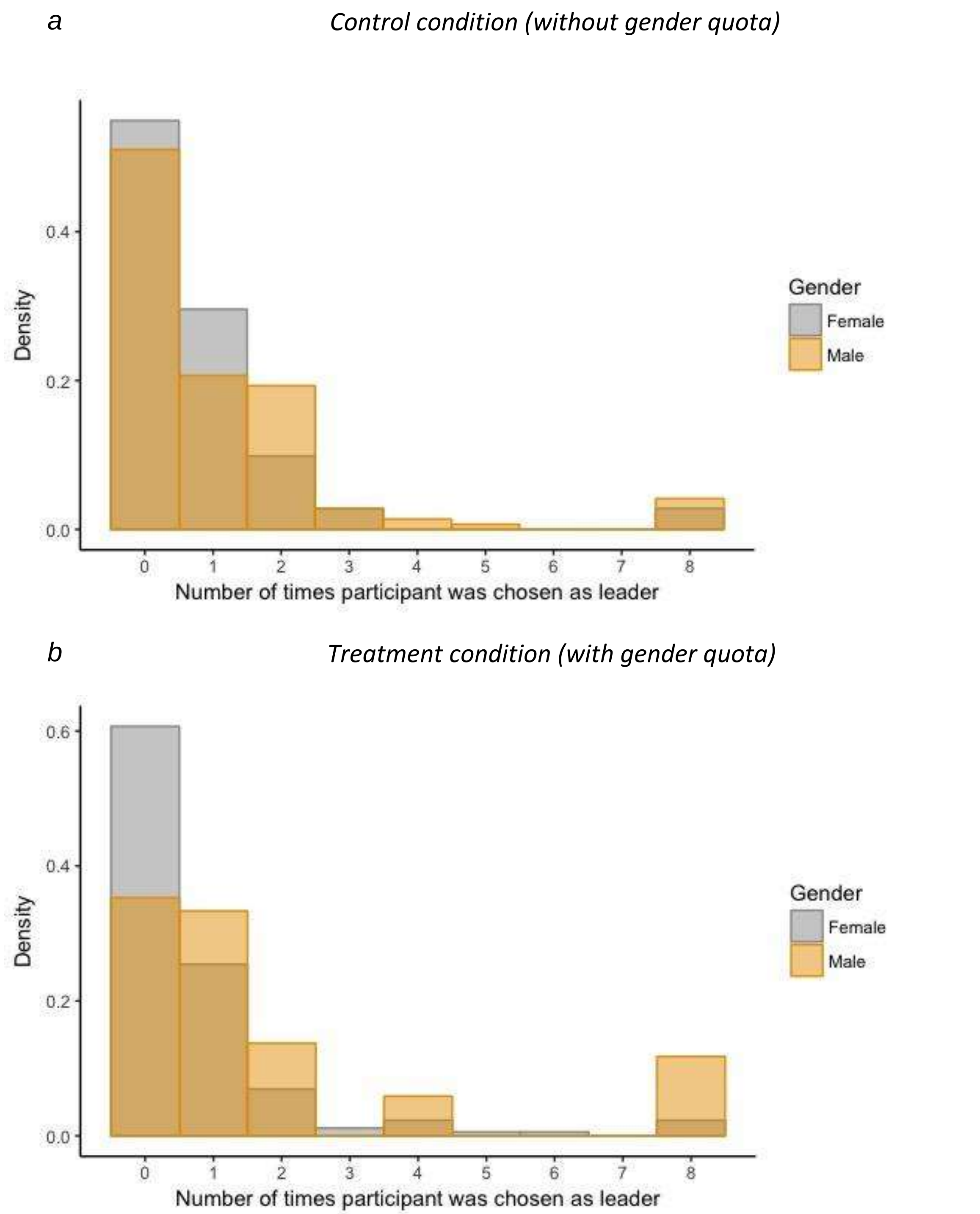
Supplementary Figure 3: Percentage of communication by women in group, by treatment assignment. 95% confidence bounds.

Supplementary Table 1: Estimated effects of gender quota on the gender of the leader, gender composition of the group, and percent of communication by women. Model S1 uses a logistic link function and group-level random intercepts to estimate the effect of the gender quota on the gender of the leader. Unit of analysis is group-round, and only observations from round 9-16 are included. Model S2 and Model S3 are cross-sectional linear regression models with 95% confidence intervals adjusted for heteroscedasticity. Models use data from groups used in the main analysis. One group is excluded from Model S3 due to missing data on the dependent variable.

	Model S1	**Model S2**	**Model S3**
Dependent Variable	*female leader* $_{gt}$	*proportion female* $_{g}$	*percent communication by women* $_{g}$
Gender quota $_{g}$	2.453 (0.704, 4.202) z = 2.749 p = 0.006	0.439 (0.346, 0.532) t = 9.285 p < 0.001	39.624 (27.305, 51.943) t = 6.304 p < 0.001
Constant	-1.863 (-3.134, -0.592) t = -2.873 p = 0.005	0.329 (0.244, 0.413) t = 7.643 p < 0.001	22.366 (13.766, 30.965) t = 5.097 p < 0.001
N	440	55	54

Supplementary Note 2. Additional game dynamics

Supplementary Figure 4 shows the number of times individual participants were chosen as leaders during the game, separated by treatment assignment and the gender of the participant. Without the randomly assigned gender quota treatment, female participants were slightly more likely than men to be chosen one time or fewer, and slightly less likely than men to be chosen two or more times (panel a). The groups treated with the gender quota exhibited larger gender disparities in the probability of reelection. In those groups, an individual woman was substantially more likely than a man to never be chosen at all, while an individual man was substantially more likely than a woman to be chosen as the leader for four or more rounds. These results are consistent with those presented in Supplementary Figure 1 and Supplementary Figure 2, which show that although the treatment group had roughly 40% more women than the control group, the treatment group had only about 30% more female leaders than the control group. This suggests that the groups exhibited gendered biases in leadership selection, biases which persisted even under the treatment condition where men were less numerous.



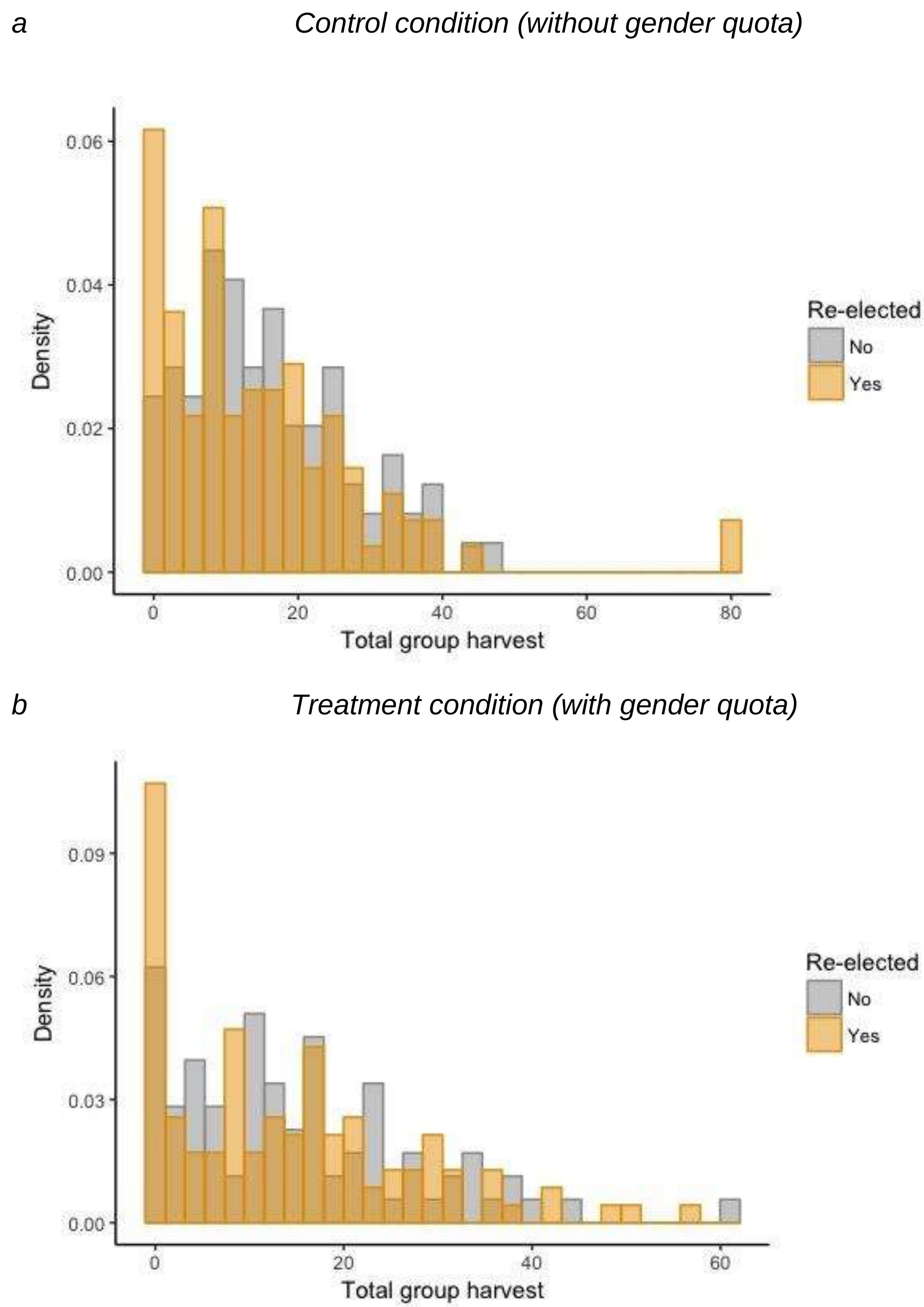
Supplementary Figure 4: Number of times participant was chosen as leader, by gender and treatment assignment. Each observation represents an individual participant.

Additionally, Supplementary Figure 5 and Supplementary Table 2 show how the reelection of the leader in the subsequent round covaried with group harvesting rates and inequality in the distribution of the PES, respectively. Supplementary Table 2 only reveals small differences between the treatment and control groups: If a leader distributed the PES unequally in the control group, they were slightly *more* likely to be reelected in the next round than to not be reelected (panel a), whereas if a leader distributed the PES unequally in the treatment group, they were slightly *less* likely to be reelected in the next round than to not be reelected (panel b). Supplementary Figure 5 shows no strong differences in the relationship between total group harvesting rates and leader reelection. The distribution of the per-round group harvesting rate does not appear substantially different, comparing rounds when the leader was subsequently re-elected to rounds when the leader was subsequently replaced, regardless of treatment assignment. Finally, we use mixed-effects logistic regression models to predict the likelihood of leader reelection in the next round as a function of the time-varying Gini coefficient and total group harvest, estimating the relationships separately for the treatment and control groups. These estimates are given in Supplementary Table 3. While large confidence intervals prevent us from inferring that the relationships are null, the estimates on the Gini coefficient and total group harvest fail to reach statistical significance at the 95% confidence level in both models (although the negative estimate on the total group harvest approaches statistical significance in the control group). Taken together, these descriptive analyses do not reveal any striking differences in the likelihood of leadership reelection based on conservation outcomes or inequality in the distribution of the PES.

Supplementary Table 2: Relationship between reelection and PES distribution, by treatment assignment. Each observation represents a single group in a single round.

a	*Control condition (without gender quota)*	
	Leader was reelected	Leader was not reelected
Leader distributed PES equally	45%	34%
Leader distributed PES unequally	11%	9%

b	*Treatment condition (with gender quota)*	
	Leader was reelected	Leader was not reelected
Leader distributed PES equally	49%	39%
Leader distributed PES unequally	5%	8%

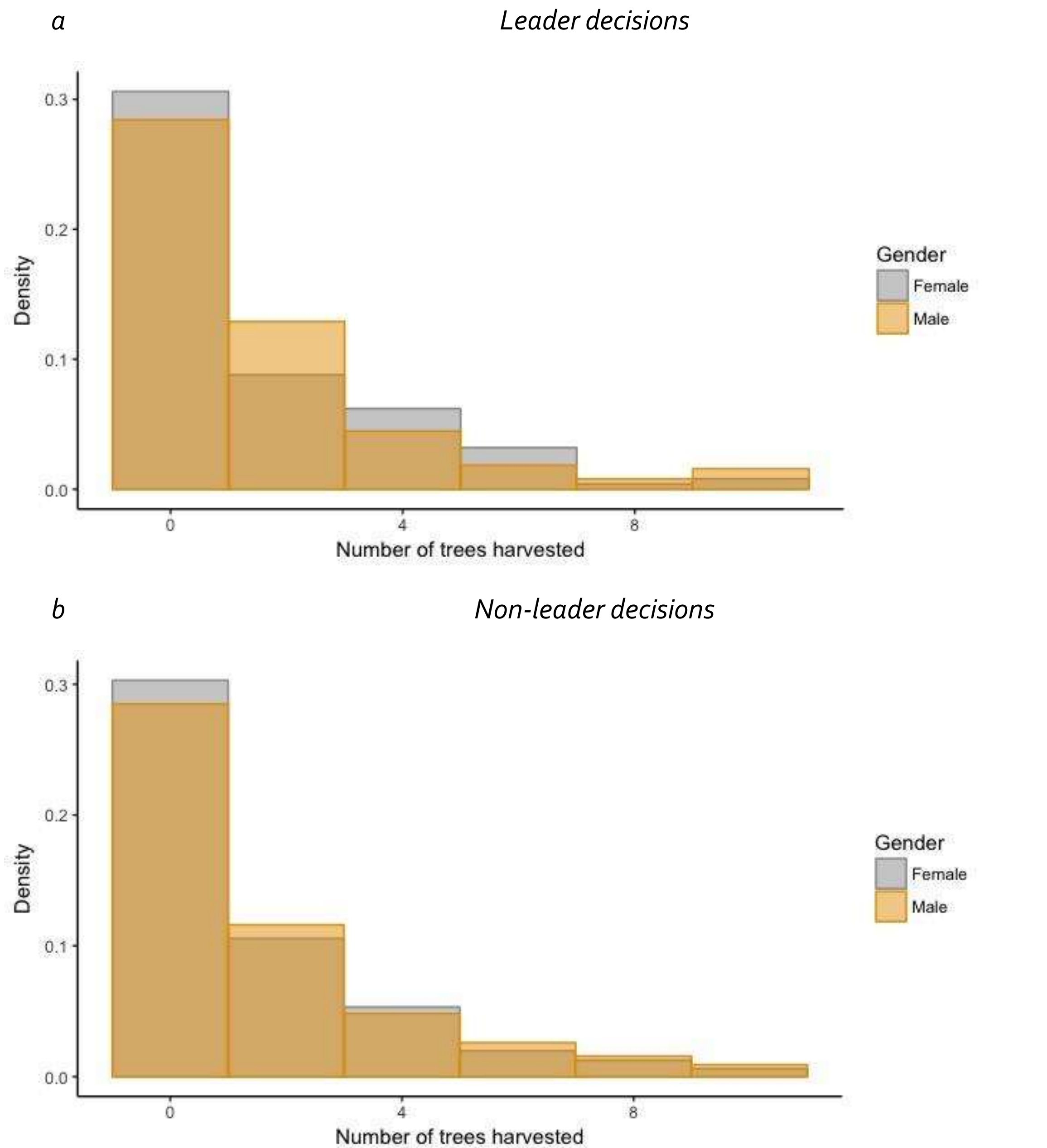


Supplementary Figure 5: Relationship between total group harvest and leader reelection in the subsequent round, by treatment assignment. Each observation represents a single group in a single round.

Supplementary Table 3: Correlates of leader reelection in the next round. Estimates from mixed-effects logistic regression models with 95% confidence intervals in parentheses. Unit of analysis is group-round for both models. Estimation was performed separately for groups assigned to treatment and control. Both models include random intercepts at the group level.

	Model S4 (Treated groups)	**Model S5 (Control groups)**
$Gini_{gt}$	-3.746 (-12.778, 5.286) z = -0.813 p = 0.417	-1.229 (-3.987, 1.529) z = -0.873 p = 0.383
$harvest_{gt}$	-0.081 (-0.187, 0.025) z = -1.496 p = 0.135	-0.106 (-0.217, 0.005) z = -1.878 p = 0.061
Constant	1.551 (-0.697, 3.800) z = 1.352 p = 0.177	1.754 (-0.103, 3.611) z = 1.851 p = 0.065
N	140	127

Finally, Supplementary Figure 6 shows the harvesting decisions of leaders and non-leaders. Because the position of the leader can be awarded to different participants in a given group at different rounds, each data point represents an individual decision, with data points in panel *a* representing individual decisions taken by participants during a round in which they were the leader, and data points in panel *b* representing individual decisions taken by participants during a round in which they were *not* the leader. The results do not reveal any notable differences in harvesting decisions between leaders and non-leaders, even when further disaggregated by gender of the participant.



Supplementary Figure 6: Harvesting decisions of leaders compared to those of non-leaders. Each observation represents an individual participant's harvesting decision in a single round. Panel *a* shows all decisions taken by participants while holding the leadership position, and panel *b* shows all other decisions (those taken by participants while they were *not* holding a leadership position).

Supplementary Note 3. Joint outcomes

The results presented in Table 1 of the main text raise questions about the effect that gender quotas might have on effectiveness and equality outcomes jointly. Building on recent research to assess how local environmental governance institutions affect multiple outcomes simultaneously *(1)*, to what extent do gender quotas increase the likelihood of user groups jointly achieving more equality and more conservation?

Supplementary Table 4 lends some preliminary descriptive evidence regarding joint outcome patterns with and without gender quotas in our experiment. We calculated a time-invariant Gini coefficient representing the inequality in the total distribution of the PES across participants in each group, and calculated the summed number of trees harvested by participants in each group during rounds 9-16. We estimated Pearson correlation coefficients for these two variables, separately for groups assigned to treatment and control. For the groups assigned to the control condition, there was a negative correlation between total harvesting rates and the aggregate Gini coefficient during the rounds in which the PES was offered. This result suggests that most of the control groups faced tradeoffs in the experiment: The groups that tended to achieve equality had high harvesting rates, and the groups exhibiting more inequality had lower harvesting rates, but few of the control groups came close to Pareto-optimal levels with respect to both outcomes. The groups treated with the gender quota, however, exhibited the opposite pattern: They tended to either jointly maximize equality and conservation outcomes or fail with respect to both outcomes. In other words, the data produced by our experiment suggest that groups without a gender quota exhibited conservation-equality “tradeoffs” whereas groups with a gender quota achieved synergistic joint outcomes.

Supplementary Table 4: Correlation coefficients for time-invariant Gini coefficient and total harvests, aggregated across rounds 9-16. Estimation was performed separately for treatment and control groups. Time invariant Gini coefficient was calculated by taking the Gini coefficient of the total distribution of the PES in each group of eight participants, across all rounds in which the payment was offered.

	Treated groups	**Control groups**
r(25)	0.508	-0.397
	p = 0.007	p = 0.040
N	27	27

Supplementary Note 4. Replication of results with generalized linear modeling

In this section we present a replication of our results using a generalized linear modeling approach. We maintained the same data structure, variables, and sample as in the original analysis and used two over-dispersed Poisson error models as a robustness check (Supplementary Table 5). Model S6 is analogous to Model 1 in the main text. The time-varying Gini coefficient is converted to a percentage in this model. Model S7 replicates the results from Model 2 in the main text. Because there was evidence that mixed-effects over-dispersed Poisson regressions were unable to converge properly, we omitted the group-level random intercepts and instead accounted for the clustered nature of the data using a group-level cluster-correction for the standard errors. The results from both models are similar to the original results. The only notable difference is that the pre-PES difference in harvesting rates between groups assigned to treatment and control, represented by the coefficient on the gender quota variable in Model S7, is no longer statistically significant ($p = 0.237$). We therefore cannot conclude that the groups with the gender quota exhibited statistically different harvesting rates in the pre-PES rounds compared to the groups assigned to control.

Supplementary Table 5: Replication of results with over-dispersed Poisson regression. 95% confidence intervals in parentheses, estimated with group-level cluster correction

	Model S6	**Model S7**
Dependent Variable	*Gini (%)$_{gt}$*	*harvest$_{gt}$*
Gender quota$_g$	-1.140 (-2.097, -0.183) z = -2.334 p = 0.020	0.181 (-0.119, 0.482) z = 1.181 p = 0.238
PES$_t$		-0.489 (-0.623, -0.354) z = -7.103 p < 0.001
Gender quota$_g$ x PES$_t$		-0.238 (-0.462, -0.014) z = -2.078 p = 0.038
Constant	2.226 (1.564, 2.888) z = 6.591 p < 0.001	3.204 (2.982, 3.426) z = 28.255 p < 0.001
N	304	879

Supplementary Note 5. Descriptive statistics on experiment participants

Supplementary Table 6 gives basic descriptive statistics on the experiment participants.

Supplementary Table 6: Descriptive statistics for experiment participants.

Country	Statistic	Age	Female	Years of formal education
Indonesia	Mean	35.83	0.61	8.11
	SD	9.21	0.49	2.51
	N	127	128	118
Peru	Mean	38.42	0.57	6.83
	SD	12.39	0.50	3.41
	N	120	120	115
Tanzania	Mean	41.17	0.50	6.86
	SD	12.63	0.50	3.05
	N	192	192	192
All	Mean	38.87	0.55	7.20
	SD	11.86	0.50	3.06
	N	439	440	425

Supplementary Note 6. Individual-level balance tests and replication with controls

Although the experimental treatment was assigned randomly to groups of participants, the unique nature of the treatment (which involves manipulating who is eligible to be in each group) creates the possibility of systematic differences between treatment and control groups that could confound the results. For example, if for some reason the women who volunteered for our activity tended to be less (or more) educated than the men, the randomly assigned gender quota would lead to differences in education between the treatment and control groups that could bias the results (if education is related to the behaviours measured in this study). We explore this possibility through an individual-level balance test based on a number of key participant characteristics. We test for imbalance between treatment and control participants on age, years of formal education, and hectares of land owned by the household (a proxy for wealth). We also test for balance on a measure of forest use: the number of days in the last month that the participant reported visiting the forest, a proxy for the degree to which the participant uses the forest.

Supplementary Table 7 shows the results of the balance tests. Logistic regression models were used to predict the dichotomous treatment indicator as a function of the variables discussed above. There are no discernable differences (other than the expected gender difference) in the characteristics of participants in treatment groups versus those in control groups, with all estimates failing to reach statistical significance at conventional levels. Furthermore, replicating the original linear mixed-effects models while controlling for group-level averages of the variables discussed above does not change the original estimates (Supplementary Table 8).

Supplementary Table 7: Individual-level balance tests. Dependent variable is a dichotomous indicator for treatment assignment. Logistic regression models with group-level cluster correction. 95% confidence intervals in parentheses.

	Model S8	Model S9	Model S10	Model S11	Model S12	Model S13
Female$_i$	1.896 (1.341, 2.450) z = 6.701 p < 0.001					
Age$_i$	0.016 (-0.013, 0.045) z = 1.078 p = 0.282	0.004 (-0.020, 0.028) z = 0.326 p = 0.745	0.006 (-0.017, 0.028) z = 0.481 p = 0.631			
Years of education$_i$	-0.053 (-0.158, 0.053) z = -0.979 p = 0.328	-0.075 (-0.169, 0.020) z = -1.553 p = 0.121		-0.065 (-0.158, 0.028) z = -1.364 p = 0.173		
Hectares of land owned by household$_i$	-0.003 (-0.095, 0.088) z = -0.074 p = 0.941	-0.013 (-0.096, 0.070) z = -0.315 p = 0.753			-0.008 (-0.091, 0.075) z = -0.190 p = 0.850	
Days visited forest in last month$_i$	0.006 (-0.039, 0.051) z = 0.261 p = 0.795	0.006 (-0.034, 0.047) z = 0.307 p = 0.759				0.004 (-0.034, 0.042) z = 0.200 p = 0.842
Constant	-1.306 (-2.949, 0.338) z = -1.557 p = 0.120	0.370 (-1.037, 1.776) z = 0.515 p = 0.607	-0.183 (-1.203, 0.838) z = -0.351 p = 0.726	0.511 (-0.352, 1.373) z = 1.161 p = 0.246	0.010 (-0.558 0.578) z = 0.035 p = 0.972	0.015 (-0.559, 0.589) z = 0.051 p = 0.960
N	399	399	439	425	415	440

Supplementary Table 8: Replication of model results with controls. Model specifications are the same as those reported in Table 1 of the main text, with the addition of time-invariant controls.

	Model S14	Model S15
Dependent variable	$Gini_{gt}$	$harvest_{gt}$
Gender quota$_g$	-0.041 (-0.075, -0.007) z = -2.380 p = 0.018	4.097 (2.738, 5.457) z = 5.908 p < 0.001
PES$_t$		-9.519 (-11.045, -7.992) z = -12.222 p < 0.001
Gender quota$_g$ X PES$_t$		-5.671 (-7.763, -3.578) z = -5.311 p < 0.001
Average age$_g$	0.001 (-0.002, 0.004) z = 0.635 p = 0.526	0.255 (0.165, 0.344) z = 5.564 p < 0.001
Average years of education$_g$	0.011 (-0.002, 0.024) z = 1.662 p = 0.097	-0.140 (-0.522, 0.242) z = -0.720 p = 0.472
Average hectares of land owned by household$_g$	0.001 (-0.005, 0.008) z = 0.364 p = 0.716	-2.006 (-2.474, -1.537) z = -8.391 p < 0.001
Average days visited forest in last month$_g$	-0.006 (-0.009, -0.003) z = -4.091 p < 0.001	0.250 (0.116, 0.384) z = 3.649 p < 0.001
Constant	-0.003 (-0.154, 0.147) z = -0.045 p = 0.965	16.853 (11.676, 22.031) z = 6.380 p < 0.001
N	302	863

Supplementary Methods

The full field protocol for our experiment is provided in *(2)* (pp. 9-16; 28-35). A similar version of the experiment, but with a different set of treatments, is presented in the SI of *(3)*.

Supplementary References

1. Persha, L., Agrawal, A. & Chhatre, A. Social and ecological synergy: local rulemaking, forest livelihoods, and biodiversity conservation. *Science* **331,** 1606–1608 (2011).
2. Lopez, M.C. & Andersson, K. *WP7 Field Protocol Training Modules and Manual.* (CIFOR, 2016). https://www.cifor.org/library/6145/ (Accessed February 13, 2019).
3. Andersson, K. *et al*. Experimental Evidence on Payments for Forest Commons Conservation. *Nat. Sustain.* **1,** 128–135 (2018).