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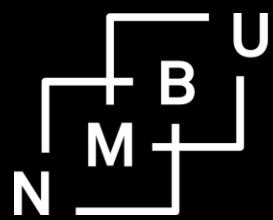
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The Importance of Ostrom's Design Principles: Youth Group Performance in Northern Ethiopia[1]

By

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Abstract

Youth unemployment and migration are growing challenges that need more political attention in many countries, particularly countries with rapid population growth and economic transformation. Proactively mobilizing the youth as a resource in the creation of sustainable livelihoods can potentially be a win-win-win solution that Ethiopia is currently attempting. The new youth employment strategy includes allocation of rehabilitated communal lands to youth groups. This study investigates the extent to which Ostrom's Design Principles (DPs) are followed and matter for the early performance of youth groups in terms of their stability, trust and overall performance. Data from a census of 742 youth groups in five districts in Tigray in northern Ethiopia is used. This study utilizes econometric methods to assess correlations between the DPs and a range of early performance indicators. The study contributes to the limited literature on local collective action utilizing large samples. We find a high degree of compliance with the DPs. Some of the DPs appeared more important for early performance of the youth groups. The Ethiopian youth group approach to mobilize landless and unemployed youth is promising and should be tested elsewhere. Further longitudinal research is needed on the Ethiopian model as it is still at an early stage of testing as most groups are less than five years old.

Key Words: Youth groups; primary cooperatives; common pool resource management; Ostrom's design principles; group performance; Ethiopia.

JEL codes: Q15; Q23.

The Importance of Ostrom's Design Principles: Youth Group Performance in Northern Ethiopia

Highlights

- Youth unemployment and migration are growing challenges that need attention

- Ethiopia has started allocating rehabilitated communal lands to youth groups

- Census data from 742 youth groups in five districts in northern Ethiopia is used

- The youth groups to a large extent comply with Ostrom's Design Principles (DPs)

- We find significant positive correlations between DP compliance and performance

1. INTRODUCTION

Despite rapid urbanization, a large share of the youth will remain predominantly rural in sub-Saharan Africa for at least two more decades (IFAD, 2016). This is especially the case in Ethiopia, where urbanization still lags behind, while the country now faces a youth bulge and rapidly growing number of landless youth that seek off-farm employment (Bezu & Holden, 2014). Some associate the youth bulge with potential social instability (Heinsohn, 2003; Beehner, 2007; Collier & Hoeffler, 1998; Goldstone, 2002; Blattman and Miguel, 2010) and youth played a central role in the recent unrest in Ethiopia. A pro-active youth policy is important for the youth to regain trust in the Ethiopian government. It still has officially to renew its youth policy of 2004 (FDRE, 2004). However, new approaches are piloted and this study aims to explore one of these pilot approaches, where rehabilitated communal lands and mineral resources are provided to youth groups formalized as primary cooperatives.

Elinor Ostrom received the Nobel Prize in economics for her contributions to understanding collective action related to natural resource management. Her Design Principles (DP)[1] were first listed in her book (Ostrom, 1990) and later refined (Ostrom, 2010). These conditions for successful collective action to secure sustainable management of natural resources were derived from assessment of a large number of studies. The DPs were used to characterize commons that had been managed in a sustainable way over a long time. However, this triggers the question of how and when the DPs were adopted in the first place? Context, such as resource characteristics and hard infrastructure (Baggio et al., 2016; Schlager, Blomquist & Tang, 1994) may also matter for which combinations of DPs are more important for group performance. By studying recently

established youth groups in northern Ethiopia, we aim to provide evidence on the extent of group compliance with the DPs and how that is correlated with early performance of these groups.

Agrawal (2001) discusses the contributions of Ostrom (1990) and relates them to other milestone contributions in the common pool resource (CPR) literature (Wade (1988) and Baland and Platteau (1996)); by highlighting the complexity of causal relationships in social-environmental systems, data limitations and the methodological challenges in expanding our understanding of the issues. Ostrom (1990) conducted a meta-analysis based on case studies by other scholars. Baland and Platteau (1996) built on a wider literature review of property rights issues. Wade (1988) built his analysis on studies in 31 villages in Southern India. Most studies of CPR governance and management have been case studies ("small sample studies") and there have been few "large sample studies"[2] that have tested the relative importance of the different DPs (Poteete & Ostrom 2008). Cox, Arnold and Villamayor Tomás (2010) and Baggio et al. (2016) are exceptions and have each assessed 91 and 69 cases respectively from the same pool of studies. Cox et al. find a correlation between the number of DPs adopted and success of the CPR in achieving ecological stability. Baggio et al. (2016) expand the investigation of forestry, fishery and irrigation projects and how combinations of DPs matter for each of these in achieving social and ecological success. We add to this literature in two important ways. First, by assessing the degree of compliance with Ostrom's DPs among new youth groups established through state-community agreements orchestrated in the Tigray Regional State in northern Ethiopia. We utilize a unique new census of such groups for this. Second, by assessing how the degree of compliance with the DPs is associated with four socio-economic performance (success) indicators for these groups. We use the following performance (success) indicators: share of initial group members still staying in the group at the

time of the census, group trust (ranked by group leader), Youth Association assessment of performance, and income from joint activity per member.

The allocation of rehabilitated forests and grazing lands to youth groups has a risk of ending as a "Tragedy of the Commons" (Hardin, 1968) unless the youth groups are able to cooperate and establish sustainable livelihoods through local collective action in line with the DPs of Ostrom (1990; 2010)[3]. More specifically, the degree of compliance with the DPs can be important for their degree of early success.

Our study is a census carried out in 2016 of 742 such youth groups in five districts in Tigray. The mean initial group size is 19.5 (st. dev. 16.1, minimum 2[4], maximum 193). Our study therefore covers 14,500 youth organized into groups over the period 2011-2015. Each group is formalized as a primary cooperative under the cooperative law (FDRE, 1998, amended 2004). They have to self-organize and elect a board of five members, develop their own bylaws, develop a business plan that needs approval by the local government, and their accounts are subject to regular auditing. Most groups are allocated a common pool resource[5] of rehabilitated communal land to protect, where they are expected to establish a productive livelihood activity, e.g. apiculture, livestock rearing, forestry, horticulture and use of irrigation. Other groups are given temporary mineral rights to allow them to build a starting capital for another form of business. When a certain amount of capital has been built, they graduate. Except for the mineral groups, which are temporary income-generating groups, the objective of the program is to create sustainable livelihoods for landless youth.

One of the difficulties of establishing causality in the relationship between the DPs and performance based on survey data is that the compliance with the DPs can be endogenous and a result of long-term institutional refinement and adjustment in complex systems. The advantage of our study is that the formation of the youth groups we study is very recent and that there may be substantial variation in the extent to which the bylaws comply with the DPs. We cautiously attempt to use this variation as a natural experiment. In other contexts such rules may be the outcome of careful testing and evolution of what works better. This is the case for many well-functioning common property regimes like those studied by Ostrom and others (Ostrom & Basurto 2011). Although the youth themselves have limited experience with such group cooperation at the time of the establishment of the groups, they come from families that have long experience with various types of collective action to produce local public goods, and have been advised by local government. These influences may have served as Ostrom's "invisible hand"[6] that may contribute to high compliance with the DPs and more successful group performance outcomes.

In light of the growing challenge of rural landlessness, youth migration and unemployment in many countries, it is of high interest to know whether the approach used in our study is a good way to promote youth entrepreneurship by providing youth groups a joint responsibility for environmental stewardship and livelihood opportunity through self-organization. Our findings are indicative of a potentially promising model for youth employment creation.

2. THEORETICAL FRAMEWORK: OSTROM'S DESIGN PRINCIPLES

An overview of the Design Principles is presented in Table 1. Ostrom (2010) acknowledges that some of the DPs in her previous work (Ostrom, 1990) were too general. She subsequently split three of them in two separate principles, each based on the proposal of Cox et al. (2010). Cox et

al. (2010) analyzed 91 studies and coded 77 cases from these, including forest, fishery, irrigation, pasture, multiple and other cases. They coded DPs 1, 2 and 4 into sub-components, which is accommodated in Table 1. E.g., DP1 in Table 1 can be seen as both a demarcation of a physical area and a group of members. DP2 can also be seen as a combination of two principles; the matching of restrictions and resources on the one hand, and provision and appropriation rules on the other (Agrawal, 2001). Similarly, DP4 can be seen as two types of monitoring; monitoring of resources and monitoring of users (Agrawal, 2001; Cox et al., 2010; Ostrom, 2010). Cox et al. classified cases by whether monitors were present (4a) and whether these monitors were members of the community (4b). This was different from what they afterwards recommended and what is adopted in Table 1, a) monitoring of users and b) monitoring of the resource.

[TABLE 1 approx. here]

Cox et al. (2010) found that two-third of the studies confirm that robust systems are characterized by most of the DPs being in place, while those that are not robust to a lower degree follow the DPs. They found moderate support for DPs 1b, 3, 4a, 5, 6, 7 and 8 and strong support for DPs 1a, 2a, 2b, and 4b. By support, they meant that the presence of the DP was positively correlated with successful management. Bardhan (2000) studied 48 irrigation systems in India and found a positive correlation between having a guard and cooperative behavior. Agrawal and Chhatre (2006) on the other hand, based on a study of 95 community-based forest management systems in India, found a negative correlation between having a guard for enforcement of rules and the forest condition. They indicated that there can be a reverse causality from poor forest condition and to hiring a guard. Establishing the direction of causality can be tricky in relation to other DPs as well.

Baggio et el. (2016) built on the work of Cox et al. (2010) and recoded many of the same cases, more especially the forestry, fishery and irrigation cases. They diversified the success criteria and related the DPs to the conceptual framework of Schlager et al. (1994), classifying resources as mobile or fixed and human-made infrastructure as hard or soft. The DPs mostly represent soft human-made infrastructure such as local institutional arrangements that are intertwined with the broader coupled infrastructure system. Baggio et al. (2016) investigated whether the DPs represent necessary and sufficient conditions for success for 69 recoded cases from Cox et al. (2010). They assessed the extent to which co-occurrence of DPs is associated with higher likelihood of success. They found that no DP alone is sufficient and necessary for success but success is associated with a larger number of DPs co-occurring. When dividing the DPs in 11, they found that having eight of these satisfied ensures success regardless of the type of resource.

The logic behind our selection of early performance (success) indicators is as follows. A low dropout rate from a group is a proxy of its stability and success, we therefore use the share of initial members staying in the group at the time of our census (2016) as a first early success indicator. Trust level in the group is the second indicator. Trust is a function of preferences and expectations (Fehr, 2009). Trust is likely to be affected by institutional arrangements such as the DPs, which may serve to build trust in the groups through raising mutual expectations. We include group trust level, on a scale from one to five, based on the group leader's assessment, as a performance indicator in our study. The youth groups are supported by representatives of the Youth Association that have representatives in each community (*tabia*). We use their rating as the third indicator. As a fourth indicator, we use the income from the group livelihood production activity per member in the previous year (2015). Generating income from the group livelihood activity is essential for the

groups to sustain their livelihoods. Groups that work harder and invest more are likely to generate higher income.

While Ostrom emphasized that the DPs should not be used as a blueprint but rather as a diagnostic tool, we investigate whether and to what extent they can be part of a recommendation package that should be considered when establishing new user groups that are given joint responsibility for a common pool resource. Our study of the Ethiopian pilot youth groups program with mixed livelihood production activities is such a bold attempt that may deserve wider testing.

3. MATERIALS AND METHODS

Biophysical, climatic and demographic description

We have carried out a census of 742 youth groups in five districts in Tigray region of Ethiopia in 2016 (Fig. 1). We obtained complete data from 725 groups for our econometric analysis. Tigray is characterized by a tropical semi-arid climate with long dry season and erratic rainfall between June and September. The mean annual rainfall varies from 200 mm in the eastern part to over 950 mm in the southwestern part. The length of the growing period varies from 75 to 90 days whereas the average annual temperature ranges from 15 to 25°C (Tesfaye, 2006; Birhane, Aynekulu, Mekuria & Endale, 2011).

Just before the time of the study, in 2015, in the five study area districts, the total human population was c. 641,000, accounting for 12.7% of the population in Tigray, covering c. 1,657 km^2 accounting for close to 26% of the land area in Tigray. Population densities in the 5 districts are lower than the average for the region and vary from 51 persons per km^2 in Seharti Samre to 73

persons per km^2 in Raya Azebo districts (Table 2). Based on the population census of 2007, youth (aged 15 to 39) account for 35.1% of the total population in the region.

[TABLE 2 approx. here]

Until 2015, 552,480 ha of land, or 13.3% of the total land area of Tigray, was rehabilitated with labor contributions of rural people in the region[7]. According to data from the Bureau of Agriculture and Natural Resources Management of Tigray, 69% of this land was rehabilitated through the Productive Safety Net Program (PSNP), 21% through the Sustainable Land Management Program, and the remaining 10% with the support from projects funded by the World Food Program and other donors. A relatively large share of close to 32% of the rehabilitated land in the region is located in the 5 districts of our study sites (Table 2). Overall, the region has distributed 18% of the rehabilitated land, which are mostly hillsides, exclosures and rehabilitated gullies, to landless people, mostly the youth.

[FIGURE 1 approx. here]

Data

Table 3 gives an overview of the distribution of youth groups across districts by main livelihood activities. A structured questionnaire was used to interview the chairperson of each youth group.

[TABLE 3 approx. here]

Performance indicators and their distributions are presented in Tables 4 and 5 and Fig. 2. Table 4 shows performance indicators, including group trust and Youth Association ranking, with distributions. The share of the initial group members remaining at the time of our census (2016) is an indicator of the stability of the group and its distribution is shown in Fig. 2. Table 5 gives an overview of mean individual income by group livelihood production activity.

[TABLE 4 approx. here]

[TABLE 5 approx. here]

Table 6 gives an overview of variables included as controls in the performance related models. Some of these can be endogenous in nature and require cautious assessment, see next section for how this is handled. In addition, district and main livelihood activity dummy variables are used as controls (see Table 3 for the number of observations per district and per main activity).

[TABLE 6 approx. here]

Estimation strategy

First, we examine whether the DP indicator variables can be considered as "pre-determined" relative to the outcome variables that we are assessing their correlation with. If they are pre-determined, we may be more able to rule out reverse causality (performance affecting the DPs) but not endogeneity[8] of these DPs (correlations with group and community characteristics). An individual DP characterization follows. DP1 (encroachment control system in place) is assessed during our census in 2016. We cannot rule out that the encroachment control system has responded to actual exposure to violations since establishment of the group. Such controls have a higher likelihood of being imposed where encroachment is a problem and this may cause an underestimation of the effect of imposing such controls. DP2 (bylaw regulating sharing arrangements), DP3a (bylaw regulating frequency of meetings), DP4 (number of bylaws regulating management) and DP5 (number of bylaws stipulating graduated sanctions) are bylaws that were agreed upon by the youth groups when they were established. We investigated whether these bylaws were revised after their initial establishment but there were hardly any such adjustments. We can therefore be confident that these represent "pre-determined" variables. DP3b (all members involved in decisions) is, on the other hand, based on an assessment at the time of the census and indicates that decisions have not been delegated to the elected members or the leader. This variable cannot, therefore, be considered as pre-determined and the causality could go both ways. DP6

(satisfactory conflict resolution system) is also an assessment at the time of the census and may depend on the extent to which weaknesses in the conflict resolution system have been revealed through exposure to conflicts. Similarly, we therefore cannot rule out reverse causality.

Information about the key performance indicators is presented in Tables 4 and 5 and Fig. 2. A fractional response probit model is used for the 'member share staying' models (Wooldridge, 2010)[9]. Ordered probit models[10] are used for the level of trust (group leaders' assessment) and the Youth Association's assessment of group performance. Censored tobit models[11] are used for the group (log-transformed) income per member models. We assess the correlations between these performance indicators and the DPs as shown in equation (1).

(1) $$PI_g^p = f^p \left(DP_g, G_g, A_g, D_g, IMR_g \right) + e_g$$

PI_g^p represents the vector of performance indicators[12] for each youth group g, DP_g represents the vector of DP indicators, G_g is a vector of group characteristics, A_g is a vector of livelihood production activity dummy variables, D_g is a vector of district dummy variables, IMR_g is the inverse mills ratio for groups that were able to self-select themselves into groups. The $f^p(.)$ function implies that the functional relationship between the performance indicators (p) and the RHS variables varies across the models.

We assessed the potential endogeneity of the DPs by first regressing them on the set of controls (equation (2)).

(2) $$DP_g = a_0 + a_1 G_g + a_2 A_g + a_3 D_g + a_4 IMR_g + v_g$$

The correlations between the DP indicator variables and the controls using Ordinary Least Squares (OLS) is shown in Table A25 in the Appendix. 80 to 95% of the variation in the DPs was

unexplained by these controls. Certain DPs were more likely to have been implemented in certain districts (*woredas*). It also shows a higher R^2 for the DPs that were more likely to have changed after the formation of the groups (DP1, DP3b, DP6). Endogeneity may therefore be more of an issue for these DPs. We tried instrumental variable (IV) estimation with a number of candidate instruments but these attempts failed. Either the instruments were not strong (low F-values in the first stage regression) or they failed the over-identification tests (were significantly correlated with the outcome regression error term). We have therefore resorted to the second best strategy of careful interpretation of the results when potentially endogenous variables are included, whether these are the DPs or the control variables.

The DP variables may potentially be closely correlated with each other and therefore create problems with multicollinearity in the regressions. We assessed this and the correlation coefficients can be inspected in Table A24 in the Appendix. We also assessed the effects on significance levels from dropping some of the most closely correlated DPs but this did not make any difference in the statistical significance of the remaining DPs. The correlations therefore appeared tolerable.

Finally, we constructed an aggregate measure of the six DPs by giving each DP equal weight (=1) and thereby get a DP index with values from zero to six. The DP index variable was exposed to the same robustness assessment and IV tests as the disaggregated DP indicator variables. In this case, we were also unable to find strong and valid instruments and could not reject the exogeneity hypothesis[13]. The aggregate distribution of the DP index is shown in Fig. 3.

[FIGURE 3 approx. here]

We ran models to assess factors potentially correlated with this aggregate DP index. The index may be spatially correlated due to local cultural differences and variations in agro-ecological conditions. The type of main livelihood production activity and area per member may also matter and so may various group characteristics such as timing of establishment, group size, female share in the group, and gender of group leader. Self-selection of group members may also be important and we assessed potential selection bias related to this. The model results are presented in Table A27 in the Appendix. We found that only the female share of group members and district dummies were significant. Overall, the explanatory power of the models was low. All the analyses were conducted using Stata 14.2.

4. RESULTS

We start by looking at the compliance with each of the DPs in the full sample. Here we provide a summary of findings from a detailed descriptive analysis found in the Appendix.

Ostrom's DP 1: Clearly defined borders

We found that less than 6% of the youth groups experience illegal harvesting on their land more frequently than monthly and only 1.1% experience it more frequently than weekly. Most youth groups have a guarding system protecting their borders and area. From this we can conclude that the resource base of the youth is well protected from extraction by outsiders. Membership of the groups is also clearly identified although the form of cooperation in terms of activities and responsibilities varies.

Ostrom's DP 2: Sharing of benefits and costs/congruence between appropriation rules and

provision rules

97.6% of the groups have a bylaw that regulates the sharing of responsibilities and incomes from the group activities. Equal sharing of income is the rule for 98.7% of the youth groups. The work

responsibilities are shared equally in only 56.7% of the groups, as female members are allowed to do less of the heavy bodywork in the remaining groups.

Ostrom's DP 3: Joint decision-making system

As a primary cooperative, the groups have to establish themselves with a chairperson, vice chairperson, a secretary, an accountant and a treasurer. 92.2% of the groups have penalties for non-participation in the group meetings. There are graduated sanctions against non-participation as well as late arrival to meetings. Moreover, these sanctions have been enforced. Monetary sanctions are most common (86%) of the sanctions. 43.6% of the groups had members that had been penalized for absence from meetings and 36.9% penalized for late arrival to meetings. It is clear that group membership implies strong participation obligations. 68% of the groups have meetings at least biweekly. When asked about influence in decision-making, 71% of the group leaders stated that all members are equally influential, while 26% stated that the elected board of five is more influential. Male dominance is not stated to be strong in the groups, however this response could be confounded given most group leaders are males.

Ostrom's DP 4: Internal monitoring system

As seen above, there is a system with frequent meetings and punishments for non-participation and late arrival. This implies one form of internal monitoring related to decision-making. In addition, we asked whether there is a monitoring system related to participation in group work activities and for late coming to such activities. 92.6% of the groups have bylaw stipulating penalties for not coming to group work activities. 26.1% of the groups have members that have been punished for not coming to group work activities. 79.9% of the groups have bylaws stipulating penalties for arriving late to group work activities and 21.7% of the youth groups have punished some members for late arrival to group work activities.

Ostrom's DP 5: Graduated sanctions

It was the rule rather than the exception to have bylaws with penalties for violations (80-93% of the groups), while 51-82% of all groups had graduated sanctions for the four types of violations. Groups that have bylaws related to non-participation in and arriving late to group meetings and work activities commonly used monetary and non-monetary sanctions. The non-monetary sanctions varied from simple warnings, to "last warning", dismissal from the group, and having to work additional time. The monetary penalties were in most cases increasing with the number of violations, but were in fewer cases the same amount regardless whether the violation was the first, second or third time. Some had a mixture of non-monetary and monetary sanctions. Another common practice was to give a monetary sanction the first two times and then dismissal the third time. There were also mixed penalties such as combinations of monetary and additional work obligations or a monetary sanction combined with last warning. There was also variation in the level and incremental changes in monetary sanction amounts across groups with increasing number of violations by the same person.

Ostrom's DP 6: Conflict resolution system

Approximately 25% of the youth groups have experienced at least one dispute and about 12% have experienced a serious dispute. Disputes between the group and some outsiders were more likely to be perceived as serious than disputes within the group. 82.9% of the disputes within the group were resolved within the group itself while only 19.2% of the disputes between the group and outsiders were resolved among the parties themselves. As much as 39.7% of the disputes between the groups and outsiders were still unresolved at the time of the interview, compared to 3.4% of the within-group disputes. There was a high level of satisfaction (96.6%) with how within-group disputes had been resolved, while 76.6% were satisfied with how the disputes between the group

and some outsiders had been resolved. The local informal conflict resolution system appears to work well for within-group disputes because there were only few cases when the groups had to get help from community (*tabia*) or district (*woreda*) officials to resolve disputes. Some of the conflicts with outsiders were with neighboring tabias (communities) due to disagreements about the location of borders. Many of the internal disputes were conflicts among group members about group activities and organization of the group. Quite a few of these disputes resulted in a change of board members in the group. Since there is 100% compliance with DP7 and DP8, there is no variation in our data. These DPs are therefore not included in our analysis. In order to simplify the analysis we develop a concise set of indicator variables that should capture the variation in the extent to which the youth groups comply with the first six DPs.

The distribution of the DP indicator variables is summarized in Table 7. Note that DP4 and DP5 only are numeric, ranging from zero to four, while the others are represented by dummy variables. Table 6 demonstrates a high degree of compliance with the DPs among the youth groups.

[TABLE 7 approx. here]

DPs and Performance Indicators

The results for the DP and performance indicator models are presented in Table 8. Positive significant coefficients indicate that compliance with the DPs enhance or is positively correlated with performance. DP1 (encroachment control system established) is significantly associated with better performance for three out of four performance indicators. DP2 (bylaw regulating sharing arrangements) and DP4 (number of bylaws regulating management) are not significantly associated with any of the performance indicators. DP3a (bylaw regulating frequency of meetings) is significantly related with, possibly enhancing, one of the performance indicators (the rating by Youth Associations). DP3b (all members involved in decisions) is significantly related with two

indicators but only one of these (trust) has a positive sign (enhancing direction). DP5 (number of graduated sanctions) is significantly related with three of the indicators, two of which are in the enhancing direction. It seems to have contributed positively to (or is positively correlated with) higher share of members staying on in the groups and Youth Association rating (both significant at 1% level) but is negatively correlated with income per member (significant at 10% level only). A higher number of members staying also implies that more members have to share the income from the group activity and this may partly explain this finding. DP6 (satisfactory conflict resolution system) is significantly related with two of the indicators, trust and the Youth Association rating, both with positive sign. Overall, for seven DP measures and four performance indicators we found nine significant positive relationships enhancing performance and two that were significant and negative. The high compliance with many of the DPs resulted in few observations where the DPs were unfulfilled. This may have limited the number of significant positive effects such as for DP2 where the compliance was 97.3%.

For the Member stay share models only DP5 (number of graduated sanctions) was significant (at 1% level) and positive. In the trust model three of the DPs were significant and positive; DP1 (encroachment control system in place) - significant at 0.1% level; DP3b (active participation by all group members in decision) - significant at 1% level; and DP6 (satisfactory conflict resolution system in place) - significant at 5% level. Groups that were allowed to form themselves (self-selection of members) demonstrate significantly (at 0.1% level) higher level of internal trust. A change in board member positions in the groups is associated with a significantly (at 0.1% level) lower level of trust.

We next compare the Youth Association's rating of the groups (a higher number indicating a higher/better rating). The Youth Association has representatives located in each community (*tabia*) who are responsible for following up the youth groups. Table 8 demonstrates that four of the DPs had a significant positive correlation with the Youth Association rating; DP1 (encroachment control system in place) - significant at 0.1% level; DP3a (having bylaw regulating frequency of meetings) - significant at 5% level; DP5 (number of graduated sanctions) - significant at 1% level; and DP6 (satisfactory conflict resolution system in place) - significant at 1% level. DP3b (all members involved in group decisions), is significant (at 1% level) but with a negative sign. DP3b is not pre-determined and endogeneity may play a role. Overall, this gives a good correspondence between the DPs and group performance as judged by the Youth Association.

Irrigation /horticulture groups are rated as performing significantly (at 5% level) better than other groups by the Youth Association. Forest groups are rated to perform poorer than other groups (significant at 10% level only). Self-selection into groups is associated negatively with the ranking while larger area per group member is associated with higher ranking (significant at 5 and 10% levels respectively).

Table 7 shows a very strong and highly significant (at 0.1% level) relationship between DP1 (encroachment control system in place) and member income from group activity. The direction of causality could go both ways in this case. With a more valuable group livelihood production activity, which generates more income for the group, there may also be higher risk of encroachment and theft and making guarding of the area important. Among the other DPs only DP5 (number of graduated sanctions) is significant (at 10% level only) with a negative sign. A

higher number of graduated sanctions is associated with lower income per group member. This could indicate a dis-incentive effect from graduated sanctions. The signs of all the other DPs are positive but insignificant.

Among the other variables, we see that establishment year and month is highly significant and negative in the income models and positive in the member stay share models. This may be because it takes time before the youth group livelihood production activities start to generate income. Dropout rates may also increase over time and there may have been more organizational problems in relation to the establishment of the earliest groups due to less experienced local administrations. Lower income is particularly associated with the forest groups for tree production takes longer time than other activities to generate income. Apiculture also gave significantly lower income than other activities except forestry. 2015 was a drought year and this may have affected negatively the production of honey by apiculture groups. Lower income is not directly related to distance to road or distance to market as these variables are insignificant. However, input access problems were related with lower income (significant at 1% level), and 66% of the groups stated to have such a problem, giving an indirect indication that market access may be a constraint. Income is positively related to the area allocated per initial group member (significant at 10 and 5% levels). Income per current member is increasing significantly (at 0.1% level) with the reduction in group size since start. A higher dropout of members gives more income per remaining members if these are not substituted with new members. Dropouts could also lead to selection of more hard-working members remaining in the groups. The initial female share in the group is negatively associated with income per initial member. This could be because some of the investment activities are physically demanding and more difficult for females to contribute to. Cultural norms may also

play a role here. Some groups allowed females to contribute less to such activities without changing the principle of equal sharing of income. Groups that have had a change in board member positions since start (27% of the groups have had such a change), had significantly (at 0.1% level) higher income per member. Here also causality could go both ways. Higher income could cause more internal controversies and a demand for change of persons in key positions. Such a change could also lead to better group management and higher income.

DP Index models

In Table 9 we present a summary of the model results for the DP index variable across the different performance indicators. The results appear robust across models without and with the control variables. Seven out of eight models give a significant positive correlation between the performance indicators and the DP index. For the group income per member models, the coefficient was significant only in the model without additional controls.

Table 10 summarizes the results for the DP index variable for each of the main livelihood production activities for each of the performance indicators. Due to the more limited number of observations in each activity the number of controls had to be reduced. Only district dummy variables and the year of establishment of the groups are included with the DP index variable in these models.

The DP index is significant in 13 of the 20 models and is significant and positive in 11 of the models, giving two models where it is significant and negative. The two significant and negative models were for forestry groups where the sample size was smallest (42 groups). For the trust indicator the DP index was significant and positive in all livelihood production activity type models.

5. DISCUSSION

Cox et al. (2010) and Baggio et al. (2016) have made important steps towards assessing Ostrom's DPs across a larger set of cases and CPR resource types. Their criteria for success focused primarily on the conservation of the natural resource base. We add to this literature in two important ways. First, we assess the role of the DPs in relation to the establishment of new CPRs[14]. Second, we assess the extent of compliance with the DPs and how it relates to a number of socio-economic rather than ecological success (performance) indicators. These indicators matter for the early survival and stability of the groups in charge of the CPRs. Our study demonstrates a high level of compliance with the DPs and the number of DPs adopted by each youth group is positively correlated with the early performance (success) indicators we have assessed. Since these youth groups have not been trained in these Design Principles we may see this as an effect of Ostrom's "invisible hand". The youth may have been influenced by their parents and local government representatives who have long experience with various forms of collective action that are commonly used in Tigray region of Ethiopia to invest in local public goods such as watershed conservation management institutions and infrastructure.

We used four performance indicators in our study; a measure of group stability; trust within the group as perceived by group leaders; a performance ranking by local Youth Associations and group income per member. The DPs were more strongly correlated with the trust and Youth Association rankings while the results for group income per member were less robust. Trust may be a better indicator or early performance than group income per member as such income depends on the type of production activity and some of the production activities (such as forestry and fruit tree production) take quite a few years before they start to generate income. Complementary sources of income are therefore crucial in the early stages of development and such income is an

individual responsibility among group members. Further research is needed to investigate how such complementary sources of income contribute to group performance. Further analysis is also required to assess the differentiated impacts of combinations of DPs on the different success performance indicators within the alternative livelihood production activities (livestock rearing, apiculture, forest, horticulture/irrigation and mining). This is left for future research, which can yield valuable additional insights about which DPs and combinations of DPs are more important in each of the livelihood production activities.

The Ethiopian pilot approach of subdividing local CPRs into smaller CPRs that are allocated to local youth groups is an innovative idea that deserves further testing and support to assess its potential for scaling up. Ethiopia is special in the sense that its constitution grants local residents without other livelihood options rights to land for livelihood for free (Holden & Ghebru, 2016)[15]. This is an important legal basis for allocation of rehabilitated communal lands to youth that come from the same community that invested in the rehabilitation. How much land can be mobilized for such allocation will vary from community to community. This depends on the availability of CPRs as well as local, regional and federal public support. The number of landless rural youth is growing and the demand for land is high as illustrated by long waiting lists in most rural communities such as in our study areas. Many parents with insufficient land for their children therefore favor such allocations.

The youth-inclusive land restoration policy in Tigray region received the Future Policy Gold Award 2017 from World Future Council and the United Nations Convention to Combat Desertification (UNCCD) (World Future Council, 2017). The land restoration involves integrated watershed management with strong local participation through mass mobilization and coordination of activities. Recently, bench terracing has been introduced (Hagos & Holden, 2002; Haregewey,

Berhe, Tsunekawa, Tsubo, & Meshesha, 2012; Nyssen et al. 2007). However, the youth group pilot project in Tigray is still at an early stage and may be facing multiple threats, including climate risks. The vulnerability of their group livelihood activities to such shocks and their possible complementary activities and public and family support may be crucial for the success of the combined DPs as well. Hard infrastructure such as water access, market access and appropriate technologies is important to reduce vulnerability. A diversification of their livelihood activities may enhance the youth groups' robustness to climate risks. Better linking of the youth groups to value chains will be important for the prices they can achieve for their products such as vegetables, fruits and honey. Entrepreneurship training, skill formation and provision of credit may be crucial for expanding their businesses. A longitudinal study of the youth groups is therefore important to learn from their experiences and identify important constraints that may imply a need for outside support.

The pressure towards livelihood intensification may potentially become a threat to the biodiversity that the youth groups are required to protect in their rehabilitated CPR areas. There may, for example, be a potential conflict of interest between fodder production for livestock and protection of local trees (Mekuria, Veldkamp, Tilahun & Olschewski, 2011). Descheemaeker, Mapedza, Amede and Ayalneh, (2010) argue that besides restoring, regulating and supporting ecosystem services, establishing exclosures and water harvesting structures on degraded lands would lead to a more efficient use of the scarce water resources for biomass and livestock production. Abebe, Oba, Angassa and Weladji (2006) found that establishing exclosures on degraded mountain rangelands influenced the herbaceous species richness and species diversity. Initially the establishment of exclosure for rehabilitation may lead to higher pressure on surrounding areas but after rehabilitation the total supply of ecosystem services will increase. Climate shocks may also

trigger desperate survival strategies that involve excessive harvesting unless alternative coping mechanisms or safety net options are available. The institutionalized rule that the youth groups' CPR rights are conditional on their sustainable land management and proper protection of the vegetation may be sufficient. Whether self-monitoring is sufficient to enforce this rule in a crisis situation, remains to be seen.

Provision of temporal mineral rights and mobilizing youth groups in infrastructure development also holds potential for substantial employment creation and can facilitate rural as well as urban transformation and development. Operationalizing self-organized youth groups can potentially be a cost-effective way for the government that achieves economies of scale through collective action in business formation through these public-private partnership arrangements. The DPs may thus have relevance beyond the sphere of CPRs in more diverse group-based primary cooperatives or similar formal business models. We suggest this is one direction for further future research.

Distance to market was not significantly correlated with any of the performance indicators we used but constraints to input access were negatively associated with group livelihood income. Cox et al. (2010) and many studies they referred to found that market integration could have a negative effect on cooperative behavior and CPR management due to increasing inequality, higher incentives for excessive resource extraction, and reduced dependence on the resource (Bardhan, 2000; Tucker, Randolph & Castellanos, 2007; Gibson, 2001). Most of the youth in our study, especially in the forest and apiculture groups, depend on complementary sources of income as their youth livelihood activity produces limited or no income in the first years after establishment. Market integration may be important for the access to complementary sources of income for youth group members and better market integration may therefore not necessarily destabilize youth groups. A longitudinal study of the livelihood strategies of individual youth in the youth groups

could provide additional insights about the relationship between market integration and group stability.

A central issue we may draw from the study by Baggio et al. (2016) is that the ease and cost of monitoring may be crucial for successful outcomes in the management of CPRs and investments in hard human-made infrastructure can reduce such monitoring costs and expand the scope for successful outcomes. Such infrastructure may enhance transparency and thereby also reduce the costs of imposing graduated sanctions. A globalized digitized world may thus potentially come to the rescue of local commons through provision of better and cheaper tools (such as satellite imagery for monitoring of changes in vegetation over time in specific areas) through global collective action (international organizations may provide technical and other forms of support for this to national and local government institutions). However, this development is still at a very early stage and much remains before we can say that it is a success and local institutions will still be crucial in policy implementation.

6. CONCLUSION

Ostrom (2010) warned against being too optimistic about being able to solve social dilemmas, as there are many examples of failures (e.g. Dietz, Ostrom & Stern, 2003; Berkes, 2007; Meinzen-Dick, 2007). She emphasized that further research is needed. We contribute to this research in terms of assessing the success of kick-started youth groups in terms of their ability to cooperate and self-manage themselves as custodians of an allocated land resource that is intended to be a source of livelihood and joint business. We found a high degree of compliance with Ostrom's Design Principles and the adoption of a higher number of DPs was associated with more favorable outcomes for a set of four outcome performance indicators (group size maintenance, trust, a rating by the Youth Association, and group livelihood income per member. We found that DP1 (having

an encroachment control system in place that protects the borders of the land allocated to the group) was the most significant among the DPs. While we found some significant differences between the different group livelihood activities, further research is needed to better understand the importance of the individual DPs and combinations of these for the success of each of these livelihood activities (livestock rearing, apiculture, forest, horticulture/irrigation and mining).

For the general assessment of the DPs related to the hard natural and human infrastructure a longitudinal study of the youth groups and their performance is needed. The DPs are no miracle cure. While these local institutional arrangements can make a big difference in many cases, political support and stability (DP8) are important for the youth groups' future success. In particular, we think the youth groups' vulnerability to climate change and shocks and finding ways of making them more robust to such shocks can be critical. However, it is possible that youth groups themselves have the potential to build their own transformative adaptation pathways and resilience from within. We saw some groups that had started to diversify and intensify their production activities but such changes may also need clearing with local authorities. Most members had their own complementary sources of income such as sharecropping on rented land, construction work or trade.

Overall, we think the youth group model we have studied shows promise as an approach to engaging landless and unemployed youth in productive livelihood activities and as environmental custodians. Giving youth groups self-organization responsibilities, opportunities, as well as obligations as primary cooperatives and environmental caretaker units is an approach that we recommend for testing elsewhere, given the growing problem of youth unemployment and

landlessness. Programs inclusive to youth can also contribute to political stability and shape youth

into the valuable resource for society they deserve to be.

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Table 1. *Ostrom's Design Principles (DPs).*

DP No	Short name	Explanation
1	Clearly defined borders	Individuals with rights to the common pool resource (CPR) must be clearly defined and the same applies to the borders of the CPR 1a. User boundaries, 1b. Resource boundaries
2	Matching appropriation and provision rules	There must be a balance between appropriation rules (benefit sharing rules), provision rules (required contributions by group members) and this must match the CPR 2a. Congruence with local conditions, 2b. Appropriation and provision
3	Collective choice arrangements	There must be an inclusive decision-making process related to adjustment of rules for CPR utilization and management
4	Monitoring	There must be an accountable monitoring system in place that monitors the CPR management and ensures its protection 4a. Monitoring users, 4b. Monitoring the resource.
5	Graduated sanctions	Appropriators who violate the rules for CPR management or extraction face graduated sanctions depending on the seriousness of the violation or repetition of violations
6	Conflict resolution mechanism	Appropriators have a good and efficient (low-cost) system for conflict resolution among themselves or between appropriators and outsiders
7	Recognized rights to organize	Government bodies allow groups to self-organize by forming own internal rules of conduct
8	Nested enterprises	Appropriation, provision, monitoring, enforcement, conflict resolution, and government activities are organized in multiple layers of nested enterprises

Sources: Ostrom (1990; 2010). *Note*: In this study, we only focus on the first six of these design principles. There is no variation in the sample related to the last two.

Table 2. *Human population, rehabilitated land area, and area of distributed hillsides and exclosures in Tigray in 2015.*

District	*Total land area in km2	*Population		*Popu-lation density	†Rehabilitated land in ha	†Distributed hillsides and exclosures in ha	†Beneficiaries of distributed hillsides and exclosures		
		Total	Age 15 to 39				Male	Female	Total
Adwa	1888.60	108872	38215	58	21282	3914	4788	3513	8301
Kilite Awlalo	2058.25	110821	38899	54	23123	10650	15309	7691	23000
Degua Temben	1852.89	126953	44562	69	9894	5340	5325	1926	7251
Seharti Samre	2723.89	139479	48958	51	40981	8939	13491	4106	17597
Raya Azebo	2132.83	154861	54358	73	80662	1746	2181	1417	3598
Sum 5 districts	10656.46	640986	224992	60	175941	30590	41094	18653	59747
Sum other districts	30753.49	4415013	1549708	144	376539	68822	97179	60912	158091
Tigray total	41409.95	5055999	1774700	122	552480	99412	138273	79565	217838

Sources: *: Central Statistical Agency of The Federal Democratic Republic of Ethiopia (CSA, 2015), †: Tigray Bureau of Agriculture and Natural Resources Management.

Table 3. *The distribution of youth groups by district and main activity*

	Raya Azebo	Degua Tembien	Seharti Samre	Kilite Awlalo	Adwa	Total
Livestock rearing	47	17	24	1	51	140
Apiculture	6	32	27	11	83	159
Forest	3	3	2	0	34	42
Irrigation/Horticulture	34	19	19	4	20	96
Mining[a]	110	2	29	145	9	295
Other	1	0	8	0	1	10
Total	201	73	109	161	198	742

Source: Own census data. [a] Mining activities include stone and sand mining. Mineral rights given to youth groups are typically for a limited period for the youth to generate savings for another livelihood option.

Table 4. *Distribution of key performance indicators*

How do you rate the trust among the group members overall?				
Variable code	Response	Freq.	Percent	Cum.
5	Very high	402	54.25	54.25
4	Quite high	306	41.30	95.55
3	Ok	18	2.43	97.98
2	Not so good	12	1.62	99.60
1	Very poor	3	0.40	100.00
	Total	741	100.00	
How is the group rated by the Youth Association?				
Variable code	Response	Freq.	Percent	Cum.
5	Very good	83	11.22	11.22
4	Good	307	41.49	52.7
3	Average	295	39.86	92.57
2	Below average	37	5.00	97.57
1	Poor performance	18	2.43	100.00
	Total	740	100.00	

Source: Own census data, based on responses by group leaders.

Table 5. *Income per member from youth group livelihood activity by type of activity in 2015.*

Main group activities[a]	Mean income	St. Error	N
Livestock rearing	1362.3	389.7	139
Apiculture	295.3	36.9	157
Forest	68.1	20.1	42
Irrigation/Horticulture	945.7	204.3	95
Mining	1696.1	195.4	292
Other	7363.2	3614.6	9
Total	1212.5	122.8	734

Source: Own census data. Income in Ethiopian Birr. [a]The group activities are regulated such that income is not a result of over-exploitation of the resource.

Table 6. *Summary statistics for control variables*

Variable	Obs	Mean	Std. Dev.	Min	Max
Establishment year, GC	742	2014.4	1.584	2003.8	2016.2
Initial member number	742	19.542	16.168	2.0	193
Female share at start of group	742	0.344	0.204	0.0	1.0
Gender of group leader, 1=Female	740	0.112	0.316	0.0	1.0
Distance to road, km	734	2.411	2.653	0.0	30.0
Distance to market, km	735	8.500	5.837	0.1	36.0
Distance to home, km	735	1.453	1.369	0.0	12.0
Input access problems, dummy	742	0.662	0.473	0.0	1.0
Area allocated per person in group, ha	737	0.190	0.235	0.0	2.0
Number of returning migrants	742	1.124	3.770	0.0	70.0
Self-selection of group members, dummy	742	0.805	0.397	0.0	1.0
Change in key group positions, dummy	742	0.272	0.445	0.0	1.0

Source: Own census data.

Table 7. *Variables used as indicators for Ostrom's Design Principles in regression models*

Variable	Obs	Mean	Std. Dev.	Min	Max
DP1: Encroachment control system in place, dummy	742	0.941	0.236	0	1
DP2: Bylaw regulating sharing arrangements, dummy	742	0.973	0.162	0	1
DP3a: Bylaw regulating frequency of meetings, dummy	742	0.949	0.221	0	1
DP3b: All members involved in decisions, dummy	742	0.708	0.455	0	1
DP4: Number of bylaws regulating management	741	3.497	1.044	0	4
DP5: Number of bylaws stipulating graduated sanctions	742	2.741	1.405	0	4
DP6: Satisfactory conflict resolution system, dummy	742	0.970	0.170	0	1

Source: Own census data.

Table 8. *Performance indicators regressed on DPs and other control variables*

	Member stay share	Trust	Youth Assoc. Rating	Log(group income/member)
DP1: Encroachment control system in place	0.037	0.788****	0.807****	4.961****
DP2: Bylaw regulating sharing arrangements	0.031	0.432	0.343	-1.944
DP3a: Bylaw regulating frequency of meetings	0.038	-0.062	0.561**	1.109
DP3b: All members involved in decisions	-0.008	0.323***	-0.281***	0.631
DP4: Number of bylaws regulating management	-0.010	0.022	-0.090	0.273
DP5: Number of graduated sanctions	0.017***	0.067	0.120***	-0.330*
DP6: Satisfactory conflict resolution system	0.058	0.637**	0.632***	1.085
Establishment year & month	0.023****	-0.043	0.015	-0.689****
Female share at start of group	0.000	0.434	-0.268	-3.164**
Input access problems, dummy	0.040**	0.126	-0.042	-1.254***
Area allocated per person in group	0.003	-0.032	0.531*	2.810*
Change in key group positions, dummy		-0.358****	0.154	2.398****
Self-selection of group members	-0.012	0.548****	-0.269**	-1.050*
Number of dropped out members				0.130****
District dummies: Base=Raya Azebo	Yes	Yes	Yes	Yes
Activity dummies: Base=Livestock rearing				
Apiculture	-0.008	0.111	-0.142	-2.421****
Forest	0.003	0.209	-0.339*	-4.680****
Irrigation/Horticulture	0.022	0.033	0.310**	-0.311
Mining	-0.020	0.186	0.104	-0.011
Other	-0.016	1.266*	0.012	-0.032
Cut 1 Constant		-86.389	28.658	
Cut 2 Constant		-85.724	29.288	
Cut 3 Constant		-85.375	30.829	
Cut 4 Constant		-83.617	32.258	
Wald chi2		111.189	152.036	
Constant	-243.737****			1386.680****
Sigma constant				5.017****
Log likelihood	-247.821			-1462.817
Prob. > chi2	0.000	0.000	0.000	0.000
Number of obs.	726	725	725	719
Number of left censored obs.				315

Source: Own census data. *Note*: Dependent variables: Share of initial members staying in group at time of the survey; Trust: 5=Very high, 4=Quite high, 3=ok, 2=Not so good, 1=Very poor; Youth Association rating: 5=Very good, 4=Good, 3=Average, 2=Below average, 1=Poor performance; Log (Group income per current group member (EB) in 2015+1). The table shows marginal effects. Types of models: Fractional probit for Member Stay models, Ordered probit for Trust and Youth Association Rating models, and Tobit for Member Group Income models. Significance levels: * < 0.10, ** < 0.05, *** < 0.01, **** < 0.001. The following variables were included in the regressions but left out of the table as they were insignificant in all models: Initial member number, Distance to road (km), Distance to market (km), Distance to home (km), Gender of group leader (Female=1), Number of returning migrants in group, Inverse mills ratio (self-selection of group members), District dummy variables (some of which were significant in some models).

Table 9. *Summary of DP-index responses in models without and with additional controls*

	Member stay share	Trust	Youth Assoc. Rating	Group income/member
Without controls	0.031***	0.298****	0.216****	0.615**
With controls	0.025**	0.306****	0.241****	0.487

Source: Own census data. *Note*: Significance levels: * < 0.10, ** < 0.05, *** < 0.01, **** < 0.001. The control variables are the same as in Table 8.

Table 10. *Summary of model coefficients for the DP index responses in models by main activity*

Performance indicator	Livestock rearing	Apiculture	Forestry	Horticulture/ Irrigation	Mining
Member share staying	0.048****	0.043*	-0.086**	0.029	-0.005
Trust	0.359***	0.523****	0.678**	0.308**	0.184**
Youth Association ranking of group	0.514****	0.181	-0.019	0.314***	0.143*
Group income per member	0.242	1.358**	-1.144****	0.728	0.540

Source: Own census data. *Note*: Significance levels: * < 0.10, ** < 0.05, *** < 0.01, **** < 0.001. Establishment year and district dummy variables are the only controls included except the DP index variable.
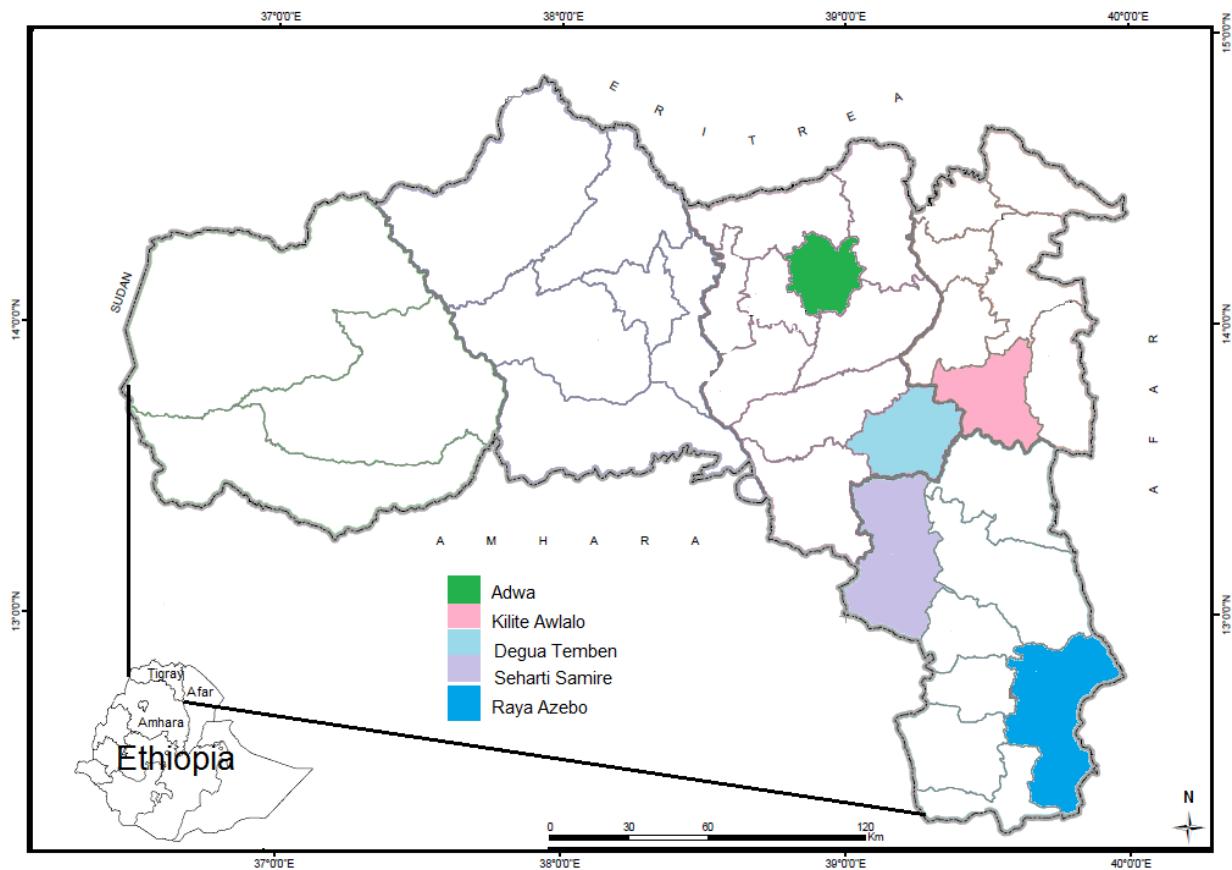
Figure 1. *Map of census districts*
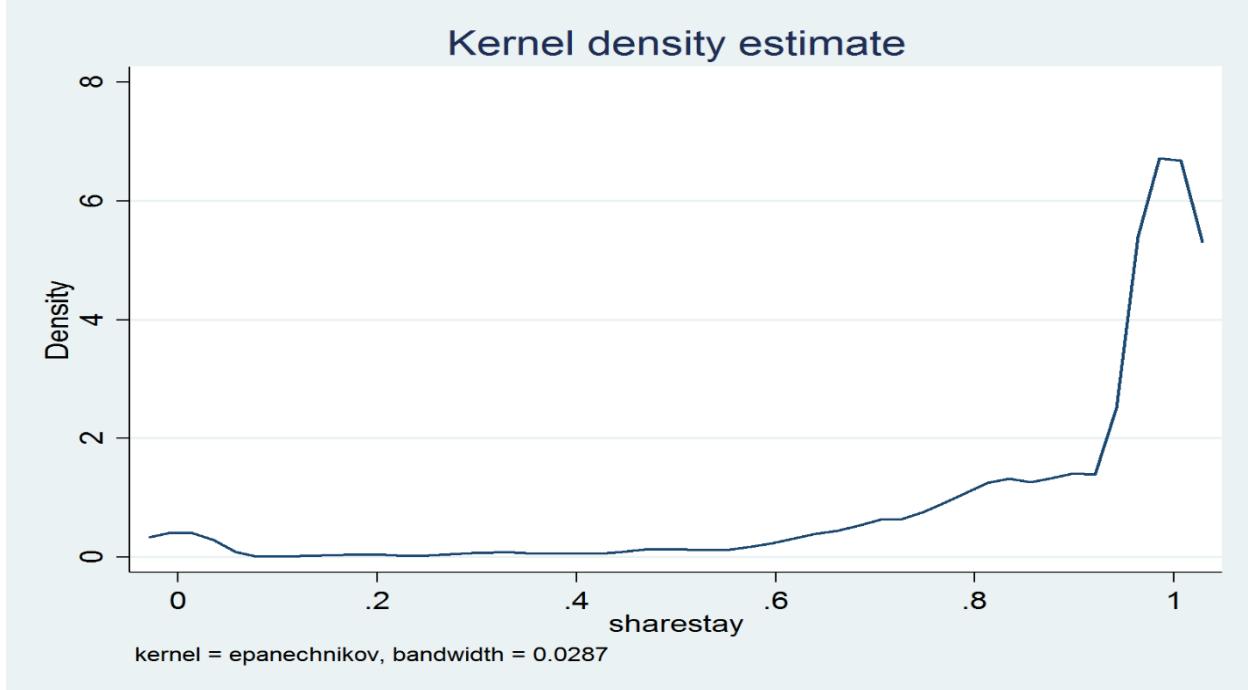
Figure 2. *Kernel density distribution for the share of initial group members remaining in 2016.*
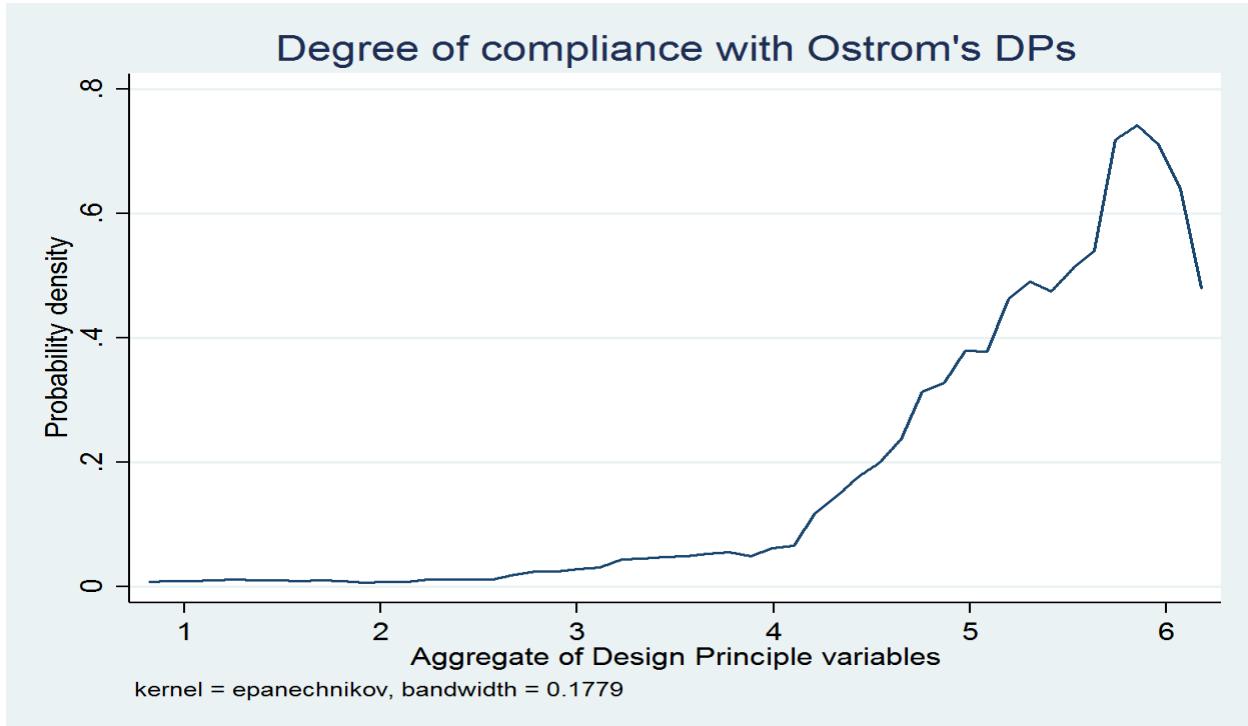
Figure 3**.** *Distribution of the DP index (aggregate measure of compliance with the Ostrom DPs).*

The Importance of Ostrom's Design Principles: Appendices

Appendix 1A: Details on adherence to Ostrom's DPs

Ostrom's DP 1: Clearly defined borders

In Table A1 we assess whether the land area that has been allocated to youth groups is clearly demarcated. The groups are grouped by the main activity they have on their land to assess whether there are systematic differences between these.

Table A1. *Assessment of Ostrom's Design Principle 1: Clear border demarcation, by type of activity*

		Animal rearing	Bee keeping	Forest	Irrigation/ Horticulture	Mining	Other	Total
Very clearly demarcated and fenced	Obs.	40.0	23.0	4.0	38.0	2.0	2.0	109.0
	%	29.2	14.5	9.5	39.6	0.7	20.0	14.8
Clearly demarcated but not fenced	Obs.	70.0	110.0	29.0	46.0	206.0	0.0	461.0
	%	51.1	69.2	69.1	47.9	69.8	0.0	62.4
Partly well demarcated	Obs.	10.0	10.0	4.0	2.0	2.0	0.0	28.0
	%	7.3	6.3	9.5	2.1	0.7	0.0	3.8
No clear borders for part of the area	Obs.	11.0	16.0	5.0	10.0	85.0	1.0	128
	%	8.0	10.1	11.9	10.4.0	28.8	10.0	17.3
Does not apply	Obs.	6.0	0.0	0.0	0.0	0.0	7.0	13.0
	%	4.4	0.0	0.0	0.0	0.0	70.0	1.8
Total	Obs.	137.0	159.0	42.0	96.0	295.0	10.0	739.0
	%	100.0	100.0	1000.0	100.0	100.0	100.0	100.0

Source: Own census data. Test for significant difference between activities: Pearson chi2(20) = 454.14, Pr < 0.0001.

Table A2. *Is there traffic by outsiders going through the area allocated to the youth group? By district*

		Raya Azebo	Degua Tembien	Seharti Samre	Kilite Awlalo	Adwa	Total
Yes, a path/road goes through	Obs.	57.0	3.0	11.0	43.0	10.0	124.0
	%	28.8	4.1	10.2	26.7	5.1	16.8
It is common by outsiders to walk through the area	Obs.	48.0	6.0	18.0	69.0	11.0	152.0
	%	24.2	8.2	16.7	42.9	5.6	20.6
Livestock of outsiders commonly enter the area	Obs.	18.0	5.0	12.0	13.0	29.0	77.0
	%	9.1	6.9	11.1	8.1	14.7	10.5
Uncommon, but it happens	Obs.	30.0	13.0	18.0	28.0	57.0	146.0
	%	15.2	17.8	16.7	17.4	28.9	19.8
No, it is well protected and no traffic by outsiders	Obs.	42.0	46.0	41.0	7.0	89.0	225.0
	%	21.2	63.0	38.0	4.4	45.2	30.5
Does not apply	Obs.	3.0	0.0	8.0	1.0	1.0	13.0
	%	1.5	0.0	7.4	0.6	0.5	1.8
Total	Obs.	198.0	73.0	108.0	161.0	197.0	737.0
	%	100.0	100.0	100.0	100.0	100.0	100.0

Source: Own census data. Test for significant difference between districts: Pearson chi2(20) = 243.76, Pr < 0.0001.

Table A3. *Is there traffic by outsiders going through the area allocated to the youth group? By main activity type*

		Animal rearing	Apiculture	Forest	Irrigation/ Horticulture	Mining	Other	Total
Yes, a path/road goes through	Obs.	6.0	5.0	1.0	4.0	107.0	1.0	124.0
	%	4.4	3.2	2.4	4.2	36.4	10.0	16.8
It is common by outsiders to walk through the area	Obs.	14.0	8.0	2.0	5.0	123.0	0.0	152.0
	%	10.2	5.1	4.8	5.2	41.8	0.0	20.6
Livestock of outsiders commonly enter the area	Obs.	14.0	23.0	7.0	7.0	26.0	0.0	77.0
	%	10.2	14.6	16.7	7.3	8.8	0.0	10.5
Uncommon, but it happens	Obs.	31.0	44.0	18.0	21.0	32.0	0.0	146.0
	%	22.6	27.9	42.9	21.9	10.9	0.0	19.8
No, it is well protected and no traffic by outsiders	Obs.	66.0	78.0	14.0	59.0	6.0	2.0	225.0
	%	48.2	49.4	33.3	61.5	2.0	20.0	30.5
Does not apply	Obs.	6.0	0.0	0.0	0.0	0.0	7.0	13.0
	%	4.4	0.0	0.0	0.0	0.0	70.0	1.8
Total	Obs.	137.0	158.0	42.0	96.0	294.0	10.0	737.0
	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Own census data. Test for significant difference between activities. Pearson chi2(25) = 678.33, Pr < 0.0001.

Table A4. *Is the group experiencing any illegal harvesting by outsiders in the allocated land area?*

		Raya Azebo	Degua Tembien	Seharti Samre	Kilite Awlalo	Adwa	Total
It is frequent (>1 per week)	Obs.	6.0	1.0	1.0	0.0	0.0	8.0
	%	3.1	1.4	0.9	0.0	0.0	1.1
It happens now and then (>1 per month)	Obs.	11.0	0.0	6.0	4.0	12.0	33.0
	%	5.6	0.0	5.6	2.5	6.1	4.5
It happens rarely (<1 per month)	Obs.	8.0	5.0	4.0	1.0	26.0	44.0
	%	4.1	6.9	3.7	0.6	13.1	6.0
It happens very rarely (<1 per year)	Obs.	21.0	16.0	9.0	14.0	49.0	109.0
	%	10.7	21.9	8.3	8.8	24.8	14.8
Has never happened since start of the group/area was allocated	Obs.	150.0	51.0	88.0	141.0	111.0	541.0
	%	76.5	69.9	81.5	88.1	56.1	73.6
Total	Obs.	196.0	73.0	108.0	160.0	198.0	735.0
	%	100.0	100.0	100.0	100.0	100.0	100.0

Source: Own census data. Test for significant difference between districts: Pearson chi2(16) = 83.42, Pr < 0.0001.

Table A5. *Frequency of illegal harvesting vs type of activity*

		Animal rearing	Bee-keeping	Forest	Irrigation/ Horticulture	Mining	Other	Total
It is frequent (>1 per week)	Obs.	3.0	1.0	0.0	1.0	3.0	0.0	8.0
	%	2.2	0.6	0.0	1.0	1.0	0.0	1.1
It happens now and then (>1 per month)	Obs.	6.0	5.0	3.0	6.0	13.0	0.0	33.0
	%	4.4	3.1	7.1	6.3	4.4	0.0	4.5
It happens rarely (<1 per month)	Obs.	13.0	15.0	8.0	6.0	1.0	1.0	44.0
	%	9.6	9.4	19.1	6.3	0.3	12.5	6.0
It happens very rarely (<1 per year)	Obs.	24.0	36.0	10.0	17.0	22.0	0.0	109.0
	%	17.7	22.6	23.8	17.7	7.5	0.0	14.8
Has never happened since start of the group/area was allocated	Obs.	90.0	102.0	21.0	66.0	255.0	7.0	541.0
	%	66.2	64.2	50.0	68.8	86.7	87.5	73.6
Total	Obs.	136.0	159.0	42.0	96.0	294.0	8.0	735.0
	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Own census data. Test for significant difference between activities: Pearson chi2(20) = 74.52, Pr < 0.0001.

We see from Tables A4 and A5 that less than 6% of the youth groups experience illegal harvesting on their land more frequently than monthly and only 1.1% experience it more frequently than weekly. This shows that illegal harvesting is not a big problem. Table A6 shows the extent of guarding that is used by the youth groups to protect their area. Most youth groups have a guarding system and we can conclude that the resource base of the youth is well protected from extraction by outsiders.

Table A6. *Frequency of illegal harvesting versus guarding of the land against outsiders (related to Ostrom's DP 1: Clear demarcation against outsider intrusion*

Frequency of illegal harvesting by outsiders in the allocated area		Continuously guarding by rotating responsibility	Guarding during daytime	Hired a guard to protect the area	No guard is considered necessary	Total
It is frequent (>1 per week)	Obs.	6.0	1.0	0.0	1.0	8.0
	%	1.7	1.4	0.0	0.6	1.1
It happens now and then (>1 per month)	Obs.	22.0	3.0	3.0	5.0	33.0
	%	6.2	4.2	2.0	3.2	4.5
It happens rarely (<1 per month)	Obs.	15.0	6.0	19.0	4.0	44.0
	%	4.2	8.3	12.8	2.6	6.0
It happens very rarely (<1 per year)	Obs.	56.0	16.0	33.0	4.0	109.0
	%	15.7	22.2	22.2	2.6	14.8
Has never happened since start of the group/area was allocated	Obs.	258.0	46.0	94.0	143.0	541
	%	72.3	63.9	63.1	91.1	73.6
Total	Obs.	357.0	72.0	149.0	157.0	735.0
	%	100.0	100.0	100.0	100.0	100.0

Source: Own census data. Test for significant difference between districts: Pearson chi2(12) = 59.00, Pr < 0.0001.

Table A7. *Is the current system for controlling encroachment functioning satisfactorily? (Ostrom's DP 1/5?)*

		Raya Azebo	Degua Tembien	Seharti Samre	Kilite Awlalo	Adwa	Total
No	Obs.	25.0	5.0	9.0	2.0	3.0	44.0
	%	12.6	6.9	8.3	1.2	1.5	6.0
Yes	Obs.	170.0	68.0	99.0	158.0	194.0	689.0
	%	85.9	93.1	90.8	98.1	98.0	93.2
Some modification is needed	Obs.	3.0	0.0	1.0	1.0	1.0	6.0
	%	1.52	0.0	0.92	0.6	0.5	0.8
Total	Obs.	198.0	73.0	109.0	161.0	198.0	739.0
	%	100.0	100.0	100.0	100.0	100.0	100.0

Source: Own census data. Test for significant difference between districts: Pearson chi2(8) = 32.66, Pr < 0.0001.

From this we conclude that Ostrom's DP 1 (Clearly demarcated and protected borders for the resource and clearly defined group with rights) is satisfied for 93% of the groups.

Ostrom's DP 2: Sharing of benefits and costs/congruence between appropriation rules and provision rules

Table A8 shows that 97.6% of the groups have a bylaw that regulates the sharing of responsibilities and incomes from the group activities.

Table A8. *Is the sharing of work and responsibilities in the group and the sharing of income regulated by the bylaw of the group?*

		Raya Azebo	Degua Tembien	Seharti Samre	Kilite Awlalo	Adwa	Total
No	Obs.	14.0	0.0	0.0	3.0	1.0	18.0
	%	7.0	0.0	0.0	1.9	0.5	2.4
Yes	Obs.	185.0	73.0	109.0	158.0	197.0	722.0
	%	93.0	100.0	100.0	98.1	99.5	97.6
Total	Obs.	199.0	73.0	109.0	161.0	198.0	740.0
	%	100.0	100.0	100.0	100.0	100.0	100.0

Source: Own census data.

Table A9. *How is the work required on the allocated land shared among the youth group members? (Ostrom's DP 2)*

		Raya Azebo	Degua Tembien	Seharti Samre	Kilite Awlalo	Adwa	Total
Equal sharing for all	Obs.	108.0	60.0	86.0	106.0	151.0	511.0
	%	54.0	82.2	78.9	65.8	76.3	69.0
Different requirement for males and females	Obs.	85.0	13.0	17.0	54.0	47.0	216.0
	%	42.5	17.8	15.6	33.5	23.7	29.2
Sharing modified to ability of each member	Obs.	3.0	0.0	0.0	1.0	0.0	4.0
	%	1.5	0.0	0.0	0.6	0.0	0.5
Sharing based on the individual motivation & other activities	Obs.	3.0	0.0	6.0	0.0	0.0	9.0
	%	1.5	0.0	5.5	0.0	0.0	1.2
Other, specify	Obs.	1.0	0.0	0.0	0.0	0.0	1.0
	%	0.5	0.0	0.0	0.0	0.0	0.1
Total	Obs.	200.0	73.0	109.0	161.0	198.0	741.0
	%	100.0	100.0	100.0	100.0	100.0	100.0

Source: Own census data. Test for significant difference between districts: Pearson chi2(16) = 67.13, Pr < 0.0001.

Table A10. *How is income from the group activities shared among group members? (Ostrom's DP 2).*

		Raya Azebo	Degua Tembien	Seharti Samre	Kilite Awlalo	Adwa	Total
Equally shared by all	Obs.	198.0	73.0	102.0	159.0	198.0	730.0
	%	99.0	100.0	93.6	99.4	100.0	98.7
Shares depend on effort and gender	Obs.	2.0	0.0	7.0	1.0	0.0	9.0
	%	0.5	0.0	6.4	0.6	0.0	1.2
Total	Obs.	200.0	73.0	109.0	160.0	198.0	740.0
	%	100.0	100.0	100.0	100.0	100.0	100.0

Source: Own census data. Test for significant difference between districts: Pearson chi2(8) = 31.93, Pr < 0.0001.

We see from Tables A9 and A10 that equal sharing of income is the rule for 98.7% of the youth groups. In Table A11 we see that the responsibilities are shared equally in 56.7% of the groups only as female members are allowed to do less of the heavy body work than males but they still get an equal share of the benefits.

Table A11. *Is there a gender difference in the sharing of responsibilities and benefits in the group? (Ostrom's DP 2).*

		Raya Azebo	Degua Tembien	Seharti Samre	Kilite Awlalo	Adwa	Total
No, all are equally treated	Obs.	114.0	34.0	61.0	61.0	117.0	387.0
	%	58.5	46.6	69.3	45.9	60.3	56.7
Females do less of the heavy work but get equal benefit	Obs.	79.0	39.0	24.0	72.0	77.0	291.0
	%	40.5	53.4	27.3	54.1	39.7	42.6
Females do less of the heavy work and get less of the benefit	Obs.	0.0	0.0	3.0	0.0	0.0	3.0
	%	0.0	0.0	3.4	0.0	0.0	0.4
Other, specify	Obs.	2.0	0.0	0.0	0.0	0.0	2.0
	%	1.0	0.0	0.0	0.0	0.0	0.3
Total	Obs.	195	73.0	88.0	133.0	194.0	683.0
	%	100.0	100.0	100.0	100.0	100.0	100.0

Source: Own census data. Test for significant difference between districts: Pearson chi2(12) = 43.99, Pr < 0.0001.

If we accept that females should be allowed to do less of the heavy work, we can state that 99% of the groups satisfy DP 2.

Ostrom's DP 3: Joint decision-making system.

95.8% of the youth groups stated to have their own written bylaw. Their bylaws also stated the frequency of meetings in these groups that have a bylaw, see Table A12.

Table A12. *Groups with bylaw that specified the frequency of meetings, by district (Ostrom's DP 3)*

		Raya Azebo	Degua Tembien	Seharti Samre	Kilite Awlalo	Adwa	Total
Weekly	Obs.	90.0	23.0	31.0	79.0	13.0	236.0
	%	50.0	31.5	31.3	50.3	6.8	33.7
Biweekly	Obs.	52.0	22.0	28.0	52.0	85.0	239.0
	%	28.9	30.1	28.3	33.1	44.3	34.1
Monthly	Obs.	37.0	28.0	40.0	26.0	90.0	221.0
	%	20.6	38.4	40.4	16.6	46.9	31.5
Other, explain	Obs.	1.0	0.0	0.0	0.0	4.0	5.0
	%	0.6	0.0	0.0	0.0	2.1	0.7
Total	Obs.	180.0	73.0	99.0	157.0	192.0	701.0
	%	100.0	100.0	100.0	100.0	100.0	100.0

Source: Own census data. Test for significant difference between districts: Pearson chi2(12) =120.73, Pr < 0.0001.

92.2% of the groups have penalties for non-participation in group meetings. There are actually graduated sanctions against non-participation as well as late arrival to meetings. And these have been enforced. Monetary sanctions are most common (86% of the sanctions). 43.6% of the groups had members that had been penalized for absence from meetings and 36.9% of the groups had members that had been penalized for late arrival to meetings. It is very clear that group membership implies strong participation obligations. Close to 68% of the groups have meetings at least biweekly.

Table A13. *Who are the most dominant in making decisions in the group and enforcing consensus decisions? (Ostrom's DP 3)*

		Raya Azebo	Degua Tembien	Seharti Samre	Kilite Awlalo	Adwa	Total
Male group	Obs.	8.0	1.0	1.0	3.0	0.0	13.0
	%	4.0	1.4	0.9	1.9	0.0	1.8
Male chairman	Obs.	4.0	0.0	0.0	1.0	0.0	5.0
	%	2.0	0.0	0.0	0.6	0.0	0.7
Female chairman	Obs.	0.0	0.0	1.0	0.0	0.0	1.0
	%	0.0	0.0	0.9	0.0	0.0	0.14
Elected group (5 officials)	Obs.	34.0	26.0	23.0	50.0	60.0	193.0
	%	17.2	35.6	21.3	31.1	30.5	26.2
All are equally influential and participate in decision-making	Obs.	152.0	46.0	83.0	107.0	137.0	525.0
	%	76.8	63.0	76.9	66.5	69.5	71.2
Total	Obs.	198.0	73.0	108.0	161.0	197.0	737.0
	%	100.0	100.0	100.0	100.0	100.0	100.0

Source: Own census data. Test for significant difference between districts: Pearson chi2(16) = 38.50, Pr < 0.001.

When asked about influence in decision-making, about 71% of the group leaders state that all members are equally influential while 26% state that the elected group of five are more influential. Male dominance is not stated to be strong among the group leaders (who mostly are males).

Ostrom' DP 4: Internal monitoring system

We have already in the previous section seen that there is a system with frequent meetings and punishments for non-participation and late arrival. This implies one form of internal monitoring related to decision-making. In addition, we assess whether there is a monitoring system for not coming to the work activities of the group and for late coming to such group work activities (Tables A14 and A17).

Table A14. *Does the group have a bylaw stipulating penalties for not coming to work activities of the group?*

		Raya Azebo	Degua Tembien	Seharti Samre	Kilite Awlalo	Adwa	Total
No	Obs.	21	2	14	7	12	56
	%	10.5	2.7	12.8	4.4	6.1	7.6
Yes	Obs.	180	71	95	154	186	686
	%	89.6	97.3	87.2	95.6	93.9	92.4
Total	Obs.	201	73	109	161	198	742
	%	100	100	100	100	100	100

Source: Own census data. Test for significant difference between districts: Pearson chi2(4) = 12.21, Pr< 0.016.

Table A15. *Have any group members been punished for not coming to group work activities?*

		Raya Azebo	Degua Tembien	Seharti Samre	Kilite Awlalo	Adwa	Total
No	Obs.	146.0	38.0	84.0	141.0	139.0	548.0
	%	72.6	52.1	77.1	87.6	70.2	73.9
Yes	Obs.	55.0	35.0	25.0	20.0	59.0	194.0
	%	27.4	47.9	22.9	12.4	29.8	26.1
If yes, how many punished?	%	4.4	4.9	3.8	5.1	3.8	4.3
Total	Obs.	201.0	73.0	109.0	161.0	198.0	742.0
	%	100.0	100.0	100.0	100.0	100.0	100.0

Source: Own census data. Test for significant difference between districts: Pearson chi2(4) = 35.77, Pr < 0.0001.

Table A14 shows that 92.6% of the groups have bylaw stipulating penalties for not coming to group work activities. Table A15 shows that 26.1% of the groups have members that have been punished for not coming to group work activities.

Table A16. *Does group have bylaw for penalties for late coming to group work activities?*

		Raya Azebo	Degua Tembien	Seharti Samre	Kilite Awlalo	Adwa	Total
No	No	33.0	9.0	38.0	37.0	32.0	149.0
	%	16.4	12.3	34.9	23.0	16.2	20.1
Yes	No	168.0	64.0	71.0	124.0	166.0	593.0
	%	83.6	87.7	65.1	77.0	83.8	79.9
Total	No	201.0	73.0	109.0	161.0	198.0	742.0
	%	100.0	100.0	100.0	100.0	100.0	100.0

Source: Own census data. Test for significant difference between districts: Pearson chi2(4) = 21.99, Pr < 0.0001.

Table A16 shows that 79.9% of the groups have bylaws stipulating penalties for late coming to group work activities and Table A17 shows that 21.7% of the youth groups have punished some members for late arrival to group work activities.

Table A17. *Have any group members been punished for late arrival to group work activities?*

		Raya Azebo	Degua Tembien	Seharti Samre	Kilite Awlalo	Adwa	Total
No	Obs	148.0	44.0	91.0	141.0	157.0	581.0
	%	73.6	60.3	83.5	87.6	79.3	78.3
Yes	Obs	53.0	29.0	18.0	20.0	41.0	161.0
	%	26.4	39.7	16.5	12.4	20.7	21.7
If yes, how many punished?	%	4.4	5.5	3.1	3.3	5.3	4.6
Total	Obs	201.0	73.0	109.0	161.0	198.0	742.0
	%	100.0	100.0	100.0	100.0	100.0	100.0

Source: Own census data. Test for significant difference between districts: Pearson chi2(4) = 26.53, Pr < 0.0001.

Finally, we aggregate the extent of use of the four types of sanctions (absence from and late arrival to meetings and to group work activities) by adding four dummy variables for whether each group has used each of the four types of sanctions. The distribution of aggregate use of the sanctions is presented in Table A18, by district.

Table A18. *To what extent have groups penalized their group members by number of types of violations, by district.*

Number of types if violations	Raya Azebo	Degua Tembien	Seharti Samre	Kilite Awlalo	Adwa	Total
0 Obs.	86.0	17.0	57.0	98.0	72.0	330.0
%	42.8	23.3	52.3	60.9	36.4	44.5
1 Obs.	33.0	12.0	16.0	22.0	41.0	124.0
%	16.4	16.4	14.7	13.7	20.7	16.7
2 Obs.	35.0	12.0	16.0	21.0	38.0	122.0
%	17.4	16.4	14.7	13.0	19.2	16.4
3 Obs.	27.0	14.0	14.0	15.0	24.0	94.0
%	13.4	19.2	12.8	9.3	12.1	12.7
4 Obs.	20.0	18.0	6.0	5.0	23.0	72.0
%	10.0	24.7	5.5	3.1	11.6	9.7
Total Obs.	201.0	73.0	109.0	161.0	198.0	742.0
%	100.0	100.0	100.0	100.0	100.0	100.0

Source: Own census data. Test for significant difference between districts: Pearson chi2(16) = 57.88, Pr < 0.0001.

Table A18 shows that 44.5% of the groups have used none of the sanctions, 16.7% have used one type of sanctions, 16.4% have used two types of sanctions, 12.7% three types, and 9.7% have used all four types of sanctions. This does not mean that each of the sanctions are graduated, however, which is the focus of the next of Ostrom's DPs. It shows that monitoring is practiced and punishment for violation of bylaws is implemented quite widely among the groups. This probably implies that monitoring and punishment are important for compliance with the group bylaws.

Ostrom's DP 5: Graduated sanctions

We have assessed the existence of bylaws within groups for not coming to and late arrival to group meetings and to joint group work activities and the extent to which there are specified graduated sanctions as part of the bylaws for non-compliance with these. We found that monetary and non-monetary sanctions were commonly used by groups that have bylaws related to participation in and late arrival to group meetings and work activities. The non-monetary sanctions varied from simple warnings, to "last warning", dismissal from the group, and having to work extra for the group as punishment. The monetary penalties were in most cases increasing with the number of violations but were in fewer cases the same amount regardless whether the violation was the first, second or third time. Some had a mixture of non-monetary and monetary sanctions. For example, there could be only a warning first time but then a monetary sanction the second and third times. Another common practice was to give a monetary sanction the first two times and then dismissal

the third time. There were also mixed penalties such as combinations of monetary and additional work obligations or a monetary sanction combined with last warning. There were also a lot of variation in the monetary amounts that had to be paid across groups and the variation from first to second and third violation by the same person.

Table A19 gives an overview of the presence of bylaws for the four types of violations, and whether there are graduated sanctions in place related to these bylaws.

Table A19. *The existence of bylaws and graduated sanctions for violations of the bylaws*

Type of behavior	Bylaw specifying penalty for behavior, % of all groups	Graduated sanctions, % of all groups	Graduated sanctions, % of those with bylaw
Not showing up for group meetings	92.3	81.5	88.3
Late coming to group meetings	84.9	62.4	73.5
Not showing up for group joint work activities	92.5	72.0	77.8
Late coming to group joint work activities	79.9	58.2	72.8

Source: Own census data.

Table A19 shows that it is the rule rather than the exception to have bylaws with penalties for violations (80-93%), while 51-82% of all groups have graduated sanctions for the four types of violations, giving 72-88% of the bylaws with sanctions applying graduated sanctions.

We also assessed the extent to which there is variation in existence of such bylaws and graduated sanctions across the five districts. We created a sum for the four dummies for the graduated sanctions to assess the aggregate distribution of the four types across groups and districts.

We can conclude that graduated sanctions are considered an important tool for ensuring compliance with the group bylaws as 88.4% of the groups have at least one type of graduated sanction in relation to participation in group meetings and group work activities.

Table A20. *Number of types of graduated sanctions related to participation in group meetings and group work activities, by district*

Number of types of graduated sanctions		Raya Azebo	Degua Tembien	Seharti Samre	Kilite Awlalo	Adwa	Total
0	Obs.	35.0	4.0	22.0	17.0	8.0	86.0
	%	17.4	5.5	20.2	10.6	4.0	11.6
1	Obs.	23.0	8.0	6.0	18.0	14.0	69.0
	%	11.4	11.0	5.5	11.2	7.1	9.3
2	Obs.	37.0	11.0	25.0	24.0	32.0	129.0
	%	18.4	15.1	22.9	14.9	16.2	17.4
3	Obs.	17.0	18.0	16.0	30.0	44.0	125.0
	%	8.5	24.7	14.7	18.6	22.2	16.9
4	Obs.	89.0	32.0	40.0	72.0	100.0	333.0
	%	44.3	43.8	36.7	44.7	50.5	44.9
Total	Obs.	201.0	73.0	109.0	161.0	198.0	742.0
	%	100.0	100.0	100.0	100.0	100.0	100.0

Source: Own census data. Test for significant difference between districts: Pearson chi2(16) = 50.75, Pr < 0.0001.

Ostrom's DP 6: Conflict resolution system

Table A21 shows that about 25% of the youth groups have experienced at least one dispute and about 12% have experienced a serious dispute. Disputes between the group and some outsiders were more likely to be of the serious type than disputes within the group.

Table A21. *Seriousness of dispute versus who were involved in the dispute*

		The group versus some outsiders	Some group members versus outsiders	Internal dispute within the group	No response	Total
No disputes	Obs.	0.0	0.0	0.0	554.0	554.0
	%	0.0	0.0	0.0	99.6	74.7
Some serious disputes	Obs.	41.0	2.0	47.0	0.0	90.0
	%	64.1	50.0	39.8	0.0	12.1
Some less serious disputes	Obs.	23.0	2.0	71.0	2.0	98.0
	%	35.9	50.0	60.2	0.4	13.2
Total	Obs.	64.0	4.0	118.0	556.0	742.0
	%	100.0	100.0	100.0	100.0	100.0

Source: Own census data.

Table A22 shows that 82.9% of the disputes within the group were resolved within the group itself while only 19.2% of the disputes between the group and outsiders were resolved among the parties themselves. As much as 39.7% of the disputes between the groups and outsiders were still

unresolved at the time of the interview while only 3.4% of the within-group disputes were still unresolved.

Table A22. *How were disputes resolved versus who were involved in the dispute*

How have the disputes been resolved?		The group versus some outsiders	Some group members versus outsiders	Internal dispute within the group	Total
Solved among the parties themselves	Obs.	12.0	1.0	97.0	110.0
	%	**19.1**	25.0	**82.9**	59.8
Resolved with help of local conflict mediators	Obs.	4.0	0.0	0.0	4.0
	%	6.4	0.0	0.0	2.2
Resolved with help from the Land Administration Committee	Obs.	5.0	1.0	1.0	7.0
	%	7.9	25.0	0.9	3.8
Resolved with help from tabia officials	Obs.	11.0	1.0	12.0	24.0
	%	17.5	25.0	10.3	13.0
Resolved with help from woreda officials	Obs.	6.0	1.0	3.0	10.0
	%	9.5	25.0	2.6	5.4
Unresolved	Obs.	25.0	0.0	4.0	29.0
	%	**39.7**	0.0	3.4	15.8
Total	Obs.	63.0	4.0	117.0	184.0
	%	100.0	100.0	100.0	100.0

Source: Own census data.

We also see from Table A that there was a high level of satisfaction (96.6% were satisfied) with how within-group disputes had been resolved while 23.4% were not satisfied with how the disputes between the group and some outsiders had been resolved. We can conclude that local informal conflict resolution works well for within-group disputes and only in few cases have they had to get help from community (tabia) or district (woreda) officials.

Table A23. *Satisfaction with dispute resolution versus who were involved in the dispute*

Who were involved		Satisfied with how the dispute was resolved		
		No	Yes	Total
The group versus some outsiders	Obs.	15.0	49.0	64.0
	Row %	23.4	76.6	100.0
	Col %	**75.0**	29.5	34.4
Some group members versus outsiders	Obs.	1.0	3.0	4.0
	Row %	25.0	75.0	100.0
	Col %	5.0	1.8	2.15
Internal dispute within the group	Obs.	4.0	114.0	118.0
	Row %	3.4	**96.6**	100.0
	Col %	**20.0**	**68.7**	63.44
Total	Obs.	20.0	166.0	186.0
	Row %	10.8	**89.2**	100.0
	Col %	100.0	100.0	100.0

Source: Own census data.

Ostrom's DP 7: Institutional recognition: Minimum rights to organize

The youth groups in Tigray have been formed through a formal institutional arrangement as primary cooperatives and therefore fall under the law of cooperatives. The group is as such an official registered unit of business with an exclusive number of members, that is provided a demarcated resource it is responsible for managing in a sustainable way (except for mining where it has a time-limited right to extract the non-renewable resource). The group has to have a business plan, have an officially elected leadership team, can apply for joint loans, and to be audited by the cooperative organization. Still, the groups are given the authority to organize themselves and have their own bylaws. The groups are monitored and provision of loans and legal documents for their land entitlement depends on good performance and compliance with the rules for resource management (taking good care of rehabilitated lands). We therefore conclude that the groups get the minimum rights to organize themselves (Design Principle 7).

Ostrom's DP 8: Nested enterprises: Common Pool Resource that is part of a larger system

The allocation of rehabilitated communal lands to youth groups in Tigray is clearly a part of a larger plan for sustainable land management at community, district and regional levels. Parts of the areas allocated to youth groups are area exclosures that the communities at an earlier stage agreed to protect from resource extraction while they also invested in the conservation of the areas

by building various forms on soil and water conservation structures. Some areas have also been planted with trees. Other areas are rehabilitated gulley areas. The rehabilitation has thus typically involved labor-intensive investments where labor has been mobilized through compulsory labor provided by community members, through Food-for-work and Cash-for-work activities under the Productive Safety Net Program (PSNP) or other food security and sustainable land management programs.

The community members that have invested a lot of their labor into these communal lands expect also to get some of the benefits from these investments. It is therefore not obvious that they agree that these lands are given to youth groups unless they have youth themselves that are included among the beneficiaries. Therefore, all the youth that have been allocated a rehabilitated area come from the same community where the area is located. There is variation from community to community in terms of how much land is suitable for such distribution and that communities also agree to allocate to youth groups. However, the number of landless youth in each community is growing by the day and community motivation to allocate land to such youth has therefore also increased. The allocation extends the livelihood options for youth who are more likely to remain within the community such that outmigration reduces. Most of the youth being part of such a youth group continue to live with their own family unless they have married and have been able to get a plot to build their own house if they do not stay with their family. The youth allocated such land are landless and will therefore not be the ones taking over the land from their parents (landlessness is one of the criteria for being able to join a youth group).

Appendix 2A. Additional statistical tests and regressions

Correlations between DP indicators

Table A24. *Correlation coefficients for the DP variables*

	DP1	DP2	DP3a	DP3b	DP4	DP5	DP6
DP1: Encroachment control system in place	1						
DP2: Bylaw regulating sharing arrangements	0.3105	1					
DP3a: Bylaw regulating frequency of meetings	0.2522	0.3388	1				
DP3b: All members involved in decisions	-0.0738	-0.0157	0.0789	1			
DP4: Number of bylaws regulating management	0.2235	0.3425	0.7085	0.167	1		
DP5: Number of graduated sanctions	0.0765	0.2015	0.4205	0.1707	0.6144	1	
DP6: Satisfactory conflict resolution system	-0.0103	0.0199	0.0314	0.0447	0.0223	-0.0035	1

Source: Own census data.

Table A25. *Correlations between DPs and control variables: Assessment of endogeneity*

	ODP1	DP2	DP3a	DP3b	DP4	DP5	DP6
Establishment year & month	0.004	0.001	-0.008[*]	0.018	-0.017	-0.015	-0.001
Initial member number	0.000	0.000[c]	0.000	0.002[*]	-0.003	-0.001	0.000
Female share in group at start	0.126[****]	0.006	0.071[*]	-0.051	0.551[***]	0.744[b]	0.038
Gender of group leader, 1=Female	-0.047	0.011	-0.007	0.046	0.083	-0.060	-0.017
Distance to road, km	0.001	0.004[**]	-0.001	-0.008	-0.018	-0.032	-0.001
Distance to market, km	-0.001	-0.001	-0.001	-0.006[*]	0.000	0.003	-0.001
Distance to home, min. km	-0.002	-0.007	0.000	-0.010	0.011	0.085[**]	0.003
Input access problems, dummy	0.035[*]	0.002	-0.007	-0.052	-0.073	-0.108	-0.014
Baseline: No conflicts	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Serious conflict in group, dummy	0.009	0.014	0.035[*]	0.042	0.178[*]	0.188	-0.215[****]
Less serious conflict in group, dummy	-0.001	-0.013	0.008	0.103[**]	-0.118	-0.094	0.008
Area allocated per person in group	-0.018	0.019	0.006	0.136[d]	0.220	0.114	0.007
Number of returning migrants	0.004[*]	0.000	0.001	-0.007	0.002	-0.027[**]	0.001
Change in key group positions, dummy	0.059[****]	0.019	0.000	0.015	0.023	-0.115	0.014
Self-selection of group members	-0.036[***]	-0.005	-0.028[**]	0.400[****]	-0.075	-0.222[*]	0.000
District dummies: Base=Raya Azebo	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Degua Tembien	0.037	0.088[****]	0.070[***]	-0.032	0.307[**]	0.207	0.023
Seharti Samre	0.059	0.085[****]	0.025	0.034	-0.230	-0.160	0.047[***]
Kilite Awlalo	0.128[****]	0.047[*]	0.098[***]	0.044	0.224[*]	0.244	0.024
Adwa	0.103[****]	0.090[****]	0.037	-0.065	0.125	0.384[c]	-0.017
Activity dummies: Base=Animal rearing	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Beekeeping	-0.031	0.001	-0.004	-0.007	0.012	0.047	-0.024
Forest	0.014	-0.015	-0.027	-0.031	-0.171	-0.392	-0.007
Irrigation/Horticulture	-0.054	0.010	-0.016	-0.022	0.101	-0.047	-0.003
Mining	-0.036	0.050	-0.050	0.007	-0.052	-0.221	-0.013
Other	0.028	0.020	0.015	0.417[****]	-0.158	0.090	-0.030
Constant	-6.996	-1.035	16.103[*]	-35.296	38.403	32.979	2.919
F value	1.995	0.826	1.546	5.386	2.137	2.712	1.293
Prob > F	0.004	0.699	0.050	0.000	0.002	0.000	0.162
Number of observations	727	727	727	727	726	727	727
R-squared	0.093	0.060	0.051	0.154	0.057	0.066	0.203

Source: Own census data. OLS models for each DP. The table shows marginal effects. Significance levels: $* < 0.10$, $** < 0.05$, $*** < 0.01$, $**** < 0.001$.

Table A26. *Correlations between performance indicators*

	Member share stay	Trust	Youth Association rating	Log(Group income/member)
Member share stay	1			
Trust	0.0501	1		
Youth Association rating	0.0006	0.1616	1	
Log(Group income/member)	-0.2463	-0.011	0.2703	1

Source: Own census data.

Table A27. *OLS models assessing factors associated with the DP index variable*

	DP-INDEX_1	DP-INDEX_2
Area per person	0.168	0.013
Number of returning migrants in group	-0.003	-0.002
Group self-selected its members, dummy	0.072	0.075
Activity dummies: Base=Animal rearing	0.000	0.000
Beekeeping	-0.048	-0.057
Forest	-0.180	-0.191
Irrigation/ Horticulture	-0.063	-0.069
Mining	-0.079	-0.078
Other	0.211	0.232
Establishment year and month	-0.003	-0.006
Number of initial members	0.001	0.006
Female share of initial members	0.516***	0.602****
Gender of youth group leader	-0.038	-0.034
Road distance, km	-0.013	0.002
Market distance, km	-0.004	-0.007
Average distance to home, km	0.013	0.013
District dummies: Base=Raya Azebo	0.000	0.000
Degua Tembien	0.313***	0.660**
Seharti Samre	0.123	0.294
Kilite Awlalo	0.379***	0.638**
Adwa	0.289***	0.451**
Inverse mills ratio. Self-selection into groups		-0.688
Constant	10.436	16.392
Prob > chi2	0.000	0.000
r2	0.052	0.054
Number of observations	726	726

Source: Own census data. Significance levels: $* < 0.10$, $** < 0.05$, $*** < 0.01$, $**** < 0.001$. Coefficients are marginal effects. The second model includes control for potential selection bias due to self-selection of members into groups.

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[1] Ostrom defined a Design Principle as "an essential element or condition that helps to account for the success of institutions in sustaining the CPRs and gaining the compliance of generation after generation of appropriators to the rules in use" (Ostrom 1990, p. 90). She has also commented: "The term "design principle" has confused many readers. Perhaps I should have used the term "best practices" to describe the rules and structure of robust institutions." (Ostrom 2010, p. 653, footnote 5).

[2] We have adopted the "large N studies" concept from Poteete and Ostrom (2008) and which refers to studies with many observation units and where each observation represents a group of people managing a common pool resource.

[3] In this study we do not aim to study the effect on natural resource management. This will be one of the focuses of or future research.

[4] There were a few groups that were very small in size. Most of these were located in a peri-urban area and having a specialized business requiring limited land or space.

[5] A common pool resource is a natural or man-made resource whose yield is subtractable and whose exclusion is non-trivial but not necessarily impossible (Ostrom et al. 1992).

[6] We use the analogy to Adam Smith's invisible hand for market forces. We think of local institutional responses in form of the DPs as Ostrom's "invisible hand" that may prevent the tragedy of the commons in many situations.

[7] All adult and ablebodied rural residents in a community have to contribute a certain number of working days per year for investment in local public goods. The number of days per person per year has varied between 30 and 90.

[8] Endogeneity implies that a Right Hand Side (RHS) variable in a regression is correlated with other RHS variables and the error term. This may be due to unobservable variables (unobserved heterogeneity) that are correlated with the included variables and the error term. This results in estimation bias. Instrumental Variable (IV) methods are typically used to control for such bias but these methods depend on the identification of strong and valid instruments. Instruments are exogenous variables that are correlated with the endogenous variable but not the outcome variable.

[9] These models allow corner solutions as well as intermediate levels (fractions).

[10] Ordered probit models are preferable for ordinal ranked variables with more than two levels such as in our case.

[11] A substantial number of the groups (315) had no group income yet implying that group income was censored a zero for these groups. A censored Tobit model of log-transformed income was used to handle this censoring issue. One is added to the income of all observations to allow log-transformation for those with zero income.

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[12] We have included a correlation matrix for the performance indicators in Table A26 in the Appendix. The performance indicators were not strongly correlated.

[13] We tested Instrumental Variable (IV) models with the DP index as an endogenous variable with female share and district dummies as instruments but we could not reject exogeneity ($F(1,708) = 0.228$, $p = 0.634$) and the model did not satisfy the over-identification restriction. We therefore cautiously assume that the DP index can be used as an exogenous variable as we were unable to reject this assumption.

[14] This may more precisely be stated as a subdivision of larger CPRs into smaller CPRs.

[15] This constitutional right has become increasingly difficult to fulfill due to the rapid population growth and increasing land scarcity in the Ethiopian highlands.