Supporting Information for

Group size in social-ecological systems

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Materials and Methods

1. A simple model of group size

Organized vs. Unorganized Groups.

Mancur Olson expected groups to get organized only when crossing a given minimum size because small groups do not need an organization to function well (1). His definition of a group was a number of individuals n with a common interest. Here, we model the need of an organization through a comparison of organizational costs versus loss of efficiency in the harvesting of the commons. Organizational costs are assumed to be the sum of two components, one is *fixed* and the other *variable* with group size: TC=FC + VC (n). Organized groups are assumed to incur in no losses of efficiency. Instead, in unorganized groups losses of efficiencies monotonically increase with group size. The above consideration implies the existence of a minimum size for organized groups of $\underline{n}$.

For a theoretical benchmark consider for instance the model in Casari and Plott (2). The aggregate surplus at the Nash equilibrium is $\Pi= w\,[n/(n+1) - n^2/(n+1)^2]$ and loss of efficiency in the Nash equilibrium of a one shot interaction in a common property resource goes from 0% with 1 users, to 11.1% with 2 users, to 36,0% with 4 users, to 60,5% with 8 users, to 88,2% with 32 users. Empirical evidence for the loss of efficiency as group size increases is presented in Camera et al. (24): in an experimental study, the loss of efficiency with respect to the social optimum amount to 29,3% with 2 participants, 50.9% with 4 participants, to 65.8% with 8 participants, to 71,5% with 32 participants.

Why and when will an organized group split?

By assumption, the efficiency of organized groups is identical irrespectively of group size. Hence, their performance depends on the level of organizational costs. Group fission will occur if the costs of a single entity are greater than those of two separate entities half the size:

$$F + VC(n) > 2F + 2VC(n/2)$$
$$F - VC(n) + 2VC(n/2) < 0$$

In order to explicit n, one needs additional assumptions on VC(n). We assume monotonicity (VC'>0) and convexity (VC''>0) of group size of the variable component of organizational costs. For instance, consider the simple case where $VC=n^2$.

$$F - n^2 + 2(n/2)^2 < 0$$
$$n^2 > 2F$$

The critical size beyond which the group will benefit from splitting

$$\tilde{n} = (2F)^{0.5}$$

How can we map the model onto the data?

Three considerations are in order.

(i) The fact that one observes organized groups of different size does not contradict the model, which does not pin down an ideal group size but rather a range of values for size where organized groups will lie, $\underline{n}$ and $\tilde{n}$.

(ii) The two theoretical thresholds $\underline{n}$ and $\tilde{n}$ are determined by independent conditions: $\underline{n}$ originates from the intersection of the loss of efficiency and organizational cost function, while ñ depends entirely upon the structure of the organizational costs alone. In order to estimate ñ from observed data, one needs to make assumptions about n, which is likely to be rather small. If the group splits, the two resulting entities will have ñ/2 members each. If ñ/2 is greater than n, then the two final groups will also have an organization. We believe that this assumption is empirically reasonable.

(iii) When applying the model to the data, two implicit assumptions are set: homogeneity in organizational costs and constant returns to scale. In the simple model outlined above, all groups are assumed to be identical, in particular with respect to their organizational cost structure. Different degrees of social heterogeneity may influence organization costs due to its impact on bargaining, monitoring and conflict resolution costs (3, 4). Hence, social heterogeneity can easily generate an even wider diversity in the size of organized groups than stated in (i). The second assumption relates to returns from cooperation in terms of revenues not varying in group size. Yang and colleagues study a case of forest areas assigned to groups varying in size (5). The empirical estimate of performance in managing the forest is an inverted U-shape curve. The best performance is achieved by groups of 8 or 9 households, which corresponds to about 30 individuals.

9 households x 3.48 average members per household = 31.32 individuals
8 households x 3.48 average members per household = 27.84 individuals

After that size, group performance declines with increasing group size. This evidence is in line with the presence of a moderate amount of economies of scale in commons management.

2. Demography: population growth and household size

Population in Italy and Trentino

This section reports data about the Italian and Trentino population and the data sources used.

*Italy***.** The Italian population trend is reconstructed using the population data in Bellettini (6).

Year	*Population (Millions)*
1200	8.5
1250	10.1
1300	11
1350	9.5
1400	8
1450	8.8
1500	10
1550	11.6
1600	13.3
1650	11.5
1700	13.4
1750	15.5
1800	18.1

Trentino. To date, there exists no systematic collection of population data for the Trentino during 1200-1800. We collected population data from several sources: Cole and Wolf (7) in 1312, 1427, 1650 and 1754. For their population estimates before 1754, Cole and Wolf referred to Wopfner ((8), p. 222–324), who reported that the Trentino represented the 34.7% of the total population of the Tyrol. For 1312, 1427 and 1650, Cole and Wolf reported only the total population of the Tyrol: to compute the respective estimates, we considered that the proportion of the population of the Trentino among the population of the Tyrol remained constant at 34.7%. For the 1835 estimate, the source reported by Cole and Wolf is Fiebiger ((9), p. 15-16). The average of the populations in 1754 and 1835 - 248,000 inhabitants - is taken as a reference for the end period (1800). Debiasi (1953) reports regional estimates in 1700; Franceschini (10) in 1594, 1704; Chiocchetti and Chiusole (11) in 1780; and Grandi (12) in 1807, 1809 and 1810. The Trentino population estimates in Franceschini (10) refer to the 1573-1615 and 1685-1723 time intervals, for which we considered the median years 1594 and 1704, respectively.

Year	*Population*	*Source*
1312	83,373	Cole & Wolf (1974), (7)
1427	124,920	Cole & Wolf (1974), (7)
1594	167,000	Franceschini (2009), (10)
1650	173,500	Cole & Wolf (1974), (7)
1700	200,000	Debiasi (1953), (13)
1704	171,800	Franceschini (2009), (10)
1754	206,000	Cole & Wolf (1974), (7)
1780	180,000	Chiocchetti & Chiusole (1965), (11)
1810	229,224	Grandi (1978), (12)

Calculating group size from the Charters

We define group size as the number of individuals who are likely to interact face-to-face in the direct appropriation of the commons. We employ here the number of legitimate users of the common property resource – which is the correct variable to use – rather than the village population. We will use three relevant concepts: attendants, appropriators and population in a community.

Attendants are the community members with voting rights who actually showed up in the community assembly. Appropriators are all the community members with the right to access and who use the commons according to the rules set forth in the documents. Non-members were excluded from the access and use of the communal resources. Members entitled to participate to the assembly were one per household, usually the *pater familias*. Appropriators included all community members and their families (spouses, children, relatives) living under the same roof (it. "foco") and residing in the community. Population includes appropriators as well as non-members living in the community.

We use appropriators as the measure of group size. Our measurement of group size relied on those attending the village assembly as reported in the *Charter*, later adjusted using the quorum of the assembly, and then multiplied by the average household size.

We followed a four-step procedure to compute group size:

a) Counting household heads present at the assembly.

b) Calculating total households in the community using the assembly quorum.

We used the quorum (q=a number between 0 and 1) reported in the *Charter* to calculate total households. It was generally unclear whether the quorum was "factual" or "legal." Expressions such as "there are 3/4 of active members" in the assembly could be a statement about the actual fraction of members attending the meeting (factual) or a statement about the legal requirement for a valid meeting (legal). Here we calculate group size applying a midpoint between attendance at the quorum level and unanimous attendance:

Factual interpretation → Total households = attendants / q

Legal interpretation with unanimous attendance → Total households = attendants

Hence, the number of household in the community employed the following rule:

Group size = (attendants)/[(1+q)/2]

c) Obtaining the number of appropriators from an estimate of how many people on average comprised a household.

We multiplied the estimated number of households for a constant of 4.5 throughout the period under consideration. The data that we consulted allowed estimating an average household size of 4.5+/-1. The issue of household size is treated below as it entailed an accurate historical search.

d) We rounded the result to the nearest integer.

Assembly Quorum

Out of the 248 documents in the assembly dataset (see *below*), 113 cases also reported a quorum, *q*. The average quorum reported is *q*=0.713. We applied the average quorum for those assemblies where no quorum was reported. Moreover, we assume equality between the constitutive quorum (the number of members required to consider the assembly valid) and the deliberative quorum (the number of attending members required to consider the decision valid). The notary could report in the document the share of attending individuals (e.g. "Two parts out of three of community members are attending this assembly"') or a phrasing referring exclusively to the decision (e.g. "The decision is taken by the two parts out of three of community members"). In the latter case, it is assumed that the notary reported the number of members collectively undertaking the decision out of the total number of community members entitled to cast a vote, specifying the non-active members and - in some cases - the nays.

Household size

We assume a constant average number of 4.5 individuals per household throughout observation period. Hence, one assumption is about the level and the other about the absence of variation over time. This section provides data sources and a discussion concerning them.

Local historians and demographers have studied the issue of household size. For the period under analysis there basically exists four types of available sources: (a) ecclesiastical records about population for spiritual purposes, which report the number of faithful; (b) tax records called "liber focorum" (from latin: "book of households"); (c) population estimates by historians on the early medieval populations of major towns (like Trento, Rovereto, Riva del Garda); and (d) estimates on household size obtained from interpolation of ecclesiastical sources (birth, death, and marriage register, available since after the Council of Trento in 1564) performed by local contemporary researchers. In order to validate our assumption of 4.5 individuals per household, we crossed all of the available historical evidence.

Reliable household size estimates are unavailable until the end of c. 1300. Varanini ((14), p. 470) reports a population estimate for the city of Trento of 4,000-5,000 inhabitants in 1335. This estimate is based on a bishopric tax record cited by Seneca ((15), p. 54), which documents the tax debt of the city (4,000 lire) and also reports for the countryside the number of households relevant for the tax collection and the amount due. The limitation of this estimate rests on the existence of households exempted from the tax collection, apparently reflecting a negligible number. Therefore, Seneca (1953) suggests an estimate of 1,000 households in Trento, which according to Varanini corresponds to 4,000-5,000 inhabitants and hence an average household size between 4 and 5. This consideration is in line with the opinions of other researchers given the mortality rates in the medieval time ((16), p. 539). Varanini (14) also reports that Rovereto had 200-215 households in 1339, while in 1490 it had 1,000 inhabitants, with 192 households. These numbers suggest an average household size of 5.2 in 1490. We consider this estimate together with evidence of an increasing population trend in the region reported by other researchers ((7), see Table 1 of Appendix) and the same Varanini in other communities (the town of Riva del Garda counted 157 head of households in 1325, 124 in 1349 and 132 in 1371; in his essay, Varanini reports that according to the chronicles by father Giovanni da Parma the death toll in Trento in 1370 was of 5/6 of the population, hence we may approximate the population to 750 individuals using the 1335 population (17). Varanini reports that the population only reached the level of the early-1300s again in 1510 ((14), p. 471). This evidence brought us to consider that the real average household size in the mid-1300s was lower than 5 throughout the region. Therefore, for c. 1300 we have an indication that the average household size was included between 4 and 5.

Debiasi (13) reports data from the transcription of two scrolls containing inhabitants and number of households for the villages in the Valley of Non in 1620 and 1633. The author used a convention of 5 people per household to estimate the village population when only the number of households was available (1633). We only considered the villages where both the number of households and the population was available in 1620 (n=19), whereby we obtained an average household size of 5.34.

Garbellotti ((18), pp. 45-46) reports direct population estimates and the number of households for 25 villages in the district of Trento in 1717. The data comes from the transcription of a tax register in which every community representative had to indicate the tax subjects and establish to which tax class they belonged. The average household size obtained using this data is 3.52. In his work, Chiocchetti (16) had access to ecclesiastical sources and studies the demography of the village of Moena (Valley of Fiemme) in c. 1700. He reports that in Forno there were 6 households and 28 inhabitants in 1738, thus representing a household size of 4.6 ((16), p. 211). In Moena, there were about 3.3 surviving offspring per household in 1738, and an average of 3.7 household components. Chiocchetti states that 75% of the marriages with both living parents did not go beyond 5 components, a figure not far from the average household size of 4.73 derived from a good number of English censuses and French data for c. 1600-1700. In Moena, only 14 households out of 214 had more than 5 offspring in 1738, while only 3.7% had more than 6 offspring. Finally, the study on Moena reports accurate data for four periods - 1755-1759, 1775-1779, 1785-1789 and 1795-1799 - from which an average household size of 5.59 emerges.

The observations collected from the available resources are n=49, as illustrated in Table S1. From these observations, we obtain an average household size of 4.50 (s.d.=1.02; 25%=3.59; median=4.67; 75%=5.36), which we apply to the period under analysis in the whole Trentino region. In Figure 4 (main text), we perform robustness checks on group size using the interquartile range as a reference: the lower bound will be a household size of 3.5 and the upper bound will be 5.5.

3. Additional empirical evidence on static analysis

We performed a robustness checks for Table 1 using alternative econometric specifications (Tables S2 and S3).

4. Additional empirical evidence on dynamic analysis

Test. Repeated observations

This analysis is based on the subset of repeated observations for the same community. The share of groups that remained constant or grew in size was statistically significantly higher for large versus small groups (73% smallest vs. 34% largest, chi-squared test, z =14.19, $p<0.001$, $n_1=46$, $n_2=46$). An alternative way to measure the tendency of groups to become larger is to consider the absolute change in group size in terms of number of individuals, which is shown by the solid line in Fig. S1, which plots a moving average over adjacent observations. This line declines with group size and its cross-point at zero provides an estimate of the average attraction point in terms of size. The attraction point is located between 149 and 152.

Test. Group size is not affected by communities' resource diversity

We perform a two-sample Wilcoxon rank-sum (Mann-Whitney) test on a set of observations having prevalence of forest or pasture (N=176). We compare forest-rich ($n_1=95$) with pasture rich observations ($n_2=81$), and the rank sum test shows that their group size does not differ significantly (z=-0.111, $p>0.9114$).

5. Ecological vs. social determinants: description of methods

Classification of communities into Forest-rich, pasture-rich and mixed-resources. In order to study ecological factors we partitioned the sample into three sets of roughly similar numerosity. A community is classified as forest-rich if its surface of forest is more than ten times its surface as pasture, where pasture includes grazing land and alp. Instead, a community is classified as pasture-rich if the forest is less than six times the pasture. These parameters are somewhat subjective but they were selected in order to have a similar number of communities of each type (we also use the ratio of forest over pasture in other analysis for robustness check). In-between communities are placed in a mixed resource category. In addition, communities with only a limited endowment of common property also fall in the mixed resource category: more precisely, those where less than one-third of the land was common property and consequently more than twothirds was private property out of the total productive surface. The resulting classification is as follows:

Community Type	Frequency	Percent	Cumulative
Forest-rich	95	38.31	38.31
Pasture-rich	81	32.66	70.97
Mixed or few commons	72	29.03	100
Total	*248*	*100*	

Forest-rich (dummy). Dummy variable that codes as 1 forest-rich communities, 0 otherwise.

Pasture-rich (dummy). Dummy variable that codes 1 pasture-rich communities, 0 otherwise.

Mixed or Few commons (dummy). Dummy variable that codes as 1 communities that are neither pasture-rich nor forest-rich, 0 otherwise.

Forest over pasture (ratio). This variable expresses the ratio between forest and pasture surface.

Land resources

Here we provide more details about the dataset in reference to environmental characteristics and land resources of each community. We took as reference for the community location, the place where the assembly took place. For land resources, we relied on the cadasters (19), which contain a detailed description of land resources collected for fiscal purposes. In the year 1897 the region of Trentino was divided into 378 cadastral units, which corresponds to a finer grid than the communities that we employed in this study. Hence, a community may include one or more "cadastral units". For the empirical analysis, we built an array of variables, which are described below.

Total productive surface. Land surface in hectares of a community, excluding unproductive land such as wasteland, ponds, lakes and houses. Productive land includes plow land, vineyard, fruit garden, meadow, grazing land, alp and forest.
We relied on the 1897 cadasters for environmental data about land use. This measure is time-invariant but it is tightly linked to ecological variables such as altitude, slope, soil, and rainfall that severely constraint the type of use for land. In short, they largely fix land types and restrict them from varying much. Nevertheless, regression coefficients in Table 1 (col. 2 and 3) and 2 (col. 2) as well as in Tables S2, S3, S5, S6 might be subject to measurement error and be biased. The errors involved are likely to be small because, as noted above, ecological constraints are likely to have heavily restricted the possibility to modify land type over time.
When estimating the extent of collective and private land property we combine data from the 1897 cadasters with the 1780 cadasters in order to increase accuracy. The integration procedure is described below.

Collective and Private land. The amount of land classified as collective or private was computed starting from the 1897 cadasters' data using the following estimating equation: *commons* = grazing land + 0.145*alp + 0.801*forest, and *private*= plow land +

vineyard + fruit garden + meadow + 0.855*alp + 0.199*forest. The above shares for each type of land were estimated through an econometric analysis that compared a sample of 32 communities from the 1780 cadasters for which we have precise data not only on land type but also on property regime with the corresponding 1897 cadasters data. Purchases and sales of common land were legally possible but rare in practice. The procedure to estimate the shares is as follows. The starting points are the productive land in 1780 and 1897 from the cadasters. We know the share of common land in 1780 and estimate the corresponding surface of common land in 1897 in each community (*common land surface* = Share of common land 1780 * Productive land 1897). The OLS estimate below reveals the link between the surface of common land in grazing land, alp and forest surface based on 1897 data (R^2=0.84).

Dependent variable: Common land surface	Coefficient	Standard Error
Grazing land (1897)	1.26*	0.557
Alp (1897)	0.173	0.143
Forest (1897)	0.737***	0.184
Constant	73.894	156.814
N = 32		
R^2 = 0.84		

Statistical significance levels: * p<0.05; ** p<0.01; *** p<0.001.

Given that the coefficient for grazing land is above 1, we assume that all grazing land was common property and focus on explaining the remaining portion (*Actual common land surface* = common land surface 1897 – grazing land), through an additional OLS regression:

Dependent variable: Common land surface	Coefficient	Standard Error
Alp (1897)	0.1451	0.128
Forest (1897)	0.801***	0.122
Constant	52.251	147.764
N = 32		
R^2 = 0.78		

Statistical significance levels: * p<0.05; ** p<0.01; *** p<0.001.

The estimated shares for alp and forest in the calculation of the *Collective land* have been taken from the above regression. The shares for the *Private land* are the complement to 1.

Measuring social diversity using surnames

Surnames have been used in anthropology, biology and genetics to study family structures (20, 21), migration (22), inbreeding rates (23, 24), genetic isolation and distances between populations (22, 25).

We take an index of surname diversity in each assembly using all of the attendants' surnames. Consider an assembly with N members. The number of assembly members with surname j (or belonging to any group j) is N_j. We computed the index of surname fractionalization for each of the assemblies: $h=1-\Sigma_j(N_j/N)^2$. It measures the probability that two randomly selected individuals from the population come from different "surname groups". When surnames are all equal, there is perfect homogeneity: $h=0$, whereas when surnames are all different, there is perfect heterogeneity: $h=1$. It is analogous to the Hirschman–Herfindahl index (26) and the ethno-linguistic fractionalization (ELF) index (27–29).

Recall that only the heads of the households could attend and vote at the assembly. We argue that the index is a proxy for the diversity in preferences and wealth of households within the community where the assembly took place. Surnames in assemblies are treated as competing "parties." This can originate from an interpretation based on either the diversity of economic interests, the genetic distance of the population, or both (30–33).

For the former interpretation, the underlying assumptions are that any individuals having a different surname represent the interests of two different households, and that the interests of households having a different surname are to some degree independent and not identical in a variety of dimensions. Conversely, two identical surnames referred to the interest of the same "party."

Instead, the use of surname diversity as a proxy for genetic distance has been criticized because surnames concerns the transmission of only half of the genetic heritage, from the father's rather than the mother's side. In fact, two persons could have different surnames and yet be first cousins due to their mothers being sisters. Moreover, two persons could have the same surname and yet not be related at all due to the independent origin of the same surname (think about job-related surnames). Despite being valid, the latter criticism has a weaker force in the case of Trentino owing to the small community size and the high inbreeding rates typical of mountain environments (7, 25, 34–37).

The dataset collected comprises the surnames composition of 248 assemblies, which list a total of 7,771 persons. Based on our analysis, we identified 3,292 surnames (unique codes). The number of surnames in an assembly ranged between 2 and 173. We drew a distinction between surnames and other types of individual identifiers such as nicknames, job titles, etc. For this purpose, we referred to classes of surnames listed by Cesarini Sforza (38), an expert of Trentino history, who divides the origin of surnames into the following classes: 1. women; 2. arts, jobs, professions; 3. physical qualities, body parts; 4. moral qualities; 5. objects; 6. places; 7. animals; 8. plants; 9. food; and 10. others. We then attributed a unique code to each distinct surname to enable the within-assembly comparison of surnames with the aid of Cesarini Sforza (38). When attributing the unique codes, we relied on results from string distance minimization algorithms in an effort to also carry out an appropriate cross-assembly comparison of surnames. For the purpose of these analyses, the relevant aspect is only to distinguish whether each surname was equal to or different from the surnames of all the other attendants.

Institutional complexity

Proxy 1: Number of assembly roles. This proxy is the counts of the different offices or roles mentioned in the preamble of each charter, within the list of people present at the assembly, some of whom may have voting rights and some of whom may not. The number of roles in a community could range between 1 and 7, with an average of 3.7. There were 18 possible offices/roles (Table S4).

Test 1A. Communities with higher surname diversity are more complex (assembly roles)

We test whether surname diversity varies significantly depending on the number of assembly roles. We divide the full sample with observable surname diversity (N=236) in two subgroups, above and below the median surname diversity ($n_1=n_2=118$). The rank sum test shows that surname diversity in the two groups is statistically higher in groups with surname diversity above the median (z=-3.596, p>0.0003).

Test 1B. Resource diversity has no effect on institutional complexity (assembly roles)

We test whether resource diversity varies significantly depending on the number of assembly roles. We divide the full sample with observable resource characteristics (N=236) in two subgroups, pasture-rich observations ($n_1=159$) and resource-mixed observations ($n_2=77$). The rank sum test shows that resource diversity in the two groups is not statistically different (z=-0.354, p>0.7232).

Proxy 2: Charter length. This proxy is a simple count of the articles written in the charter document.

Test 2A. Communities with higher surname diversity are more complex (charter length)

We test whether surname diversity varies significantly depending on the number of charter articles. We divide the full sample with observable charter length (N=237) in two subgroups, below ($n_1=116$) and above ($n_2=121$) the median surname diversity. The rank sum test shows that surname diversity in the two groups is statistically higher in groups with surname diversity above the median (z=-2.884, p>0.0039).

Test 2B. Resource diversity has no effect on institutional complexity (charter length)

We test whether resource diversity varies significantly depending on the number of charter articles. We divide the full sample with observable resource characteristics (N=237) in two subgroups, pasture-rich observations ($n_1=159$) and resource-mixed observations ($n_2=78$). The rank sum test shows that resource diversity in the two groups is not significantly different at the conventional 5% level (z -1.891, p>0.0587).

We performed a robustness check using charter length as a proxy of institutional complexity. Like with the number of assembly roles, we find that social factors play a significant role in shaping institutional complexity, while ecological factors play a less clear role. Communities with high surname diversity – those above the median of the fractionalization index – are more complex than those with low diversity (Mann-Whitney test: z=-2.884, p-value=0.004, n=237). These results are also confirmed by panel data regressions after controlling for group size (Tables S5 and S6). Unlike statistical tests, in regressions both group size and surname diversity compete with one another in explaining institutional complexity, which is reassuring given their known correlation (Table 1, column 3). Instead, the effect of the type of natural resources on charter length without controlling for group size is statistically significant (Mann-Whitney test: $z=-2.809$, $p\text{-value}=0.005$, $n_1=90$, $n_2=78$). This latter effect loses statistical significance in a regression analysis (Table 2)

6. Assembly Dataset

This study is based on a sample of documents dealing with the management of common-pool resources in the Trentino region and reporting a list of attendants to community assemblies. We collected 248 documents with information on attendance, for which we were able to extract information about assembly participants, usually listed in the preamble of the document. The sources of these documents are: a book collecting several rural charters (39), a guide of the local archives in the region (40), published (mainly authored by local historians) and unpublished material (Master theses), online listings of the inventories and the archives in the region (http://www.trentinocultura.net/catalogo/cat_fondi_) and direct access to archival records.

Our dataset comprises 156 communities observed between 1249 and 1801. 100 of these communities are observed once, 36 are observed twice and 14 are observed three times, while only 6 appear in the dataset more than three times.

In addition to the name and surname of the attendants, the records also report a distinction between community members (i.e. those who were legally entitled to cast a vote) and non-members.

We coded the preamble of the documents in the following way:

Document type. There are three classes of documents: complete "Carte di Regola" ("charters"), modifications of charters and documents that are not charters. Complete charters are stand-alone documents that lay down the rules for governing the economic resources of a community: they can be a first adoption or later renewal of a previous charter. Some communities may have no charter, while others may have adopted up to seven complete charters in the period studied. Modifications are partial amendments to charters occurring after the adoption of a complete charter that take the form of additions or appendices to the pre-existing document. Other documents regulate or contract the allocation of property rights on the commons but do not take the form of charters, although they may refer to charters. Examples are contracts of purchase of community membership and contracts for the division of common forest and pastures between two or more communities. In this study, the focus is placed upon the first complete charters for two reasons: first, the first adoption of a rural charter starts a new interaction regime (formal institution); and second, in complete charters, the collective action can be better observed.

Assembly name. Contains the identifier of the community using the name of the villages considered in the document describing the assembly, which could be either a full rural charter or a modification thereof. If the assembly is held in a community with more villages, the name of the community is followed by a colon ":" with the names of the villages separated by a comma. Otherwise, if more villages share the same commons without giving a name to their organization, the villages are simply listed one after the other separated by a comma “,”.

Year. Describes the year of the assembly.

Number of active members. This variable counts the community members (it. “vicini”), the attendants having voting rights in the assembly. All members were obliged to attend the assembly.

Number of non-active members. This variable counts the number of people who are entitled to attend the assembly and cannot cast a vote, for both contingent (they are absent) and political (they are appointed officers) reasons.

Number of non-members. This variable counts the number of non-members, like the notary and the witnesses from other communities, or non-members coming from other communities who had no voting rights (it. “forestieri”, e.g. strangers).

Total listed attendants. This variable aggregates the information of the three preceding variables by providing the gross number of people involved in the assembly. We performed our analyses on assembly attendance using this set of 7,706 listed assembly participants.

Number of roles in each assembly. This variable counts the different assembly appointments in each assembly.

Quorums (from documents). The quorum that we applied denotes either the reported quorum when there is an explicit mentioning in the assembly record, or an estimated quorum, namely a weighted average of all the quorums observed in the dataset.

Number of articles in the document. For a subset of 237 assemblies, it was possible to obtain a count of the articles written in the document. We considered this measure an index of institutional complexity.

Elevation above the sea level (mts). The documents often do not specify the precise location of the assembly in the village: normally assemblies were held in the square in front of the church, usually located in the center of the community. We retrieved elevation data for the village center of each assembly using GIS.

Plow land. Surface of plow land in the community, in hectares. Source: cadaster 1897.

Meadow. Surface of meadow in the community, in hectares. Source: cadaster 1897.

Fruit garden. Surface of fruit garden in the community, in hectares. Source: cadaster 1897.

Vineyard. Surface of vineyard in the community, in hectares. Source: cadaster 1897.

Grazing land. Surface of grazing land in the community, in hectares. Source: cadaster 1897.

Alp. Surface of alp in the community, in hectares. Source: cadaster 1897.

Forest. Surface of forest in the community, in hectares. Source: cadaster 1897.

Lake, Pond. Surface of lake and pond in the community, in hectares. Source: cadaster 1897.

Wasteland, Houses. Surface of wasteland and houses in the community, in hectares. Source: cadaster 1897.

7. Group size in other settings

Here we report evidence about group sizes in the management of other common pool resources as well as in online networks.

7.1 Library on the Governance of Social-Ecological Systems (SES) at the *Center for Behavior, Institutions & the Environment* at *Arizona State University (*https://seslibrary.asu.edu, Last access: 14 October 2017*).*

The CPR database was developed in the 1980s by Elinor Ostrom and her collaborators, and contains coded answers to specific questions on a set of forms that were used to analyze systematically over eighty case studies of social-ecological systems. Some of the contributors to the entries to the database are: Anderies JM, Brady U, Moreno Martinez V, Schlager E, Tang SY. The database current manager is Marty Anderies: janderie@asu.edu and entries were coded following the CPR Coding Manual and coding protocol instructions written by E. Ostrom, E. Schlager, and S. Yan Tang at Indiana University

We extracted from the database entries concerning common pool resources worldwide (https://seslibrary.asu.edu/cpr). We retrieved the information on October 2017 from the open-access version of the *CPR Database* and summarized it in Table S7. Some cases have repeated entries. In particular, for each case the table reports the year in which the field work ended and the size of the appropriator group (the source of this information was either Institutional Analysis > CPR > Operational Level and Subgroup; or System Representation > Resource users). In building the table it was in some cases difficult to distinguish between population, residents and appropriator group (insiders). Moreover, the description does not distinguish between situations in which the set-up spontaneously emerged or it was established with a state law. For instance the two CPRs in the Philippines: Laoag-Vintar government irrigation system and Nazareno-Gamutan communal irrigation system are state owned and group sizes may have been imposed from outside. Contributors to the studies were multiple researchers and they not always followed the same procedure to estimate group size. Sometimes the estimate for group size is not precisely dated.

In total we analyzed 84 cases, which covers 27 different countries from all continents:

Asia:	Bangladesh, India, Indonesia, Iran, Iraq, Malaysia, Japan, Laos, Nepal, South Korea, Sri Lanka, Pakistan, Philippines, Taiwan, Thailand, Turkey
South America:	Belize, Brazil, Nicaragua, Jamaica
North America:	Canada, USA, Mexico
Europe:	Greece, Switzerland
Africa:	Tanzania
Oceania:	Australia

The resource types are very different from the Trentino case. Most of the resources are either fisheries (n=35) or irrigation systems (n=47). Two entries are other or mixed resources.

The origin and methodology underlying each data point are quite heterogeneous. We refer to the original dataset for a detailed description. Yet, the pattern that emerge in terms of group size are compatible with our interpretation.

For fisheries, the median size of the group of appropriators is 108 and the mean size is 136 (n=35). For irrigation systems, the median size is 105 and the mean size is 312.

Overall, if we take into consideration all entries (n=84) the median is 109 and the mean is 235.

We also provide an illustration of the distribution of groups by size and compare it with the one in Trentino (Figure S2).

7.2 Facebook

What is the size of the network of friends on Facebook (with a sample of 1.71 billion monthly active users in July 2016)? According to their website (http://www.pewresearch.org/fact-tank/2014/02/03/6-new-facts-about-facebook/, checked on Oct 24, 2017), among adult Facebook users, the average number of friends is 338, and the median is 200. Facebook figures should be compared to the pre-Facebook study of Bernard Killworth about mean of network size of people, which they report to be 291. The Facebook technology undoubtedly makes it easier the exchange of information and organization of social events with others but appears to have only slightly increased network size. The detailed breakdown of individual network sizes is the following:

100 or below:	39%
101-250 friends:	23%
251-500 friends:	20%
More than 500 friends:	15%

This distribution is asymmetric and exhibits a quite high degree of individual variability. For descriptive statistics about Facebook few years before see also an unpublished study carried out by Ugander and colleagues (2011) at: https://arxiv.org/abs/1111.4503v1. This evidence is about individual-level choices, unlike our aggregate data about group size. Because of this, it can provide a more direct test of the theory of the existence of individual constraints related to cognition in social relations.

7.3 Twitter

Goncalves and colleagues argue that in principle microblogging and mobile devices may augment human social capabilities but then report, from Twitter conversations, that users can entertain a maximum of 100–200 stable relationships (41). They interpret this finding by stating that the ‘economy of attention’ is limited also in the online world communication by cognitive and biological constraints.

8. Citation from a charter

We report a citation from the charter of the Arco community, year 1480, which highlighted the difficulties in managing the assembly: «et cogitantes grave et multum nocivum esset totum populum comunis dicti burgi archi congregare et deviare et pluries et pluries et multotiens» (translation: «and deeming it would be burdensome and harmful that all the people of the mentioned community of Arco gather unfruitfully many times repeatedly», (29), vol. 1, p. 197.

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Table S1. Empirical evidence of household size in Trentino.

No.	Year	Village	Households	Inhabitants	Average Household Size
1	1620 (1633)	Bresimo	62	375	6.05
2	1620	Cagnò	37	173	4.68
3	1620	Cis	49	271	5.53
4	1620	Cloz	87	446	5.13
5	1620	Dambel	53	328	6.19
6	1620	Denno	73	391	5.36
7	1620	Lauregno	41	284	6.93
8	1620	Livo	31	170	5.48
9	1620	Nanno-portolo	64	358	5.59
10	1620	Preghena	58	283	4.88
11	1620	Quattroville	77	396	5.14
12	1620	Revò	84	438	5.21
13	1620	Romallo	45	210	4.67
14	1620	Romeno	57	275	4.82
15	1620	Scanna	49	271	5.53
16	1620	Segonzone	80	430	5.38
17	1620	Trecappelle	60	309	5.15
18	1620 (1633)	Tregiovo	17	72	4.24
19	1620	Tuenno	115	601	5.23
20	1717	Albiano	101	352	3.49
21	1717	Bedollo	60	207	3.45
22	1717	Bosentino	78	314	4.03
23	1717	Calavino	87	323	3.71
24	1717	Cavedine	214	774	3.62
25	1717	Ciago	11	63	5.73
26	1717	Civezzano	215	691	3.21
27	1717	Cognola	147	535	3.64
28	1717	Covelo	26	93	3.58
29	1717	Fornace	58	229	3.95
30	1717	Fraveggio	23	94	4.09
31	1717	Lasino	71	288	4.06
32	1717	Lon	6	32	5.33
33	1717	Maderno	57	159	2.79
34	1717	Mattarello	96	365	3.80
35	1717	Meano	179	632	3.53
36	1717	Piné	360	1217	3.38
37	1717	Povo	234	790	3.38
38	1717	Sardagna	39	140	3.59
39	1717	Sopramonte	71	202	2.85
40	1717	Terlago	93	313	3.37
41	1717	Vattaro	62	224	3.61
42	1717	Vezzano	74	281	3.80
43	1717	Vigolo Baselga	42	128	3.05
44	1717	Vigolo Vattaro	159	564	3.55
45	1738	Forno	28	6	4.67
46	1755-1759 (1757)	Moena	1193	224	5.33
47	1775-1779 (1779)	Moena	1350	244	5.53
48	1785-1789 (1788)	Moena	1426	247	5.77
49	1795-1799 (1802)	Moena	1473	258	5.71

Data from available sources for c. 1600- c. 1800 (N=49; mean=4.5; s.d.=1.02; 25%=3.59; median=4.67; 75%=5.36). Observations 1-19 are from Debiasi (1953). Observations 20-44 are from Garbellotti (18). Observations 45-49 are from Chiocchetti (16). Indirect estimates are available from sources for c. 1300, c. 1400. No estimates are available for c.

1500. The numbers in parenthesis in observations 1, 18, 46-49 indicate the year of the estimate for the number of households used by the source author.

Table S2. Robustness check on group size (about resource endowment).

	Restricted sample that excludes communities with a mixed resource portfolio		Full sample (different proxy for resource endowment)	
Dependent variable: Group size	(1)	(2)	(5)	(6)
Year (time trend)	0.0274	0.00219	-0.00470	-0.00178
	(0.0928)	(0.0893)	(0.0657)	(0.0610)
Resource endowment is forest-rich (yes/no)	14.30	-3.512		
	(24.22)	(21.06)		
Surname diversity within the group		695.4***		791.1***
		(185.2)		(164.3)
Forest over pasture (ratio)			0.114	0.121
			(0.252)	(0.267)
Altitude above 750 mts (yes/no)	-25.71	-26.91	-24.45	-17.84
	(23.49)	(19.02)	(18.70)	(16.12)
Constant	137.8	183.8	189.8	180.7
	(150.7)	(146.2)	(111.5)	(103.4)
R^2	0.005	0.225	0.007	0.206
N	176	167	248	236

Panel GLS regression with random effects at the community levels and robust standard errors, clustered at the community level. The variable "surname diversity within the group" is mean-centered. Number of obs: 248 = full sample, 236 = full sample minus missing value for surname diversity (-12), 176 = restricted sample that excludes mixed resource communities (-72), 167 = restricted sample that excludes mixed resource communities (-72) and those with a missing value for surname diversity (-9). Statistical significance levels: * p<0.05; ** p<0.01; *** p<0.001.

Table S3. Robustness check on group size
(period dummies instead of a linear time trend).

Dependent variable: Group size	(1)	(2)	(3)
Years 1348-1524	-31.83	-33.04	-57.84
	(39.52)	(39.34)	(32.72)
Years 1525-1630	24.12	23.37	-57.64
	(43.64)	(44.42)	(37.03)
Years 1631-1801	-16.77	-17.53	-52.27
	(36.05)	(36.17)	(29.56)
Resource endowment is forest-rich (yes/no)		4.627	-6.467
		(25.11)	(21.37)
Resource endowment is pasture-rich (yes/no)		-1.384	-0.393
		(22.94)	(19.98)
Surname diversity within the group			814.8***
			(174.5)
Altitude above 750 mts (yes/no)	-24.48	-23.01	-19.02
	(18.79)	(18.55)	(16.14)
Constant	191.9***	191.0***	235.5***
	(35.30)	(36.59)	(30.90)
R^2	0.024	0.024	0.210
N	248	248	236

The following is a robustness check for the impact of different time variable structure on group size. Panel GLS regression with random effects at the community levels and robust standard errors, clustered at the community level. The variable "surname diversity within the group" is mean-centered. Period dummies are separated by the following years: 1348 (Black death in Europe), 1525 (Peasants war in Trentino), 1630 (economic and demographic crisis), 1801 (last charter after Napoleonic invasion). Statistical significance levels: * p<0.05; ** p<0.01; *** p<0.001.

Table S4. Coding of assembly roles.

Frequency	*Assembly roles*
6,151	Community member (Vicino)
369	Witness (Forestiero, Testimone, Testimone-Notaio)
221	Juror (Giurato)
213	Head of the community (Massaro, Regolano, Regolano-Saltaro, Regolano giurato, Regolano Minore, Regolano-Giurato, Giurato-Regolano, Sindaco-Regolano-Massaro, Procuratore)
172	Counselor (Consigliere, Comissario, Consigliere-Massaro, Consigliere-Giurato)
144	Guard (Mansionatore, Saltaro, Saltaro-Giurato)
135	Notary (Notaio, Notaio e accettante, Notaio-cancelliere massarile, Notaio Pubblico, Notaio Rogante, Notaio ufficiante, Notaio Verbalizzante, Notaio-Testimone, Notaio-Giurato, Notaio-Regolano, Notaio rogante)
124	Consul (Console, Console-Giurato, Console-Saltaro, Capoconsole)
117	Representative (Delegato, Eletto, Rappresentante)
83	Controller (Sindaco, Sindaco-Massaro, Sindaco Speciale)
13	Representative of the Feudal Lord (Regolano Maggiore, Vice Regolano Maggiore)
10	Assistant Head of the Community (Vicario, Vice Regolano, Vice Regolano-Giurato, Vicereggente, Correggente)
6	Assistant Officer (Vicemassaro, Vice-console, Attuario e coauditore massile)
5	Secretary (Scrivano, Scrivano-Testimone, Scrivante Vicinale, Segretario, Segretario Verbalizzante)
3	Representative of the Emperor (Gastaldo)
2	Captain (Capitano, Capitano Militare)
2	Knight (Cavaliere)
1	Priest (Curato)
7,771	**Total**

Table S5. Robustness check on institutional complexity (Assembly roles).

Dependent variable:	*Only group size*		*Only surname diversity*			*Without surname diversity*		
Number of assembly roles	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Group size		0.261***					0.249***	0.264***
		(0.0581)					(0.0479)	(0.0532)
Small group size (lower quartile)	-0.229					-0.164		
	(0.221)					(0.209)		
Large group size (upper quartile)	0.920***					0.839***		
	(0.266)					(0.238)		
Surname diversity within the group				5.354***	6.128***			
				(0.889)	(0.892)			
Low surname diversity (lower quartile)			-0.562**					
			(0.212)					
High surname diversity (upper quartile)			0.416					
			(0.243)					
Resource endowment is forest-rich (yes/no)			-0.163	-0.185	-0.275	-0.140	-0.156	-0.248
			(0.251)	(0.248)	(0.235)	(0.255)	(0.258)	(0.250)
Resource endowment is pasture-rich (yes/no)			-0.128	-0.0819	-0.0921	-0.178	-0.146	-0.167
			(0.236)	(0.235)	(0.226)	(0.240)	(0.240)	(0.238)
Year (time trend)					0.005***			0.005***
					(0.000)			(0.000)
Years 1348-1524			0.522*	0.554*		1.041***	0.898***	
			(0.260)	(0.229)		(0.283)	(0.263)	
Years 1525-1630			1.765***	1.772***		2.342***	2.281***	
			(0.289)	(0.253)		(0.293)	(0.276)	
Years 1631-1801			2.115***	2.116***		2.489***	2.439***	
			(0.260)	(0.242)		(0.286)	(0.273)	
Altitude above 750 mts (yes/no)			0.289	0.308	0.280	0.342	0.308	0.283
			(0.204)	(0.199)	(0.188)	(0.207)	(0.208)	(0.202)
Constant	3.462***	3.172***	2.118***	2.057***	-4.943***	1.453***	1.261***	-5.274***
	(0.138)	(0.141)	(0.315)	(0.241)	(0.969)	(0.323)	(0.302)	(1.017)
N	236	236	236	236	236	236	236	236
R^2	0.086	0.065	0.314	0.341	0.345	0.322	0.316	0.292

Random effects GLS regression with robust standard errors, clustered at the community level. The variable "surname diversity" is mean-centered. Period dummies are coded using 1348 (Black death in Europe), 1525 (Peasant war in Trentino), 1630 (economic and demographic crisis) and 1801 (last charter after Napoleonic invasion). For readability purposes, the variable "Group size" was divided by 100. N=236 (full sample minus missing obs. for surname diversity). Statistical significance levels: * p<0.05; ** p<0.01; *** p<0.001.

Table S6. Robustness check on complexity (charter length).

Dependent variable:	*Only group size*		*Only surname diversity*		*Without surname diversity*	
Charter length	(1)	(2)	(3)	(4)	(5)	(6)
Group size		3.339				2.445
		(1.941)				(1.778)
Small group size (lower quartile)	-13.60**				-11.10**	
	(5.026)				(3.784)	
Large group size (upper quartile)	6.858				2.632	
	(5.639)				(4.687)	
Surname diversity within the group				63.61***		
				(18.39)		
Low surname diversity (lower quartile)			-9.644*			
			(3.837)			
High surname diversity (upper quartile)			6.055			
			(5.070)			
Resource endowment is forest-rich (yes/no)			-8.779	-8.914	-8.848	-8.485
			(5.271)	(5.248)	(5.106)	(5.222)
Resource endowment is pasture-rich (yes/no)			-2.274	-1.717	-3.671	-2.454
			(5.107)	(5.011)	(4.976)	(5.065)
Years 1348-1524			1.897	3.604	7.925	7.452
			(6.075)	(6.325)	(7.142)	(6.903)
Years 1525-1630			19.59**	21.91**	28.29***	27.99***
			(6.584)	(6.707)	(7.373)	(7.074)
Years 1631-1801			16.36**	17.95**	20.93**	22.23***
			(5.551)	(5.798)	(6.585)	(6.190)
Amendment to a charter (yes/no)			-42.75***	-42.14***	-41.84***	-42.80***
			(4.363)	(4.392)	(4.468)	(4.422)
Altitude above 750 (yes/no)			4.248	4.321	5.187	4.061
			(4.325)	(4.252)	(4.294)	(4.299)
Constant	40.21***	32.69***	40.92***	38.02***	36.20***	29.51***
	(3.215)	(3.854)	(6.530)	(6.024)	(7.196)	(7.256)
N	232	232	232	232	232	232
R^2	0.0506	0.0248	0.392	0.394	0.398	0.386

Random effects GLS regression with robust standard errors, clustered at the community level. The variable "surname diversity" is mean-centered. Period dummies are coded using 1348 (Black death in Europe), 1525 (Peasant war in Trentino), 1630 (economic and demographic crisis) and 1801 (last charter after Napoleonic invasion). *Amendment* refers to an assembly that modifies parts of an existing Charter (=1), instead of approving a full charter (=0). N=236 (full sample minus missing obs. for surname diversity), 232 (some missing obs. about charter length). For readability purposes, the variable "Group size" was divided by 100. Statistical significance levels: * p<0.05; ** p<0.01; *** p<0.001.

Table S7. Common-pool resource entries in the Library on the Governance of Social-Ecological Systems at Arizona State University

#	*Case Name*	*Country*	*Resource_system*	*End year*	*Group size*
1	San Pedro Fishery	Belize	Multispecies Coastal Fishery	1979	200
2	Lobster fishing	Maine, USA	Multispecies Coastal Fishery	1974	75
3	Ayvalik-Haylazli Lagoon Fishery, Turkey	Turkey	Lagoon Fishery	1978	103
4	Alanya Coastal Fishery	Turkey	Coastal Fishery	1978	100
5	Tasucu Bay Coastal Fishery	Turkey	Coastal marine ecosystem	1978	140
6	Gahavälla Beach Seine Fishing	Sri Lanka	Coastal marine ecosystem	1971	208
7	Chisasibi - James Bay Fishery	Canada	Coastal marine ecosystem	1976	387
9	Messolonghi-Etolico Lagoon Fishery	Greece	Coastal lagoon ecosystem	1984	370
10	Rusembilan Kembong Fishery	Thailand	Coastal marine ecosystem	1964	168
11	Kampong Mee Trawl Fishery	Malaysia	Coastal marine ecosystem	1977	150
12	Arembepe Coastal Fishery	Brazil	Coastal marine ecosystem	1964	127
13	Coqueiral Raft Fishery	Brazil	Coastal marine ecosystem	1965	85
14	Jambudwip Marine Fishery	India	Coastal marine ecosystem	1968	243
15	Artisanal green turtle fishery	Nicaragua	Tropical coastal marine ecosystem	1971	106
16	Fermeuse Cod and Salmon Fishery	Canada	Marine ecosystem	1972	80
16	Fermeuse Cod and Salmon Fishery	Canada	Marine ecosystem	1891	97
16	Fermeuse Cod and Salmon Fishery	Canada	Marine ecosystem	1962	34
17	Perupok Coastal Fishery	Malaysia	Coastal marine ecosystem	1963	245
19	Baccalaos Cove Cod Fishery	Canada	Coastal marine ecosystem	1979	108
20	Ebibara Shrimp Fishing Ground	Japan	Coastal marine ecosystem	1968	150
22	Gageoda (Kagodo) Island anchovy fishery	South Korea	Marine ecosystem	1972	150
23	Port Lameron - Pagesville Lobsterfishery	Canada	Coastal marine ecosystem	1970	29
23	Port Lameron - Pagesville Lobsterfishery	Canada	Coastal marine ecosystem	2012	29
24	Port Lameron - Pagesville Finfishery	Canada	Coastal marine ecosystem	2012	33
26	Quintana Roo-Scalefish	Mexico	Multispecies Fishery	1950	150
27	Quintana Roo lobster fishery	Mexico	Multispecies Fishery	1955	49
27	Quintana Roo lobster fishery	Mexico	Multispecies Fishery	2013	35
28	Ascension Bay Lobster Fishery	Mexico	Marine ecosystem	1982	110
29	Farquhar Beach	Jamaica	Coastal marine ecosystem	1956	94
30	Port Phillip Bay scallop fishery	Australia	Coastal marine ecosystem	1982	79
30	Port Phillip Bay scallop fishery	Australia	Coastal marine ecosystem	1997	84
31	Lakes Entrance scallop fishery	Australia	Coastal marine ecosystem	1982	90
32	Petty Harbour Cod Fishery	Canada	Marine ecosystem	1973	158
33	Munglori "Turf" (forest territory) Management	India	Oak Woodland	1988	206
34	Parwara Van Panchayat Forest	India	Forest ecosystem and associated watershed	1988	110
35	The Amphoe Choke Chai Water User Association	Thailand	Irrigation system	1975	75
36	The Kaset Samakee Water User Association	Thailand	Irrigation system	1975	25
37	A watercourse on the Nam Tan River	Laos	Nam Tan River Watershed	1975	253
37	A watercourse on the Nam Tan River	Laos	Nam Tan River Watershed	1999	253
38	Tanowong traditional irrigation system	Philippines	Watershed and associated topography	1974	200
39	Tanowong Bwasao Irrigation	Philippines	Bwasao stream watershed	2015	200
40	Takkapala communal irrigation system	Indonesia	Watershed and associated topography	1978	125
41	Saebah communal irrigation system	Indonesia	Watershed and associated topography	1978	90
42	Irrigation watercourse in Punjab Province	Pakistan	Watershed and associated topography	1975	41
43	Irrigation watercourse, "Area One"	Pakistan	Watershed and associated topography	1981	50
44	A Tailend Watercourse in Area Two	India	Irrigation system	1981	10
45	"A" irrigation watercourse, Area Three	Indonesia	Watershed and associated topography	1981	460
46	Irrigation watercourse, "Area Four"	Taiwan	Watershed and associated topography	1981	300
47	Chiangmai irrigation system, Chiangmai Villages Two and One	Thailand	Watershed and associated topography	1976	167
48	Agcuyo Irrigation System	Philippines	Watershed and associated topography	1980	180
49	Silag-Butir Irrigation System	Philippines	Watershed and associated topography	1980	300
50	Subak irrigation system	Indonesia	Watershed and associated topography	1959	455
52	Kheri irrigation system	Tanzania	Watershed and associated topography	1963	128
53	Kottapalle open-field husbandry and canal irrigation	India	Watershed and associated topography	1982	800
54	Chherlung Thulo Kulo irrigation system	Nepal	Watershed and associated topography	1980	105
55	Cadchog irrigation system	Philippines	Watershed and associated topography	1980	200
56	Sabangan Bato irrigation system	Philippines	Watershed and associated topography	1980	97

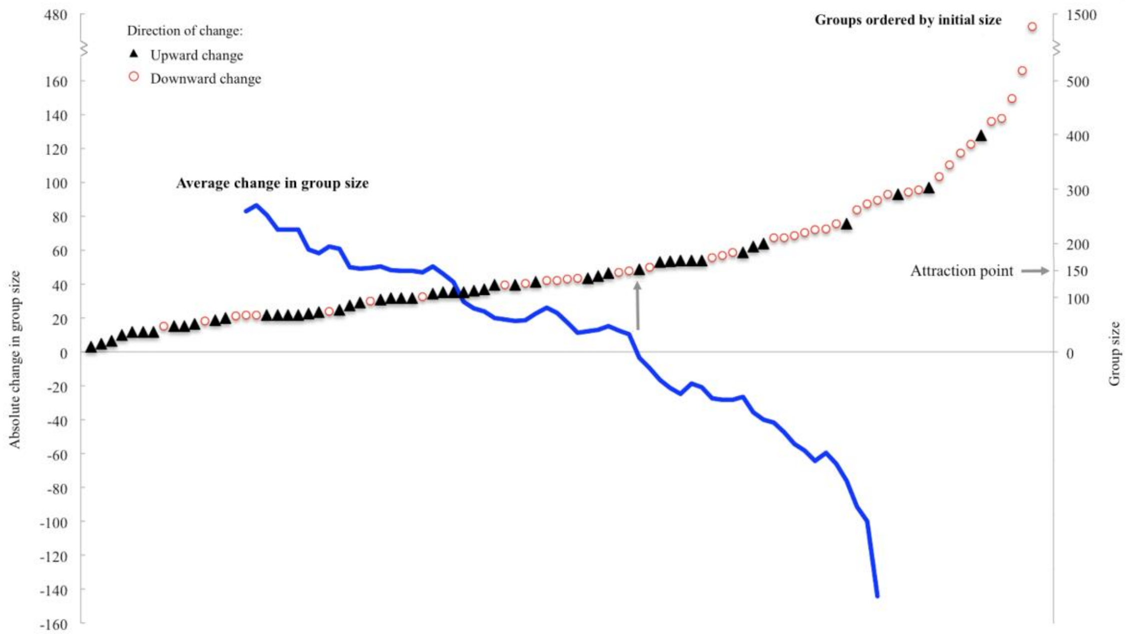
57	Argali Raj Kulo irrigation system (Jethi Kulo)	Nepal	Watershed and associated topography	1980	159
58	Deh Salm irrigation system	Iran	Watershed and associated topography	1980	80
59	Zanjera Danum indigenous irrigation system	Philippines	Watershed and associated topography	1979	23
60	Sananeri Tank irrigation system	India	Watershed and associated topography	1980	150
61	Oaig-Daya irrigation system	Philippines	Watershed and associated topography	1980	86
62	Calaoaan irrigation system	Philippines	Watershed and associated topography	1980	71
63	Laoag-Vintar government irrigation system	Philippines	Watershed and associated topography	1973	5000
64	Nazareno-Gamutan communal irrigation system	Philippines	Watershed and associated topography	1973	2500
65	Obara pond irrigation system	Japan	Watershed and associated topography	1980	50
66	Nayband irrigation system	Iran	Watershed and associated topography	1972	40
68	Chawk 16000L Dhabi Minor irrigation system	India	Watershed and associated topography	1980	60
69	Na Pae Irrigation Systems	Thailand	Watershed and associated topography	1983	80
70	El Mujarilin irrigation system	Iraq	Watershed and associated topography	1958	38
71	Muang Mai Irrigation Systems	Thailand	Watershed and associated topography	1983	60
73	Nabagram irrigation system	Bangladesh	Watershed and associated topography	1979	186
75	Mauraro irrigation system	Philippines	Watershed and associated topography	1980	26
76	Gondalpur irrigation system	Pakistan	Watershed and associated topography	1986	95
77	Silean Banua irrigation system	Indonesia	Watershed and associated topography	1979	263
78	Bondar Parhudagar irrigation system	Indonesia	Watershed and associated topography	1979	10
79	Felderin irrigation system	Switzerland	Watershed and associated topography	1981	75
80	Barrio San Antonio irrigation system	Philippines	Watershed and associated topography	1979	21
81	Ten - Dakh Branch watercourse irrigation	Pakistan	Watershed and associated topography	1979	56
82	Chhahare Khola Ko Kulo	Nepal	Watershed and associated topography	1987	250
83	Naya Dhara Ko Kulo	Nepal	Watershed and associated topography	1975	400
84	Char Hazar Irrigation System (Charhajar)	Nepal	Watershed and associated topography	1986	215
85	Lothar farmer-managed irrigation system	Nepal	Watershed and associated topography	1986	350
86	Gageoda (Kagodo) Island myok ground	South Korea	Marine ecosystem	1972	288

Supporting Figure Legends

Fig. S1. Attraction point of group size (robustness check with absolute group size change). Groups are ordered from the smallest to largest in terms of initial size (n=92, right scale). One can exploit the absolute magnitude of change in group size to identify an attraction point. The solid line represents a moving average of 31 adjacent groups over the absolute change in size in terms of number of individuals (left scale). Overall, the data in this figure refer to 56 distinct communities and comprise 148 out of the 248 observations in Fig. 2.

Fig. S2. Distribution in group size. Source: our dataset for Trentino (N=248) and Library on the Governance of Social-Ecological Systems at the Center for Behavior, Institutions & the Environment at Arizona State University (N=84, **https://seslibrary.asu.edu,** see Table S7).

Fig. S3. The Social Brain and Collective Choice Hypotheses. Group size in Trentino: see main text for the narrow interval; the wider interval is the outcome of a sensitivity analysis performed on the number of household members in the range 3.5-5.5 (It is 4.5 in the narrow interval).



Direction of change:
Upward change
Downward change
Groups ordered by initial size
Average change in group size
Attraction point
Absolute change in group size
Group size
480
160
140
120
100
80
60
40
20
0
-20
-40
-60
-80
-100
-120
-140
-160
1500
500
400
300
200
150
100
0

Fig. S1.

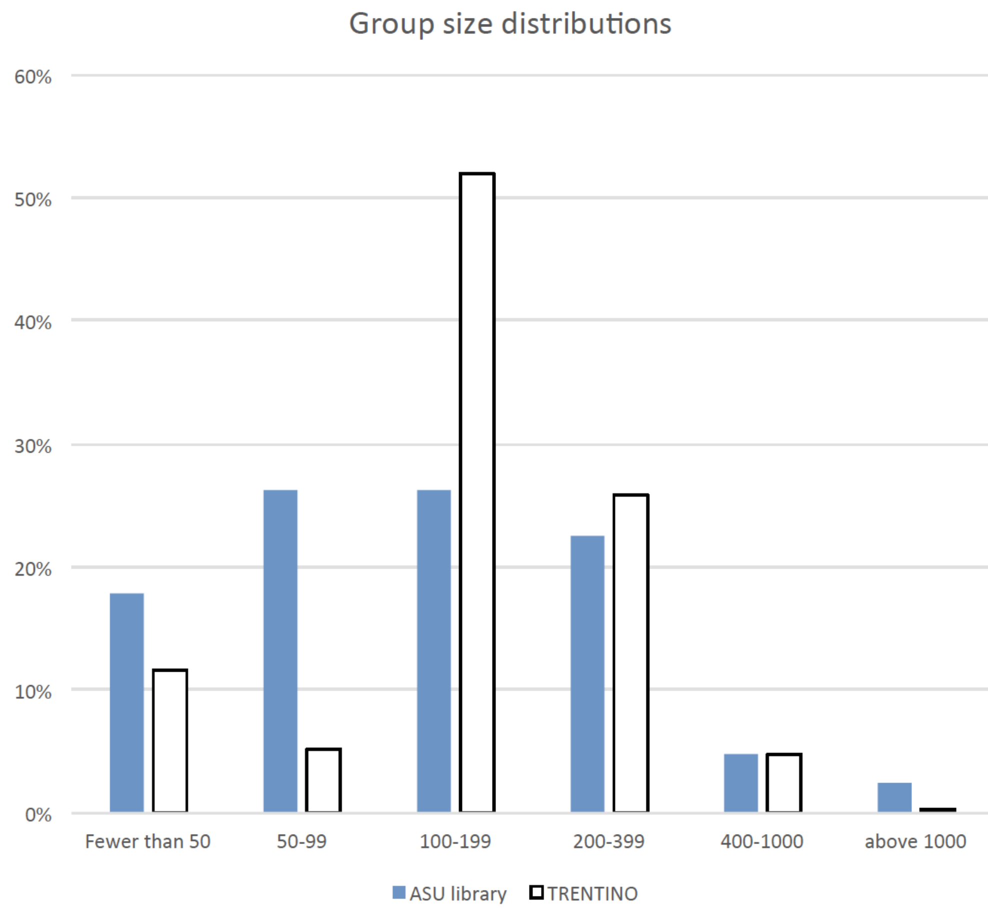

Group size distributions
60%
50%
40%
30%
20%
10%
0%
Fewer than 50
50-99
100-199
200-399
400-1000
above 1000
ASU library
TRENTINO

Fig. S2.

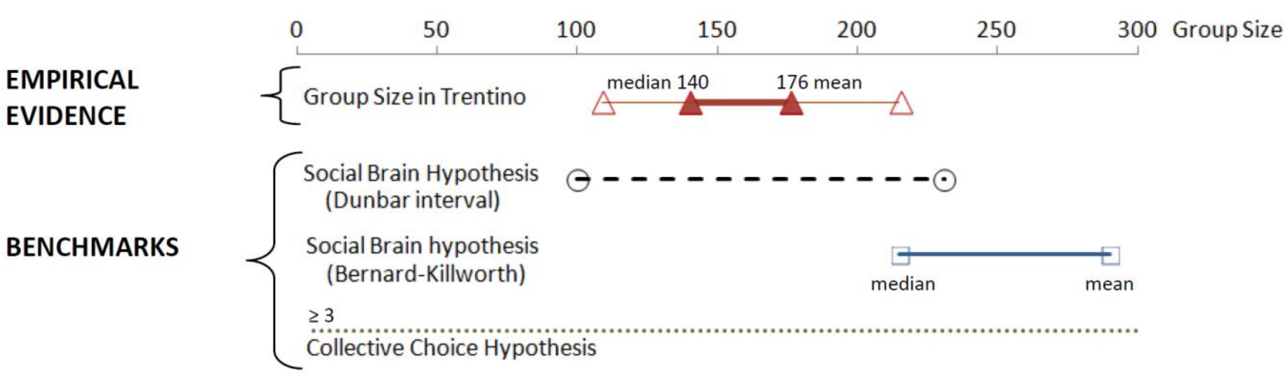

0
50
100
150
200
250
300
Group Size
EMPIRICAL EVIDENCE
Group Size in Trentino
median 140
176 mean
BENCHMARKS
Social Brain Hypothesis (Dunbar interval)
Social Brain hypothesis (Bernard-Killworth)
median
mean
≥ 3
Collective Choice Hypothesis

Fig. S3.