The Effect of Endogenous Group Formation on Sanctioning Institutions: Experimental Evidence*

Ramón Cobo-Reyes[†], Gabriel Katz[‡], Thomas Markussen[§], Simone Meraglia[¶]

Abstract

We experimentally analyze the effect of endogenous group formation on the type of sanctioning institutions arising in a society. We allocate subjects to one of two groups. Subjects play a repeated public goods game and vote on the sanctioning system (formal or informal) to be implemented in their group. We compare this environment to one in which subjects are also allowed to move between groups. We find that the possibility of moving between groups leads to a larger proportion of subjects voting for formal sanctions. This result is mainly driven by subjects with a high initial level of contribution to the public good, who are more likely to vote for informal sanctions when groups are closed than when they are open.

Keywords: Sanctions, Cooperation, Group Formation, Voting, Experiment.

JEL Classification Numbers: ... .

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[†]Department of Economics, American University of Sharjah. E-mail: rcobo@aus.edu

[‡]Department of Politics, University of Exeter. E-mail: G.Katz@exeter.ac.uk

[§]Department of Economics, University of Copenhagen. E-mail: thomas.markussen@econ.ku.dk

[¶]Department of Economics, University of Exeter. E-mail: s.meraglia@exeter.ac.uk.

1 Introduction

The presence and functioning of sanctioning institutions is key to overcoming free-riding problems (Ostrom, Walker and Gardner, 1992). Sanctioning institutions can take different forms, and each society is involved into a dynamic process of institutional adaptation. A sizeable literature has recently recognized the relevance of the endogenous choice of sanctioning institutions (e.g. Ertan et al., 2009; Sutter et al., 2010; Andreoni and Gee, 2012). In particular, increasing attention has been devoted to the choice between decentralized, peer-to-peer sanctions, and more centralized and formalized forms of punishment. Several studies find considerable support for peer-to-peer sanctions, even when centralized sanctions are theoretically expected to prevail (Markussen et al., 2014; Zhang et al., 2014; Kamei et al. 2016; Nicklisch, Grechenig and Thöni 2016).

Most existing studies analyze the evolution of centralized sanctioning institutions in closed societies, i.e. in places where neither the group size nor its composition change over time. Little is known about the choice between centralized and decentralized sanctioning institutionsin open societies, i.e. in groups where inward and outward migration is possbile. In practice, the choice of sanctioning institutions occurs within mobile environments. Members of a society choose the institutions governing their interactions; yet, members can vary over time. Institutional and location choices are then intimately related. On the one hand – in accordance with the classic literature on 'voting with feet' (Tiebout, 1956) – better functioning sanctioning institutions attract individuals. On the other hand, individuals vary with respect to their attitudes towards free-riding and preferences for institutions. In this paper, we take an important step towards the analysis of the effect of endogenous group formation on the choice of sanctioning institutions. We find strong support for a positive relationship between individuals' ability to move across groups and the emergence of more centralized forms of sanctioning institutions. To the best of our knowledge, this is the first paper that studies how the formation of sanctioning institutions varies between open and closed societies.

A priori, it is far from clear whether one should expect individuals to prefer more or less

centralized forms of sanctioning institutions when groups' size and composition can vary. The literature has shown that endogenous group formation affects cooperation, although results depend on the rules controlling migration. In particular, endogenous group formation increases cooperation rates when the receiving group has control over the identity of individuals accessing the group (Page et al., 2002; Cinyabuguma et al., 2005), whereas unstable societies with low levels of cooperation tend to emerge absent such control (Ehrhart and Keser, 1999).[1] In the latter case, we expect societies to develop sanctioning institutions. How 'strong and stable' we do expect institutions to be? The findings in Gurerk et al. (2006) suggest that informal (peer-to-peer) sanctioning institutions may well be stable enough to sustain cooperation when groups' size and composition vary. Also, in the presence of exogenously fixed groups, Markussen et al. (2014) show that the popularity of centralized sanctions is highly sensitive to the fixed cost of sustaining a centralized sanctioning authority. However, the question of whether societies would evolve towards more or less centralized forms of sanctioning institutions when their composition varies over time remains open.

This paper uses a laboratory experiment to investigate whether the possibility of endogenous group formation affects subjects' voting behaviour on sanctioning institutions. In particular, we compare the type of institutions – formal vs informal – that emerge when subjects can move between different groups to the institutions that emerge when groups are exogenously fixed. In our baseline treatment, we employ a setting similar to Cobo-Reyes, Katz and Meraglia (2017). At the beginning of the experiment, we randomly allocate subjects to two groups of 5 people to play a Public Goods Game (PGG). Subjects interact for 30 periods and groups' size and composition remain fixed for the entire duration of the experiment. Subjects vote at fixed intervals on the sanctioning institutions – either formal or informal – to be implemented in their group. We compare this baseline with our main treatment, in which subjects can also (freely) move between groups. In other words, we compare an evironment where "voice" (voting by hand) and "exit" (voting with feet) strategies are

[1] Ahn et al. (2008) and Grund et al. (2015) also find a non-positive effect of endogenous group formation on cooperation rates in a public good game when there are no barriers to entry.

available, to one where only the "voice" option exists (Hirschman 1970).

We find that the endogenous group formation dramatically affects institutional choice, but in different ways depending on groups' initial conditions. In particular, in our baseline almost 80% of the times subjects prefer Informal to Formal Sanctions when groups experience high initial contributions; however, this percentage decreases to 52% when subjects can move between groups. When initial contributions to the public good are low, the opposite results hold. In this case, 35% of the subjects vote for Informal Sanctions when groups are fixed, whereas more than 40% of the subjetcs choose Informal Sanctions when they can move between groups. Results also show that, in our main treatment, on average 20% of the subjects move between groups in each period. Subjects' group choice is mainly determined by the difference in contribution between the subject and other group members, and the punishment she receives. We also find that although contributions are on average larger when Formal Sanctions are in place, this difference does not affect migration behavior and subjects do not tend to move more towards societies with Formal Sanctions in place.

The emphasis on subjects' ability to move between groups and choose their preferred institutional setting links our paper to Tiebout-like models in which subjects can vote either only 'with their feet' (see, for instance, Gürerk et al., 2006) or 'with feet and ballots' (Robbet, 2014, Cobo-Reyes et al., 2017). Our analysis differs from this literature in two main ways. First, unlike Gürerk et al. (2006), we are interested in understanding the effect of endogenous group formation on the evolution of sanctioning institutions within a given group. Second, unlike Robbett (2014) and Cobo-Reyes et al., (2017), we focus primarily on the type of institutions that emerge in mobile and changing environments, rather than on subjects' ability to achieve efficient outcomes.

The paper proceeds as follows. Section 2 describes the experimental design. Section 3 reports and discusses our findings. Section 4 concludes.

2 Experimental Design and Procedures

We conducted laboratory experiments at the University of Exeter between October 2017 and February 2018. Subjects were mainly students of economics, business administration, and engineering, but other disciplines were also represented. We ran two different treatments with a total of 20 sessions, 10 sessions per treatment. Each session was composed of 10 subjects; the average individual earnings were £14. All instructions can be found in Appendix A.

The experimental design consists of two treatments: the Moving Treatment (MT) and the No-Moving Treatment (NMT). Treatments differ depending on whether the groups are endogenously formed.

Moving Treatment (MT). In the first period subjects are randomly assigned to one of two groups – A and B – of 5 people each. In each period, each subject is endowed with 50 tokens to be allocated between a group and a private account.

There exist two institutional settings (rule-sets) affecting subjects' payoffs.

(a) Under **Rule-Set 1**, informal sanctioning institutions (IS) are in place. Subjects observe the contributions to the group account made by their fellow group members. They then have the opportunity to reduce the earnings of other group members. Subjects learn the amount of punishment they receive, but not who punished them or how much punishment others receive in total.

Specifically, any subject i can impose a sanction of 3 units on any other group member j at a cost of 1 unit to herself. The payoff of subject i under Rule Set 1 is:

$$\pi_{i} = (50 - C_{i}) + \frac{1.6}{n}\left(\sum_{j=1}^{n^{h}} C_{j}\right) - \sum_{j=1}^{n^{h}} R_{i,j} - 3\sum_{j=1}^{n^{h}} R_{j,i}, \tag{1}$$

for $i, j = 1, ..., n^{h}$ and $h = A, B$, where n^{h} denotes the total number of subjects located in group h, $C_{i} \in [0, 50]$ denotes i's contribution to the group account. We denote by

$R_{i,j}$ the number of tokens that i uses to punish j. We also denote by $R_{j,i}$ the number of tokens that j uses to punish i.

(b) Under **Rule-Set 2**, formal sanctions (FS) are in place. Each subject in the group pays a fixed fee of 5 tokens per period. In addition, each subject pays a fine equal to 80% of the amount of tokens allocated to the private account in a given period. The fixed fee and the fine (if applicable) are deducted from subjects' monetary payoff at the end of the period. Under Rule-Set 2, subject i's per-period monetary payoff is:

$$\pi_i = (50 - C_i)(1 - 0.8) + \frac{1.6}{n}\left(\sum_{j=1}^{n^h} C_j\right) - 5, \tag{2}$$

for $i, j = 1, ..., n^h$ and $h = A, B$.

At the end of each period, subjects receive information about *(i)* the average payoffs in their current group, *(ii)* the average payoffs in the other group, *(iii)* the Rule-Set implemented in their current group, and *(iv)* the Rule-Set implemented in the other group. Subjects then decide whether to move from their current group.

In the first 5 periods, both Group A and B implement Rule-Set 1. Starting with period 6, subjects vote every 5 periods on the Rule-Set to be implemented in their current group (i.e., the group in which they play in that particular period). Subjects therefore vote 5 times in total. Information about the Rule-Set chosen by the majority of voters is publicly released to all subjects; the Rule-Set is implemented immediately after voting and applies until the next voting round.

Note that, to allow subjects to develop 'norms' of behavior under IS, we fixed the size and composition of the two groups for the first 5 periods of the experiment. In period 6, we allow subjects to vote by letting them know that, by the end of that period and until the end of the experiment, 'moving' between groups is allowed. We implement this process to better understand the impact of 'opening borders' on subjects' choice of sanctioning institutions.

No Moving Treatment (NMT). This treatment differs from MT in one aspect only. In NMT subjects cannot move between groups. Hence, in NMT there are two groups of 5 members that are fixed for entire duration of the experiment.

3 Results

We start by comparing subjects' voting behavior in our baseline and main treatments. We then examine the main determinants of subjects' contribution, migration, and punishment decisions.

3.1 Voting Behavior

We start with an overview of groups' dynamics in voting behavior in the two treatments. Figure 1 plots the average percentage of people voting for IS over time in NMT and MT.

Figure 1: Distribution of participants voting for IS over time, by treatment

Figure 1 reveals that a larger fraction of the population votes for IS in all voting periods

in NMT than in MT. As a result, the average percentage of subjects voting for IS is significantly larger in NMT (57.20%) than in MT (46.40%).[2]

To better understand subjects' voting behavior, in Figure 2 we divide groups depending on whether their initial contributions to the public good is 'high' or 'low' relative to the median sample contribution – i.e., the median contribution of all groups in the experiment – in the first 5 periods of the experiment. The top panel in Figure 2 plots, for both treatments, the average share of subjects in groups with 'high' initial contributions who vote for IS; the bottom panel shows, for both treatments, the average share of subjects in groups with 'low' initial contributions who vote for IS.[3,4]

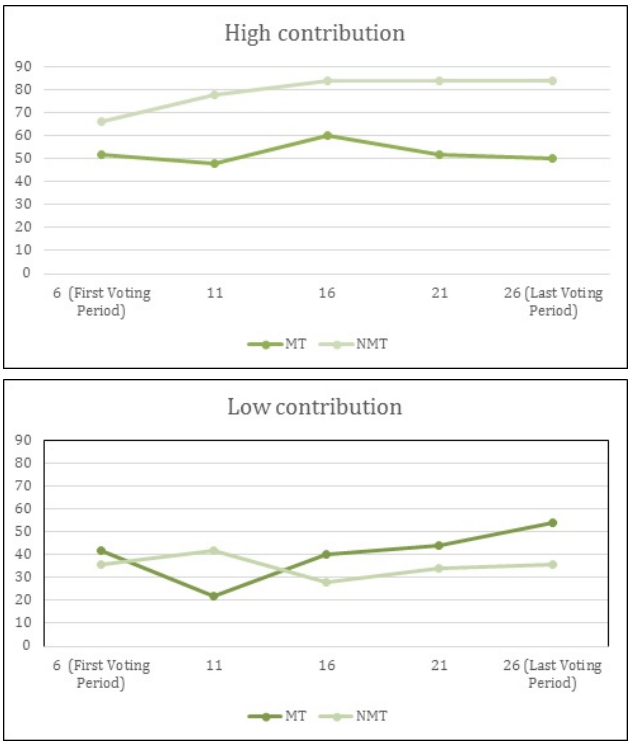

Figure 2: Percentage of people voting for IS over time, by group contribution in initial phase

As shown in the top panel in Figure 2, in societies with high relative contribution levels,

[2] $p = 0.001$, test of proportions.

[3] We consider the first 5 periods of the experiment because groups' size and composition are fixed, and IS is in place. Hence, we use this threshold as a relative measure of the level of cooperation within a group.

[4] Results are robust to using different thresholds. See Appendix XX for the analyses in which 'high' initial contributions are defined as an average group contribution above the third quartile of the distribution of contributions across all groups in the experiment.

a larger percentage of people vote for Informal Institutions when the groups are exogenously imposed. The percentage of subjects who vote for IS in the last three voting periods in NMT (84%) is significantly larger than in MT (54%).[5,6] The bottom panel shows that for the case of societies with low relative initial contributions results reverse; subjects are less likely to vote for IS when the groups remain the same over the course of the experiment. Considering again only the last three voting periods, we observe that the corresponding figures for NMT and MT are 32.67% and 46%, respectively.[7]

Result 1. *A larger proportion of subjects vote for IS in NMT than in MT when the initial contribution of the society is high. For societies with low, initial contribution levels, the result reverses and a larger share of the population votes for IS in MT than in NMT.*

To better understand the mechanisms underlying the group-level patterns reported above, we next present individual-level analyses of voting decisions. The first column of Table 1 reports the marginal effects from a Probit regression model in which the dependent variable, $Vote_{i,t}$ equals 1 (0) if i voted for (against) IS in period t. We have the following explanatory variables: $Moving$, a binary covariate that equals 1 if subjects participated in MT, and 0 otherwise; $High\ Contribution_g$ that takes value 1 if the average contribution of the members of i's current group in the first 5 periods of the experiment is greater than the median group contribution, and 0 otherwise; the interaction between $High\ Contribution_g$ and $Moving$; $Average\ Initial\ Payoff_{-g}$, the average payoff of the member of the group other than i's initial group in the first 5 periods of the experiment; the interaction between $Average\ Initial\ Payoff_{-g}$ and $Moving$; $Contribution_{i,t-1} - Contribution_{g(-i),t-1}$, the differ-

[5]Chi-square= 31.56, $p = 0.00$ for a two-tailed test of equality of proportions taking one session as one independent observation. Equivalently, Mann-Whitney test: $z = 2.33$, $p = 0.02$, two-tailed.

[6]We choose the last three voting periods to allow for some learning in the process. Results are the same if we take the last two voting periods ($z = 2.28$, $p = 0.02$) and the last voting period ($z = 2.27$, $p = 0.02$).

[7]Chi-square= 0.02, $p = 0.02$ for a two-sided test for equality of proportions, taking one session as one independent observation.

ence between i's contribution and the average contribution of the other group members in period $t-1$; $IS_{i,t-1}$, a dummy variable that takes value 1 if subject i has experienced IS in the period previous to the voting and 0 otherwise; and $GroupSize_{i,t}$, the size of subject i's group in the voting period. For the final version, Table 1 will include "marginal effects for the change in the probability of voting for sanctions associated with a change in each covariate; "raw" parameter estimates will be relagated to the appendix.

Table 1
Determinants of individual voting decisions

	(1)	(2)	(3)
Intercept	0.25	-0.78	-0.44
	(0.99)	(0.92)	(1.03)
Moving	0.31	0.64	0.72
	(1.28)	(1.16)	(1.27)
High Contribution$_{g(i)}$	1.28***	0.97***	1.14***
	(0.31)	(0.31)	(0.34)
High Contribution$_{g(i)}$ × *Moving*	-0.96**	-0.78**	-0.90**
	(0.39)	(0.36)	(0.39)
Average Initial Payoff$_{-g(i)}$	-0.10	0.02	-0.01
	(0.15)	(0.14)	(0.15)
Average Initial Payoff$_{-g(i)}$ × *Moving*	-0.04	-0.10	-0.12
	(0.20)	(0.18)	(0.20)
Contribution$_{i,t-1}$ − *Contribution*$_{g(-i),t-1}$	-0.25**	-0.17	-0.20
	(0.10)	(0.11)	(0.12)
$IS_{i,t-1}$	0.57***	0.34**	-3.23***
	(0.14)	(0.15)	(0.81)
Group Size$_{g(i),t}$	-0.05	-0.03	-0.04
	(0.03)	(0.04)	(0.03)
$Vote_{i,t-1}$		0.91***	1.01***
		(0.14)	(0.14)
$Payoff_{i,t-1}$			-0.54**
			(0.26)
$Payoff_{i,t-1}$ × $IS_{i,t-1}$			3.68***
			(0.87)

Notes. The table reports parameter estimates of panel probit models for the probability of voting for informal sanctions. Units of observation are individuals-per-voting period. All specifications include subject, period, group, and session random effects. Standard errors are presented in parentheses. Significance levels: *** at 1%, ** at 5%, * at 10%.

The tendency to vote for IS increases significantly when the subjects experience high initial contributions at the beginning of the experiment. Note that IS are in place in both groups in the first 5 periods. Thus, this result suggests that participants are more willing to vote for IS when these institutions worked properly in the first place.

The negative and significant effect of the interaction between *Moving* and $High\ Contribution_g$ shows that, in line with the results reported in Figure 2, participants experiencing high (relative) initial contributions tend to vote more for IS when they are in a society with exogenously fixed groups vis-à-vis the case of endogenous group formation. In groups with low, initial contributions, the sole possibility of people moving between groups does not have an effect on voting behavior (as shown by the insignificant main effect on "Moving"). This lack of significance could be due to the fact that endogenous group formation increases the probability of voting for IS when initial contributions are (relatively) low.

The probability of voting for IS also increases for subjects experiencing these institutions right before the voting period. This probability decreases with the difference in the subject's contribution and that of the other group members in the period before voting. Hence, it seems that people are willing to switch from IS to FS when their contribution is high compared to the average contribution in their group.

The average payoff of the other group in the first 5 periods of the experiment, along with its interaction with the treatment dummy, do not influence the probability of voting for IS. Finally, the lack of significance of group size supports the results of Gurerk et al. (2006): an increasing size of the group does not reduce the probability of participants voting for IS.

To account for autocorrelation and for subjects' tendency to adjust their behavior over time (Smith, 2013), column (2) incorporates the lag of the dependent variable among the regressors of the column (1) specification. The estimate for $Vote_{i,t-1}$ indicates that the average propensity to support IS rises for subjects who already voted in favor of that type of sanctions in the previous voting period. Thus, it seems that subjects are consistent in their

preferences over time.

Column (3) repeats the specification in Column (2) and incorporates $Payoff_{i,t-1}$, i's payoff in the period previous to voting, as well as its interaction with $IS_{i,t-1}$ to the set of explanatory variables. Subjects' payoff in the period before voting negatively affects their willingness to vote for IS, if the pay-offs are generated under FS (cf. negative coefficient on "Payoff"). However, when these payoffs are generated under IS, they lead to a higher probability of voting for such regime.

We now investigate a potential explanation for the reported negative effect of endogeneous group formation on the probability of subjects voting for IS when the group's initial (relative) contribution is high. We argue that subjects located in a well performing group might expect that subsequent migration from the other group could potentially harm the provision of the public good. This expectation, in turn, can lead subjects in the well performing group to vote for FS if these institutions are believed to be better at ensuring high contributions. To study to what extent subjects vote for FS in anticipation of a negative effect of migration, Table 2 reports subject's decisions in the first voting period in each treatment distinguishing by 'high' and 'low' relative initial contributions. Because in both treatments subjects are not allowed to move between groups before the first voting round, when migration is allowed (MT), subjects' voting behavior is affected by their expectation of out-members' future behavior (but not by out-members' past contributions *per se*). We restrict our analysis to the case of heterogeneous groups, that is, the case in which one group's average contribution in the first 5 periods is (relatively) 'high', and the other group's average contribution in the first 5 periods is (relatively) 'low'.

Table 2
First vote on Informal Sanctions

MT		NMT	
Low Contribution	High Contribution	Low Contribution	High Contribution
36.67	46.67	35	90

As Table 2 shows, the voting behavior in the two treatments is very similar for groups with 'low' initial contribution levels. The percentage of subjects voting for IS in MT is 36.67% compared to a 35% in NMT. Differences are not statistically significant ($p = 0.904$). Results however differ for groups with 'high' initial contribution. In this case, 90% of subjects vote for IS when groups are fixed (NMT), whereas less than 47% of subjects vote for IS in MT. Differences are statistically significant ($p = 0.002$). These results suggest that subjects' expectations of other participants' behaviour – along with other particpants' past and current behavior – play a relevant role in affecting subjects' institutional choice.

3.2 Migration Behavior

We now analyze the main determinants of subjects' location choice in MT. This analysis sheds light on the endogenous dynamics of group formation. It also informs our understanding of the above-mentioned neutrality of group size on subjects' voting behavior (see Section 3.1). Groups can grow in size more or less abruptly. Arguably, a 'slow' growth makes it easier (say, cheaper) for a host society implementing IS to discipline newcomers.[8] Hence, we expect a 'slow' increment in the number of subjects populating a given group to minimize any pontential negative impact of group size on IS' effectiveness to induce high contributions.

The top panel in Figure 3 plots the average share of subjects moving between groups in each period. The bottom panel shows the average group size over time.

Results show that, in a given period, a non-negligible fraction of subjects move between groups. Over the 30 periods of the experiment, on average 20% of subjects switch group. As shown in the bottom panel of Figure 3, over time, subjects' migration patterns lead to groups diverging in their size. The average group size across all sessions and over the entire duration of the experiment is 7.03 for Group A and 2.03 for Group B. In both cases the average group size is significantly different from 5 (Mann-Whitney test: $z = 4.03$, $p = 0.00$, two-tailed).[9]

[8]Evidence pointing in this direction is provided by Weber (2006). The author finds that a slow growth in group size has a positive effect on coordination.

[9]The maximum average group size in one period is 8.7.

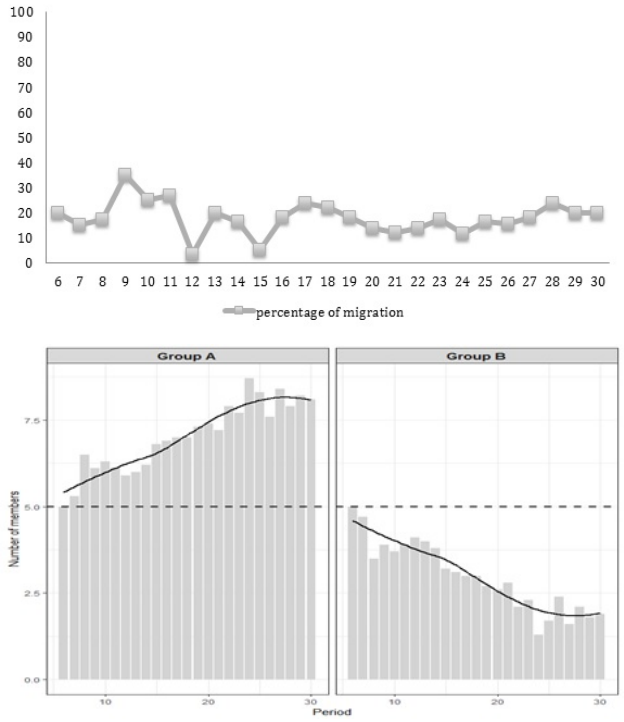

Figure 3: Migration and group sizes over time

Hence, the relatively slow variaiton in group size can account for the lack of significance of group size on subjects' voting behavior. To analyze with more detail subjects' migration choices, Column (1) of Table 3 reports the marginal effects obtained from a panel probit model fitted to data. The dependent variable is $Migration_{i,t}$, a dummy taking the value 1 if subject i moves in period t, and 0 otherwise. We include as predictors of the moving decision: $IS_{i,t}$, a dummy variable that takes value 1 if subject i is in a group governed by IS in period t, and 0 otherwise; $Contribution_{i,t} - Contribution_{g(-i),t}$, the difference between i's contribution and the average contribution of the other group members in period t; $Group\ Size_{i,t}$, the size of subject i's group in period t; and $Vote\ Different\ from\ Group_{i,t-1}$, measuring whether i's institutional choice in the most recent voting period differs from the decision of the majority of her group members; $Punishment\ Received_{i,t}$, the punishment received by subject i in period t; and the interaction between $Punishment\ Received_{i,t}$ and $IS_{i,t}$. The model also incorporates subject-specific (correlated) random effects (Wooldridge, 2005, 2010) as well as

period, group, and session random intercepts. For the final version, Table 3 will include "marginal effects for the change in the probability of moving associated with a change in each covariate; "raw" parameter estimates will be relagated to the appendix.

Table 3
Determinants of migration decisions

	(1)	(2)	(3)	(4)
Intercept	-4.31***	-4.32***	-4.18***	-4.19***
	(0.53)	(0.53)	(0.54)	(0.54)
$IS_{i,t}$	-0.12	-0.12	-0.13	-0.13
	(0.10)	(0.10)	(0.10)	(0.10)
$Contribution_{g(i),t-1} - Contribution_{g(-i),t-1}$	0.11***	0.11***	0.11***	0.11***
	(0.03)	(0.03)	(0.03)	(0.03)
$Group\ Size_{g(i),t}$	-0.13***	-0.13***	-0.13***	-0.13***
	(0.02)	(0.02)	(0.02)	(0.02)
$Vote\ Different\ from\ Group_{i,t-1}$	0.30***	0.30***	0.29***	0.29***
	(0.09)	(0.09)	(0.09)	(0.09)
$Different\ Institutions_t$		0.03		0.03
		(0.09)		(0.09)
$Punishment\ Received_{i,t}$	0.33***	0.33***	0.32***	0.20***
	(0.07)	(0.07)	(0.07)	(0.05)
$Punishment\ Received_{i,t} \times IS_{i,t}$	-0.02	-0.02	-0.03	-0.02
	(0.08)	(0.08)	(0.09)	(0.08)
$Migration_{i,t-1} \times IS_{i,t}$			0.15	0.15
			(0.09)	(0.09)

Notes. The table reports parameter estimates for the panel probit models for individual migration decisions. All the models include subject, period, group, and session random effects. Standard errors are reported in parentheses. Significance levels: *** at 1%, ** at 5%, * at 10%.

All the covariates in the model, but the dummy for IS and its interaction with $Punishment\ Received_{i,t}$, have a statistically significant effect on $Migration_{i,t}$. All else equal, the larger the difference between i's contribution and the average contribution of other members in her group in a given period, the higher the probability that she moves at the end of the period. Group size negatively affects the probability that the average subject moves in a given period. We also observe that i's probability of moving between groups increases when the group does not adopt her preferred Rule Set in the most recent voting round.[10] Finally,

[10]For a similar result, see Cobo-Reyes, Katz and Meraglia (2017).

the higher the punishment received by a subject, the higher is the probability she leaves the group, independently of whether the punishment originates from IS or FS.

Column (2) of Table 3 incorporates a dummy variable $Different\ Institutions_t$ that takes value 1 if the two groups have different Rule Sets in place in period t, and 0 otherwise. Surprisingly, the probability of migration does not increase when the two groups implement different sanctioning institutions. Thus, it seems that subjects care more about institutions' effectiveness in fostering contributions to the public good, rather than institutions *per se*.

Columns (3) and (4) of Table 3 present the results of a dynamic model in which we incorporate the lagged of the dependent variable to columns (1) and (2). All results are robust to this dynamic specification. Also, migrating in the previous period does not have a significant effect on the propensity to migrate in the current period.

3.3 Contribution Behavior

Next, we analyze subjects' contribution to the public good. This analysis is key to better understand subjects' propensity to vote for different sanctioning institutions. The top (bottom) panel in Figure 4 plots, for both treatments, the average contribution level over time when groups implement IS (FS).

As the top panel of Figure 4 shows, IS are more efficient in boosting contributions in NMT than MT. In NMT, average contributions across sessions is 44.69, whereas the corresponding value in MT is 37.46. The difference in average contributions between treatments is statistically significant (Wilcoxon signed rank test: $z = 4.37$, $p = 0.00$). Average contributions across sessions under FS are also significantly larger in NMT (45.12) than in MT (42.8). Differences in differences in contributions between the two treatments are not statistically significant ($p = 0.46$). This result implies that in the two treatments FS increase contributions by a similar amount when compared to IS. Therefore, it seems that the higher effectiveness of FS in MT does not drive subjects' voting behavior.

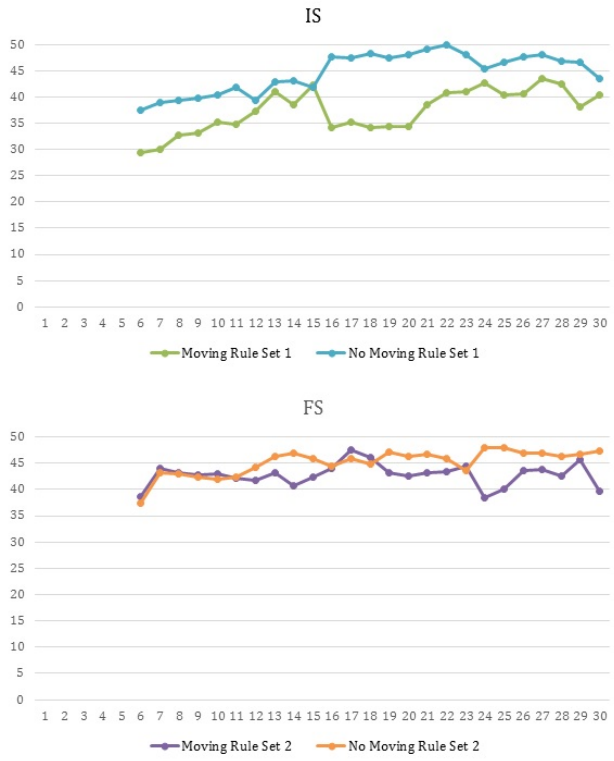

Figure 4: Contributions over time

To study the main determinants of contribution, the column 1 of Table 4 reports the marginal effects from a (doubly) censored regression model (Greene, 2012) in which the dependent variable is the i's individual contribution in period t. We include as predictors: *Moving*, a binary covariate that equals 1 if subjects participate in MT, and 0 otherwise; $IS_{i,t}$, a dummy variable that takes value 1 if subject i is in a group governed by IS in period t, and 0 otherwise, $High\ Contribution_g$, a dummy variable that takes value 1 if the average contribution of the members in i's current group in the first 5 periods of the experiment is (relatively) 'high', and 0 otherwise; $Contribution_{g,t-1}$, the average contribution of the other members in i's group in period $t-1$; $Punishment\ Received_{i,t-1}$, the punishment received by subject i in period $t-1$; the interaction between $Punishment\ Received_{i,t-1}$ and $IS_{i,t-1}$; and $Group\ Size_{i,t}$, the size of subject i's group in period t.

Individual contributions to the public account increase significantly when subjects belong to a group with a relatively 'high' initial contribution level. In the same line, all else equal,

Table 4
Determinants of individual contributions

	(1)	(2)
Intercept	16.32***	11.80***
	(1.22)	(1.08)
Moving	-3.83***	-3.62***
	(1.16)	(0.94)
$IS_{i,t}$	-5.78***	-5.62***
	(0.39)	(0.38)
High Contribution$_{g(i)}$	4.70***	3.68***
	(0.94)	(0.70)
Contribution$_{g(-i),t-1}$	0.58***	0.30***
	(0.01)	(0.02)
Punishment Received$_{i,t-1}$	0.16***	0.36***
	(0.04)	(0.04)
Punishment Received$_{i,t-1} \times IS_{i,t-1}$	-0.22***	-0.25***
	(0.04)	(0.04)
Group Size$_{g(i),t}$	0.71***	0.63***
	(0.09)	(0.09)
Contribution$_{i,t-1}$		0.40***
		(0.01)

Notes. The table reports parameter estimates from fixed-effects panel data censored regression models for individual contributions. Units of observation are individuals-per-voting period. All specifications include subject, period, group, and session effects. Standard errors are presented in parentheses. Significance levels: *** at 1%, ** at 5%, * at 10%.

average individual contributions also increase with the average contribution of the group members in the previous period. This result suggests subjects' contribution behavior depends on their previous experience; subjects located – either at the beginning of the experiment or in a more recent period – in a group that cooperates more, also contribute more to the public good later on. Surprisingly, group size also has a positive and significant effect on subjects' contributions. On the contrary, i's contribution drops when groups form endogenously (MT) as well as when i's group is governed by IS.

Concerning the effect of punishment, the larger the punishment received by a subject in the previous period, the larger is her contribution in period t. However, the interaction term shows that when the punishment comes from other group members – that is, when IS is in place – the punishment reduces the contribution in the next period. This latter effect may

stem from a type of negative reciprocity present under IS, but not under FS.

Column (2) incorporates the lag of the dependent variable among the regressors of column (1) specification. The estimate for $Contribution_{i,t-1}$ indicates that roughly 40% of subject i's contribution in period t is explained by her contribution in the previous period. Nonetheless, the results emerging from the static model remain unchanged.

4 Conclusions

The results of the experiment support the conclusion that the type of institutions emerging in a society depends on the society's initial conditions as well as on whether groups form endogenously. When societies are sufficiently cooperative under an informal sanctioning mechanism, the presence of fixed groups reinforces the effectiveness of these institutions and, therefore, subjects' preference for them over time. However, when groups form endogenously, it becomes harder to sustain cooperation. Importantly, when voting for their preferred institution, subjects consider both (i) current group members' behavior and (ii) potential newcomers' expected behavior. Overall, subjects' expectations play a key role in leading to an early adoption of centralized, formal institutions. The implication is that allowing for groups to form endogenously decreases the subjects' willingness to adopt informal sanctioning institutions.

When a society is characterized by an initial low level of cooperation under an informal sanctioning mechanism, the dynamics are essentially the opposite. In the presence of exogenously fixed groups, subjects can only rely on centralized formal institutions to improve cooperation. When groups form endogenously, however, self-selection (in the willingness to contribute and punish free-riders) can allow for an improvement in cooperation under informal sanctioning institutions, leading to a higher percentage of subjects voting for these institutions compared to the case of fixed groups.