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Mohamed Ali Bchir, Marc Willinger

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« Do clubs foster provision success? »

M.A BCHIR
Marc WILLINGER

DR n°2009-19

Faculté de Sciences Economiques - Espace Richter
Avenue de la Mer - Site de Richter C.S. 79606
34960 MONTPELLIER CEDEX 2
Tél: 33(0)467158495 Fax: 33(0)467158467
E-mail: lameta@lameta.univ-montp1.fr

Université Montpellier 1
agro Montpellier Ecole Nationale Supérieure Agronomique
CNRS Centre National de la Recherche Scientifique
INRA

Do clubs foster provision success?

Bchir M.A. ([1]), Willinger Marc ([2])

Abstract

We report the results of an experiment on the provision of a step-level collective good. We compare subjects' behavior in a public good game and in a club good game. In the club good game, players who contribute less than the amount required to become a member, do not benefit from the collective good. Compared to the benchmark step-level public good, we find that the introduction of a small membership fee has surprisingly strong effects. It increases significantly the provision success of the collective good.

JEL : C92 ; D71; D60 ; H41;

Keywords: Public goods, club goods, voluntary adhesion, step-level, coordination.

[1] Corresponding author, SupAgro Montpellier - 2, place Pierre Viala - UMR LAMETA – 34000 - Montpellier. France. bchir@supagro.inra.fr

[2] Faculté de Sciences Economiques, LAMETA, avenue de la mer, C.S. 79606 / 34960 - Montpellier cedex 2, France

1 Introduction

Many collective goods are provided only if a minimum contribution level is reached, e.g. the number of members required for founding a club of a sport, the NATO deterrence threshold, generic advertising campaign. Because of free-riding incentives, mechanisms based on voluntary contributions often fail to reach the threshold contribution level. The issue of under-provision becomes even more severe, whenever contributors have to bear the risk of a failure in the provision of the collective good. This happens whenever contributors are not refunded in the event where the threshold contribution level is not met (Money invested in NATO or in generic advertising is lost, time spent by unsuccessful promoters of a club is not refundable). The absence of money-back guarantee is therefore likely to exacerbate the social dilemma faced by potential members of a club. To overcome the free-riding issue, a widespread practice consists in imposing a membership-fee for members to benefit from the collective good. Agents that fail to reach the fee are excluded from the benefits of the collective good. Those who meet the fee can enjoy the collective good whenever it is provided.

Our main hypothesis is that the requirement of a membership-fee, even the smallest one, affects the subject's perception of the contribution effort. When an agent has the possibility to benefit from a collective good without an effort, the agent focuses on the "free lunch" side. This is known as the free riding strategy. In contrast, when an agent is obliged to adhere in order to benefit from the collective good, the focus of the agent is shifted towards the success of his effort. Our aim is to isolate the extent to which dropping the "free lunch" side of a collective good affects its success of provision. For that purpose, we set the adhesion fee at the smallest possible unit in our experiment so that it is almost costless. We conjecture that in this fee setting, subjects contribute strongly whenever they decide to adhere otherwise they do not contribute.

Few experiments have investigated the relevance of the voluntary adhesion principle for providing collective goods. Orbell and Dawes (1986) showed that allowing for the option to adhere or not to a prisoner dilemma game improves cooperation. More recently, Swope (2002) introduced an adhesion fee in a linear public good game. He showed that average contributions are increased. However, social welfare is not necessarily improved. It can even be lowered when the adhesion fee is too high in a low

Marginal Per Capita Return (MPCR) environment. Cason *et al.* (2004) introduced a two stage game in a linear public good game. Subjects have the possibility to commit contributing nothing in the first stage before contributing in the second one. They found that free riding declines over time for spiteful motives. Boun My and Chalvignac (2009) introduced the possibility of exclusion in a similar two stage game for a linear public good game and found that it lowers the decay of average contributions over time. In our investigation, we tackle another issue, the relation between voluntary adhesion and the provision success of a step-level good.

Our benchmark is the standard threshold public good game, which admits two Nash equilibria in aggregate contributions: one where none of the agents contributes to the public good and one where the aggregate contribution is equal to the threshold level. We consider a slightly modified contribution game, for which a minimum contribution is required to benefit from the collective good whenever it is provided. Essentially, the minimum contribution requirement transforms the standard public good contribution game into a club good contribution game. Agents who decide to contribute less than the minimum requirement are excluded from the benefits of the club good. From a theoretical point of view, the principle of voluntary adhesion does not affect the structure of the threshold public good game. The modified game admits the same two Nash equilibria than the original game. However, the set of contribution vectors which are compatible with the threshold level Nash equilibrium is now restricted to strictly positive contribution vectors, where the smallest value is precisely equal to the minimum contribution level required for benefiting from the club good.

Our experimental findings show that voluntary adhesion increases significantly the success rate of provision with respect to the benchmark treatment. While few subjects provide the main effort to produce the public good yielding an unequal distribution of efforts, a proportion of the free riders is converted to contributors in the club good. The club is therefore provided with a larger number of contributing members improving the success of provision. However, when the free riders are not converted to contributors, the club fails to improve the success of provision.

Section 2 presents a simple model of voluntary adhesion to the provision of a club good. Section 3 introduces our experimental design and section 4 provides a discussion

about our conjectures. Section 5 presents the main results of our experiment. Section 6 provides a discussion of the results and section 7 concludes.

2 Theory

Let G be the amount of club good provided by a group of n agents. We note g_i agent i's contribution to the club good and $x_i = w_i - g_i$ the value of his consumption of private goods, where $w_i > 0$ denotes his endowment. We assume that each agent's utility $u_i(x_i, G)$ is linear in both arguments: $u_i(x_i,G) = \alpha_i x_i + \beta_i G$, where α_i is his marginal utility for private consumption and β_i his marginal utility of the club good. We assume that $\alpha_i < \beta_i$ for all i.

The consumption of the club good G by agent i depends on two conditions: first the group contribution must be large enough to meet the threshold level T, and second, if the first condition is met, agent i will benefit from it's consumption only if his private contribution is above or equal a minimum required contribution f (f>0). In other words, there is both a group threshold contribution level and an individual threshold contribution level. Both conditions must be satisfied in order for a group member to be able to enjoy the club good.

The provision threshold T is common knowledge: $G = 0$ if $\sum_{i=1}^{n} g_i < \mathrm{T}$ and $G = \sum_{i=1}^{n} g_i$ otherwise. We assume that if the threshold is not met, contributions are lost, i.e. there is no Money Back Guarantee (MBG) mechanism. Beyond the threshold, the club good is provided "linearly". We interpret above threshold contributions as improvements of the club good. Agent i faces a social dilemma towards such

improvements because the marginal return of the club good (β_i) is inferior to the marginal return of the private good (α_i), but $\Sigma\ \beta_i$ may be larger than α_i. For instance in the symmetric case ($\alpha_i = \alpha$, $\beta_i = \beta$ and $w_i = w$ for all i), $k\beta > \alpha$ for k large enough $0<k\leq n$. Agent i decides to adhere to the club if $u_i(w_i\text{-}f, G) > u_i(w_i, 0)$. We summarize player i's utility as follows:

$$u_i(g_i,G)=\alpha_i(w_i-g_i)+\lambda_i\beta_i G \quad \text{if } G\geq T$$

$$u_i(g_i,G)=\alpha_i(w_i-g_i) \quad \text{else}$$

$$\text{with } \lambda_i=1 \text{ if } g_i\geq f$$

$$\lambda_i=0 \text{ if } g_i<f$$

The contribution game admits two Nash equilibria in aggregate contributions: $G = T$ and $G = 0$. Depending on the parameter setting (n, w_i, T…) the interior equilibrium $G = T$ is compatible with multiple vectors of individual contributions characterized by $\sum_{i=1}^{n} g_i = T$, $g_i \leq \beta T$ and $g_i > 0$.

In the symmetric case, the interior equilibrium Pareto-dominates the equilibrium where $G = 0$. Agent i chooses his contribution g_i in order to maximize his utility given the contribution by other players, g_{-i}. The multiple Nash contribution vectors differ with respect to the cost-sharing arrangement among group members to provide the step-level good. One obvious arrangement is sharing equally the cost (T/n) among members, but there are also very unequal arrangements where some of the participants "cheap ride" on others' contributions. The group optimum is achieved whenever all players contribute their endowment to the club, i.e. we assume $n\beta > \alpha$.

Contributing 0 can no longer be interpreted as a free riding strategy in the club good game since agents are excluded from the benefits. A behavior similar to free-riding occurs in a context of provision of club goods: there is a temptation for players to contribute the minimum required amount (f) to benefit from the club good. We identify such behavior as "cheap riding". In our experimental setting we let this temptation become very strong, by setting the value of f at the minimum experimental currency unit, i.e 1 token. We chose the smallest possible value in order to study the principle of voluntary adhesion under extreme conditions.

3 Experimental design

Before presenting our test treatment based on the principle of voluntary adhesion, we start with a presentation of our reference treatment : a linear public good game with a threshold. In each round, subjects received an equal endowment of $w = 20$ tokens that they had to allocate (in integer amounts) between a private account and a collective account. The private account yielded a marginal return $\alpha = 1$ per token invested. The collective account provided a marginal return $\beta = 0.5$ per token invested if the threshold level T was met. If in a given round aggregate contributions were below the target level T, subjects' contributions were lost. If the group contribution was above the threshold, each member of the group enjoyed the total amount of the collective good provided above the threshold.

The club good treatments, hereafter called "voluntary adhesion treatments", were identical to the public good treatments (baseline), except that group members who did not contribute, were excluded from the benefit of the club good whenever it was provided. For both treatments, we compare three levels of the threshold: a low threshold

(15 tokens), medium threshold (30 tokens) and high threshold (60 tokens). Each threshold level corresponds to a different degree of coordination difficulty. Indeed, as the threshold becomes higher, subjects are exposed to a higher risk of a provision failure. In the low threshold, only one contributor (out of four) is required to reach the threshold, in the medium two contributors are needed and in the high threshold three. The number of contribution vectors constituting Nash equilibria is lowest in the low threshold and highest in the high threshold. Finally, we assumed that contribution and adhesion are simultaneous in our case. Two reasons for this choice: First, it allows examining voluntary adhesion specifically as just an option for exit. In a two-stage game, other variables - like the information of exclusion- will interfere that are not of interest to our investigation. Second, it keeps it simple for subjects. Table 1 summarizes the parameters of the experiment.

The experiment was run at the University of Montpellier I, with a large subject pool of volunteers from various disciplines: economics, law, art, psychology, literature, medicine, engineering, and sports. The experiment was programmed and conducted with the software z-Tree (Fischbacher, 2007). 132 subjects were involved in the experiment. Care was taken to ensure that no subject participated in more than one session. A public reading of the instructions followed a private one in order to make the rules of the game common knowledge. Since we test whether voluntary adhesion may affect the contribution behavior, careful attention was given in the instructions to prevent any design effect[3]. The constituent game was repeated 25 rounds. Subjects were randomly assigned to groups of 4 players in a partner design. The history of the past interactions within each group was available to each subject at any time during the

[3] We avoided the use of words like “invest” or “contributions” preferring words like “put”, “budget” or “account” in order to be neutral

experiment. The accumulated point earning over the 25 rounds was converted into Euros at the end of the experiment at a publicly announced rate.

Table 1

Experimental parameter [(a)]

Treatment	Threshold		Required contributors [(a)]	Number of groups	Step return [(b)]
Baseline	Low	15	1	6	2
	Medium	30	2	5	2
	High	60	3	4	2
Voluntary adhesion	Low	15	1	8	2
	Medium	30	2	6	2
	High	60	3	4	2

Number of contributors required to reach the threshold ; (b) Benefit /cost = $\frac{n\beta T}{T}$ [4] ;

4 Conjectures

The public good game and the club good have the same interior Nash prediction. However, the set of equilibrium contributions vectors of the club good game is included in the larger set of equilibria of the public good game. There are therefore fewer possibilities for coordination failure in the voluntary adhesion treatment than in the baseline treatment. For the low threshold the set of solution in the baseline treatment, i.e. the number of vectors constituting a Nash equilibrium, is equal to 23. Introducing voluntary adhesion drops this set of solution to 16 vectors. That is a reduction of 30.4%. For the medium threshold, it is reduced by 19.4% from 139 to 112. Our first conjecture is thus:

[4] Since we are considering a step level continuously provided above the threshold and that subjects homogenously value the provision of the collective good, the step return does not vary between the thresholds (Croson and Marks, 2000)

<u>Conjecture 1</u>: Under voluntary adhesion provision success is more likely than in the baseline.

The interior equilibrium of the public good game is compatible with contribution vectors involving one or more players who free-ride, depending on the level of the threshold[5]. In contrast, under voluntary adhesion the number of contributing members at the interior equilibrium is always equal to the number of players in the group, whatever the level of the threshold. This difference entails two consequences: first, we expect to observe a larger number of contributing members under voluntary adhesion, and second, the group payoff, called "welfare" thereafter, should be equal in both games. Moreover, if conjecture 1 is verified, voluntary adhesion may actually lead to higher average welfare over rounds, because of fewer coordination failures. Our second conjecture is thus:

<u>Conjecture 2</u>: Voluntary adhesion leads to a larger number of contributing members than in the baseline treatment, and welfare is at least as large than in the baseline.

[5] Contribution vectors for which the group contribution is equal to the threshold and for which two or three players free-ride are not necessarily Nash equilibria. In the medium threshold, there exists only one equilibrium contribution vector where exactly two players free ride (15, 15, 0, 0). The contribution vectors (16, 14, 0, 0), (17, 13, 0, 0), (18, 12, 0, 0), (19, 11, 0, 0) and (20, 10, 0, 0) are not equilibria because player 1 is always better off if he deviates (a similar arguments holds for the permutation of these vectors). The same remark holds for the low threshold: (15, 0, 0, 0), (14, 1, 0 , 0), (13, 2, 0 , 0), (12, 3, 0 , 0) , (11, 4, 0 , 0), (10, 5, 0 , 0), (9, 6, 0 , 0), (8, 7, 0 , 0) are not Nash equilibrium vectors. For the high threshold, all vectors for which the aggregate contribution is equal to the threshold are Nash equilibria. One player can free ride in the high threshold, i.e. the contribution vector (20, 20, 20, 0) and permutations of it.

The contribution of 0 tokens in the public good is the free riding strategy. In the club contributing 0 excludes the subject. Therefore, the free riding strategy in the public good cannot be applied in the club. Rather, a subject contributes the minimum unit in order to be not excluded. We call this strategy of free riding in the club cheap riding. Furthermore, in the public good treatment we cannot separate free riders and subjects that reject the contribution to the collective good. The strategy of contributing 0 can indicate either a free riding behavior or a Nash expectation (coordination on the Pareto dominated equilibrium). However, this distinction between profiting from the effort of the group and just rejecting the provision becomes possible under voluntary adhesion. When a subject contributes 1 token to the collective account, it is cheap riding. When a subject does not contribute, it is the exit choice.

As a consequence, in order to compare the strategy of free riding in the baseline to the cheap riding under voluntary adhesion we need to compare the proportion of free riders in the baseline to not only the proportion of cheap riders but also to the proportion of subjects that choose the option exit. We expect in this experiment to observe the same proportion of free riders in the baseline and in the club. Since there is no theoretical prediction on the distribution of the effort among subjects of the same group, the proportion of free riders should remain the same.

> *Conjecture 3: The proportion of free riders in the baseline treatment remains the same in the voluntary adhesion.*

In the next section, we present the results of our experiment with respect to these conjectures.

5 Results

Table 2 reports a summary of our data: the average individual contribution, the average of strictly positive contributions and the average group contribution for each treatment (baseline and voluntary adhesion) and for each threshold level (low, medium and high). The success rate of provision is measured by the relative frequency of successful provision of the step-level good, i.e. the number of periods where the group contribution is at least equal to the threshold divided by the number of periods.

Table 2: **Summary statistics**

	Average individual contribution [(a)] (SD)		**Average contribution per contributing member [(b)] (SD)**		**Success rate of provision [(b)]**		**Average group contributions (SD)**	
	Baseline	*Voluntary adhesion*	*Baseline*	*Voluntary adhesion*	*Baseline*	*Voluntary adhesion*	*Baseline*	*Voluntary adhesion*
Low (T=15)	3.95 (6.48)	5.78 (5.68)	8.68 (5.84)	6.15 (3.79)	41.3%	73.5%	15.82 (19.13)	23.14 (15.64)
Medium (T=30)	6.44 (6.67)	7.83 (5.89)	10.76 (4.06)	8.67 (3.34)	39.7%	67.7%	25.79 (17.88)	31.35 (14.26)
High (T=60)	8.21 (8.23)	7.15 (8.22)	14.61 (2.93)	12.42 (5.26)	39.0%	30.0%	32.87 (29.09)	28.60 (26.13)

(a) The symmetrical equilibrium is 3.75 for the low threshold, 7.5 for the medium threshold and 15 tokens for the high threshold

(b) Group contributions / number of contributing members in the group

(c) Success rate = Number of times groups reach the threshold / Number of periods

<u>Result 1</u>: Groups in the baseline and in the voluntary adhesion treatment do not coordinate on the Nash equilibrium.

Groups do not coordinate significantly on the threshold in both treatments and for each level of threshold. In the baseline treatment of the low threshold, only 4.82 %[6] of the provision success constitutes Nash equilibrium. It is 4.76 % for the voluntary adhesion treatment. The percentages are also weak in the medium and the high threshold: 3.33 % and 10.25% for the baseline, 6.25 % and 30.0 %[7] for the voluntary adhesion treatment.

A possible explanation to this result is the rebate rule used in the experiment: a continuous earning above the threshold. There is no penalty or loss for overcontribution. In contrary, overcontribution is rewarded. Subjects are therefore encouraged to target a higher level in order to insure the success of provision of their group or to simply earn more tokens. Our finding is consisting with the previous investigation on the rebate rules of Marks and Croson (1998). The authors showed that the "utilization rule" increases the variance of group contributions around a threshold. Since in our design the incentive for overcontribution is higher than the experiment of Marks and Croson (1998)[8], the low level of group coordination around the threshold is therefore more likely to happen. Our result confirms the previous findings of the authors.

[6] Percentage of Nash equilibria = Number of Nash equilibria / Number of times group contributions reach at least the threshold

[7] In 100 trials, subjects succeeded 30 times to reach the threshold. 9 out of these 30 successes constitute Nash equilibrium.

[8] The payoff of the collective account is twofold: it is decomposed in a constant payoff for just reaching the threshold and a lower marginal return for overcontributiuon. Our design is rather similar to the one used by Isaac and Walker (1989) with a same marginal return between reaching the threshold and overcontribution.

<u>Result 2</u>: Voluntary adhesion significantly increases the success of provision.

Introducing voluntary adhesion improves the success of provision for both threshold levels: low and medium. The success of provision is improved by 32.2% in the voluntary adhesion treatment of the low threshold with respect to the baseline and by 28.0% in the medium threshold. Visual inspection of average group contributions over time also shows a higher curve in the voluntary adhesion treatment for both levels of threshold (figures 1 and 2). Clearly, voluntary adhesion leads to a higher success of provision.

Support for result 2

The χ^2 test confirms that provision success is significantly larger under voluntary adhesion for the low threshold (χ^2 =36.86; p<0.01) and for the medium threshold (χ^2 =22.33; p<0.01) with respect to the baseline treatment. A logit panel data regression with random effects confirms the results of the non-parametric test. The binary dependent variable takes value 1 if the group contribution is larger or equal to the threshold and 0 otherwise. We take as explanatory variables the *Voluntary adhesion* dummy (1 for adhesion and 0 for the baseline), and the round number (*Period*). Table 3 reports the results. *Voluntary adhesion* has a significantly positive effect on provision success. There is a slight decline of the success of provision over time. This finding is consistent with the traditional decay of contributions in experiments on public goods.

It is remarkable to point out that just adding the possibility for adhesion to subjects improves dramatically the success of provision. The level of improvement is comparable to an incentive as strong as refunding contributions when the provision point is not met[9] (also called Money

[9] We conducted the same experiment with money back guarantee for both threshold levels. We obtain the same level of provision success: 80.0% in the low (73.5.% under voluntary adhesion) and 69.3% in the medium

Back Guarantee, see Isaac and Walker (1989)). The refund acts as an assurance mechanism. It drops the risk of loss associated to the coordination failure. Voluntary adhesion acts differently. It facilitates coordination. We discuss this issue in Result 4.

Table 3

Panel data regression for provision success (low and medium threshold [(a)])

Regressors	**T=15**	**T=30**
Intercept	1.34 (*)	--
	(1.74)	
Voluntary adhesion	2.36 (***)	1.45 (**)
	(2.36)	(2.25)
Period	-0.15 (***)	-0.07 (***)
	(-6.35)	(-3.66)
Log likelihood	-153.27	-164.78
Number of observation	350	275
Number of groups	14	11
Time periods	25	25

(***): significant at 1% level; (**): significant at 5% level; (*): significant at 10% level; -- non significant; (a): T-statistics are in parentheses

(67.7% under voluntary adhesion). There is no statistical difference between the two success of provision results. Low (χ^2 =2.00 ; p=0.15) Medium (χ^2 =0.07 ; p=0.77).

Figure 1: **Average group contributions (T=15)** **(voir annexes une autre figure possible à place de cella là)**

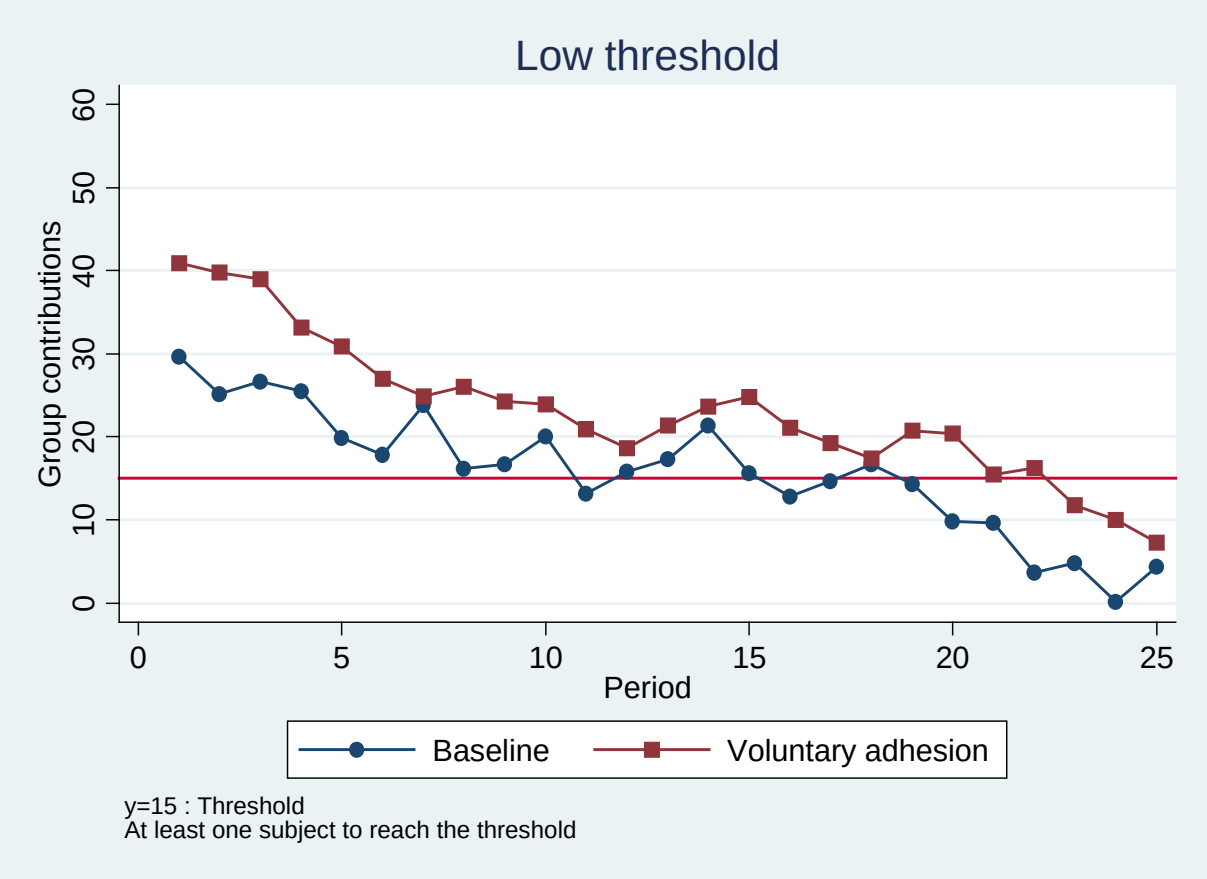
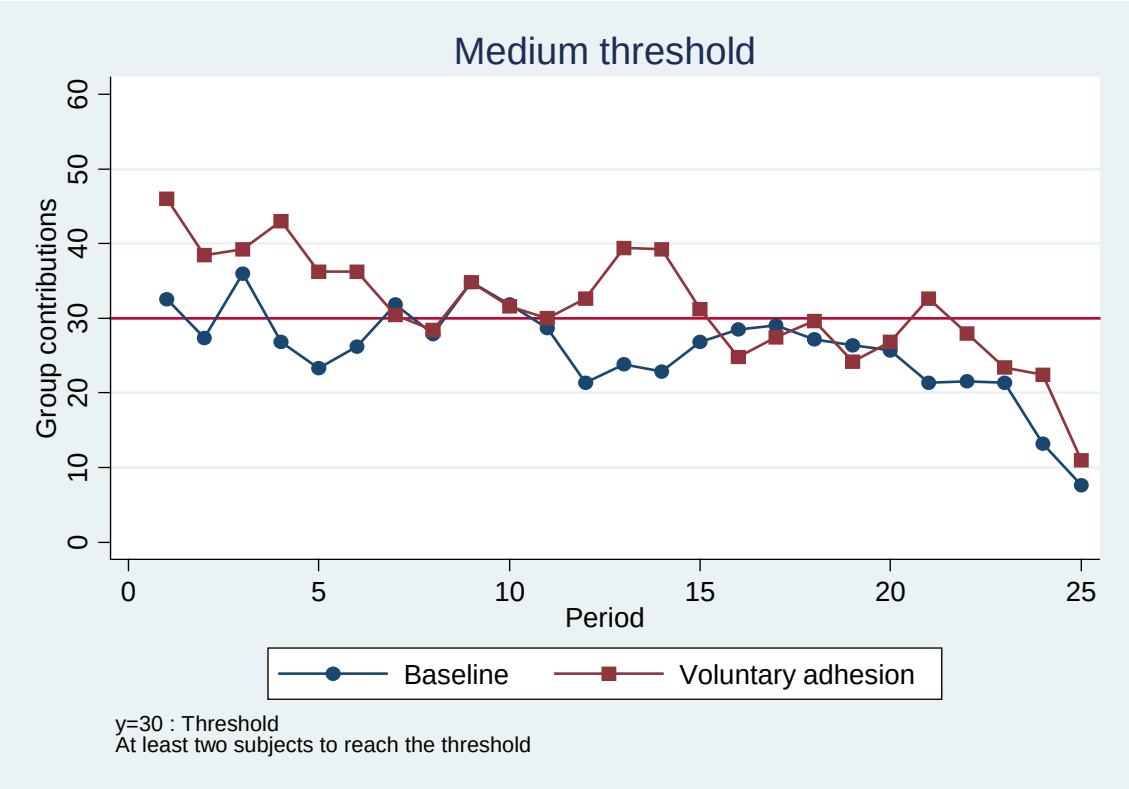


Figure 2 : **Average group contributions (T=30)**



<u>Result 3</u>: Voluntary adhesion increases the number of contributing members and improves welfare.

We define a contributing member as a subject who contributes a strictly positive amount to the collective good. Table 4 depicts the average proportion of periods for each number of contributing member per group for the low and the medium threshold. In 79% of the periods in the voluntary adhesion treatment of the low threshold, the four members of a group contribute to the collective good. This happens only in 17% of the periods in the baseline treatment. In the medium threshold the 4 members of the group contribute in 77% of the periods while this happens only in 26% of the periods in the baseline treatment. Clearly, voluntary adhesion increases dramatically the number of contributing members.

<u>Table 4</u>: Average proportion of periods for each number of contributing members per group(*)

Number of contributing members per group	**Low**		**Medium**	
	Baseline	*Voluntary adhesion*	Baseline	*Voluntary adhesion*
0	28%	3%	14%	3%
1	19%	2%	13%	3%
2	19%	4%	19%	5%
3	17%	14%	28%	13%
4	17%	***79%***	26%	***77%***
	100%	100%	100%	100%

(*) Number of contributing members per group by period / total number of periods

Support for result 3

We run a panel data regression[10] where the number of **contributing member**s per group is taken as the dependent variable. The explanatory variables are the *Voluntary adhesion* dummy and the round number *(Period)*. Table 5 reports the results of the regression. *Voluntary adhesion* has a significant and positive effect on the number of **contributing member**s in the low and the medium threshold. The number of **contributing member**s is increased by 2 in the low threshold and by 1 in the medium threshold.

Table 5

Results from panel data regressions explaining the number of contributing member**s per group for each level of threshold** [(a)]

Regressors	**Low**	**Medium**
Intercept	2.59 (***) (7.94)	3.12 (***) (12.60)
Voluntary adhesion	1.88 (***) (4.50)	1.14 (***) (3.48)
Period	-0.064 (***) (-11.37)	-0.05 (***) (-6.55)
R2(overall)	50.14%	27.86%
Number of observation	350	275
Number of groups	14	11
Time periods	25	25

(***): significant at 1% level; (**): significant at 5% level; (*): significant at 10% level; -- non significant; (a) : T-statistics are in parentheses

[10] We also perform a χ^2 test comparison. It shows an increase of the number of contributors in the low (χ^2 = 153.31; p<0.01) and in the medium threshold (χ^2 = 67.28; p<0.01).

Our conjecture 2 states that welfare in the voluntary adhesion is at least as large as in the baseline. We take as indicator the total group payoff. On average subjects earn 11.46€ in the baseline treatment and 12€.35 in the voluntary adhesion treatment for the low threshold, a significant difference (U-test = -3.30 ; p<0.01). Similarly in the medium threshold subjects earn an average of 11.16€ in the baseline and 12.52€ in the voluntary adhesion treatment (U-test = - 2.30 ; p=0.02). Conjecture 2 is therefore confirmed: voluntary adhesion improves subject's payoff.

<u>Result 4</u>: All the free riders in the baseline treatment are not converted to cheap riders in the voluntary adhesion treatment.

Our experiment shows that the proportion of free riders in the baseline decreases in the voluntary adhesion treatment. There is a peak of free riding in the baseline treatment while a lower focus on cheap riding by subjects of the voluntary adhesion treatment. In the low threshold, 56.33% of the amounts contributed are 0 tokens and 40.27% in the medium threshold. Under voluntary adhesion, there is a less marked distribution for 0 and 1 token contributed: only 9.13% and 22.88% in the low and 11.82% and 8.62% in the medium. That is 24.32% (low) and 19.83% (medium) of the free riders in the baseline have changed their behavior in the club. Thus, our conjecture 3 is rejected: we do not observe the same proportion of free riders in the baseline and the voluntary adhesion treatment. Moreover figure shows that free riders are converted we observe that the high level

Support for result 4

This result is first confirmed by a non-parametric χ^2 test: there is a significant difference between the proportion of free riders in the baseline (contribution 0 token) and the proportion of auto-excluded subjects (contribution 0) + cheap riders (contribution 1 token) in the voluntary adhesion treatment (χ^2=83.10 ; p-value<0.01 in the low and χ^2=49.85 ; p-

value<0.01 in the medium). Second, a Kolmogorov-Smirnov test shows the existence of a different distribution of the tokens contributed to the collective account in the two treatments[11] (D=0.4720 ; p-value <0.01 in the low and D=0.2853 ; p-value<0.01 for the medium threshold).

Thus, this finding supports result 3. There is a higher level of contributing members under voluntary adhesion. Part of these contributing members comes from the conversion of free riders in the baseline treatment.

<u>Result 5</u>: Average contribution per contributing member is significantly lower in voluntary adhesion treatment than in the baseline.

The collective investment of a contributing member in the voluntary adhesion is significantly lower than the one of a contributing member in the baseline treatment. Table 2 points out this finding: in the low threshold a contributing member invests 2.53 tokens more in the baseline (2.09 tokens in the medium threshold) than under voluntary adhesion.

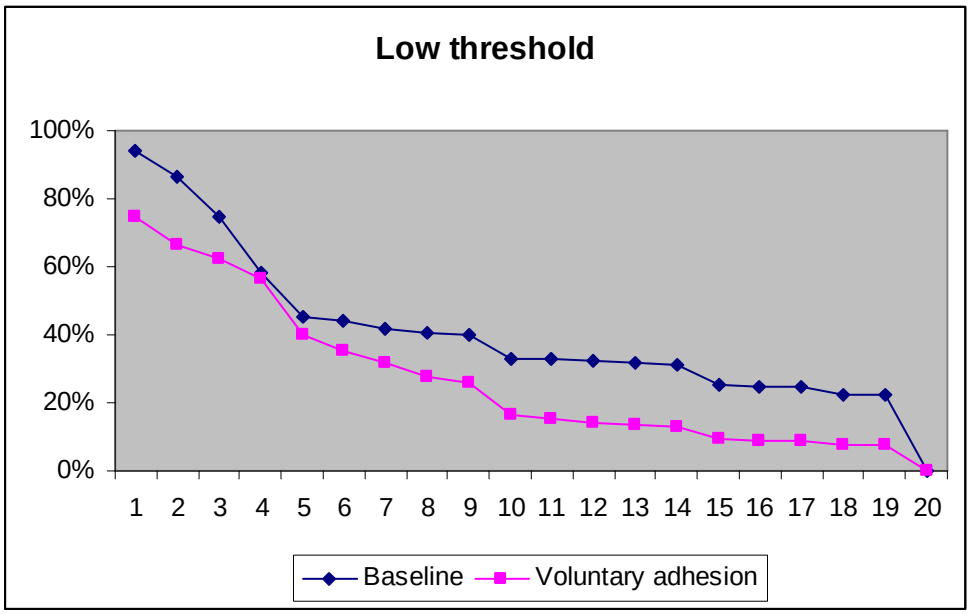
This difference is statistically significant (U=2.99; p-value<0.01 and U=3.77; p-value<0.01). This result is also found when we consider only the cases of the success of provision in the two treatments (U=5.79 ; p-value<0.01 and U=5.25 ;p-value<0.01). Note that the lower level of individual contribution in the voluntary adhesion treatment is not correlated to the existence of a higher number of contributing members in the group (Cf. Result 3). Indeed, the group contribution in the voluntary adhesion treatment is significantly different than in the baseline (U=-5.71 ; p-value<0.01 for the low and U=-3.32; p-value<0.01 for the medium).

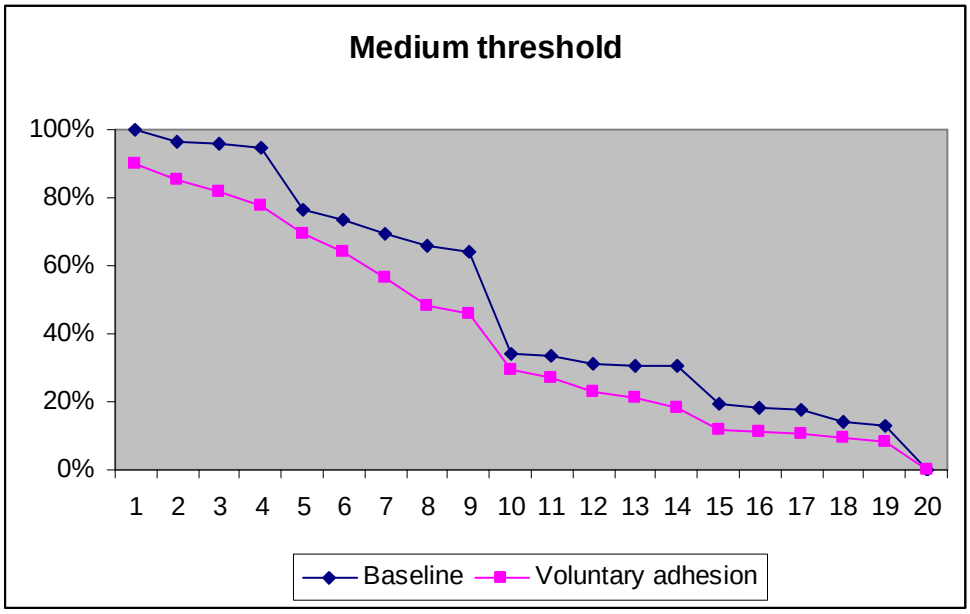
Hence, the collective contribution in the club is different on two aspects with respect to the baseline: first we observe more subjects contributing in the group. Second, subjects contribute less. But, as members in a group under voluntary adhesion are numerous to contribute they

[11] Figure 5 and 6 in the appendix depicts the distribution of amounts contributed to the collective account.

reach a higher level of success of provision. That is in the baseline treatment, a few generous individuals provide the public good whereas in the voluntary adhesion treatment all the subjects provides the club good but with less individual effort. Figure 3 illustrates this modification of subjects' collective contribution under voluntary adhesion. It depicts the decumulated frequency of the contributing members to the collective account. It shows that for each level of contribution there is a higher frequency of observation in the baseline treatment than in the voluntary adhesion treatment.

Figure 3: Dec**umulated frequency of contributing members**





<u>Result 6</u>: In the high threshold, there is no significant difference between the baseline treatment and the voluntary adhesion treatment. There is however a lower welfare under voluntary adhesion.

In the high threshold, group contributions in the baseline and the voluntary adhesion treatment do not reach the threshold level on average. Besides, neither the baseline nor the voluntary adhesion treatment perform significantly better. Both treatments reach the same average level of group contributions. Introducing the principle of voluntary adhesion is therefore not sufficient to improve the success of provision in the high threshold. While in the low and the medium threshold just allowing for an exit dramatically improves the success of provision, this is not the case for the high threshold.

Support for result 6

Figure 4 depicts average group contributions over time for the high threshold. A visual inspection clearly shows that group contributions do not reach the threshold. It is confirmed by a unilateral T test for the baseline (t = -9.32 ; p-value<0.01) and (t = -12.01 ; p-value<0.01) for the voluntary adhesion treatment. Figure 4 also shows that there are no significant differences between the success rate in the baseline and the voluntary adhesion treatment (χ^2 =1.79; p=0.18) and group contributions (U=1.27 ; p=0.20).

The low success of provision found for the high threshold is consistent with previous experimental results on threshold goods without refunding. (Bougherara *et al.*, 2007; Dawes *et al.*, 1986; Isaac *et al.*, 1989; Suleiman and Rapoport, 1992). A possible explanation is that subjects face a high risk of provision failure. The threshold level requires a costly effort from the members of a group: three endowments out of four are needed to reach the threshold. Another example, the symmetrical Nash equilibrium, a focal point, is to contribute 75% of the endowment of each member. Besides, there is no refund of contributions whenever the

threshold is not met. As a consequence, small departures from equilibrium contributions entail costly loss for the members of the group who try to reach the provision point. Subjects stop therefore coordinating around the threshold.

In addition to this high risky level of threshold, we observe this time the same number of contributing members in the baseline and the voluntary adhesion treatment for the high threshold (U=6.26 ; p-value=0.18). At the difference of the low and medium threshold, voluntary adhesion did not increase the number of contributing members. This may explain the failure of the voluntary adhesion as an incentive for the high threshold. Besides, our finding shows that such incentive can lower subject's payoff. We observe a higher payoff in the baseline treatment than in the voluntary adhesion treatment (U=2.72; p-value<0.01). Giving the option of auto-exclusion can be at the end inefficient for high threshold levels.

6 Discussion

It is a remarkable result that just dropping the free aspect of a step level collective good can dramatically improve the success of provision while the theoretical predictions remain the same. Under voluntary adhesion, the success of provision increases by 32.2% in the low threshold and 28.0% for the medium threshold. This improvement of the success of provision is not obtained by a higher individual contribution. In contrary, a contributing member invests significantly less under voluntary adhesion with respect to the contributing members of the baseline treatment (*Cf.* Result 4). We could expect that subjects in the club would keep the same level of contribution to the one of the baseline treatment or even increase it. This is not the case. The contributing members of the group contribute less but as they are numerous to provide the collective good, they provide a higher investment in the collective account and obtain therefore a better level of success of provision.

The Nash prediction can explain the higher number of contributing members (Cf. conjecture 2). All the equilibrium are made of the 4 players of the group. But the Nash prediction states a same Pareto-dominant equilibrium for both treatments. It does not explain therefore the better success of provision observed under voluntary adhesion. Our findings suggest rather the existence of a relation between the reductions of the set of the solution and the coordination issue. As stated in conjecture 1, voluntary adhesion reduces the set of the solution for players[12]. It seems that the more the reduction of the set is important the more likely the success of provision will be important. Indeed, the most effective results are observed first with the low threshold, then with the medium threshold and finally with the high threshold.

However, the experiment also reveals that dropping the free aspect of a high level of threshold is not sufficient to improve the success of provision. In contrary, it decreases the welfare by excluding subjects. A possible explanation is that we observe the same number of contributing members on both treatments in this case. It seems that the reduction of only XXX% of the number of contributions vectors in a risky environment is not sufficient to improve coordination. Further investigation on the relation between the reduction of the set of the solution and the facilitation of the coordination effort is required[13].

Conclusion

We aim to investigate the relation between the option of voluntary adhesion and the success of provision. Allowing for voluntary adhesion drops the free aspect of a collective good. It is a club good when there is an option for exit and a public good else. For that purpose we set an experiment where voluntary adhesion is almost costless. We compare three levels of

[12] The problem faced by our player is close to the tacit coordination experiment of Van Huyck et al. (1990) but in a context of non-Pareto ranked equilibria.

[13] See the investigation of the same authors on this issue.

threshold, each time with and without voluntary adhesion. There are few theoretical differences between theses two games. In particular, the equilibrium in aggregate group contributions remains the same, providing exactly the threshold.

Our experiment reveals that voluntary adhesion significantly increases the success of provision and welfare (except for the high threshold) while it decreases the effort of contributing members. These results suggest that a few generous subjects contribute the bulk of the group contributions in the public good treatment. However, in the voluntary adhesion treatment the effort to provide the threshold is more fairly distributed among the subjects. A possible explanation to our result is the decrease of the set of the contribution vectors of Nash equilibrium. This decrease percentage is maximal when the threshold is low. This is also the most effective setting in our experiment. Voluntary adhesion is an incentive to decrease the coordination failure.

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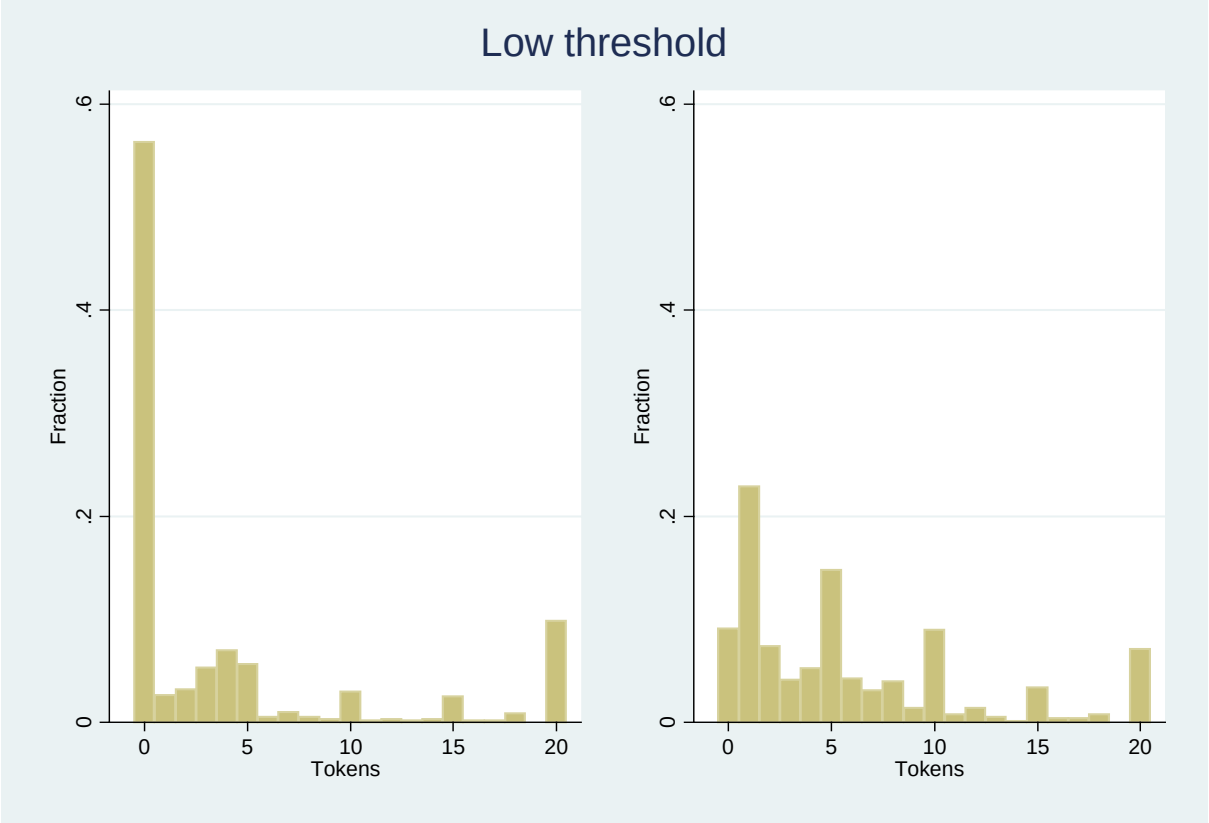
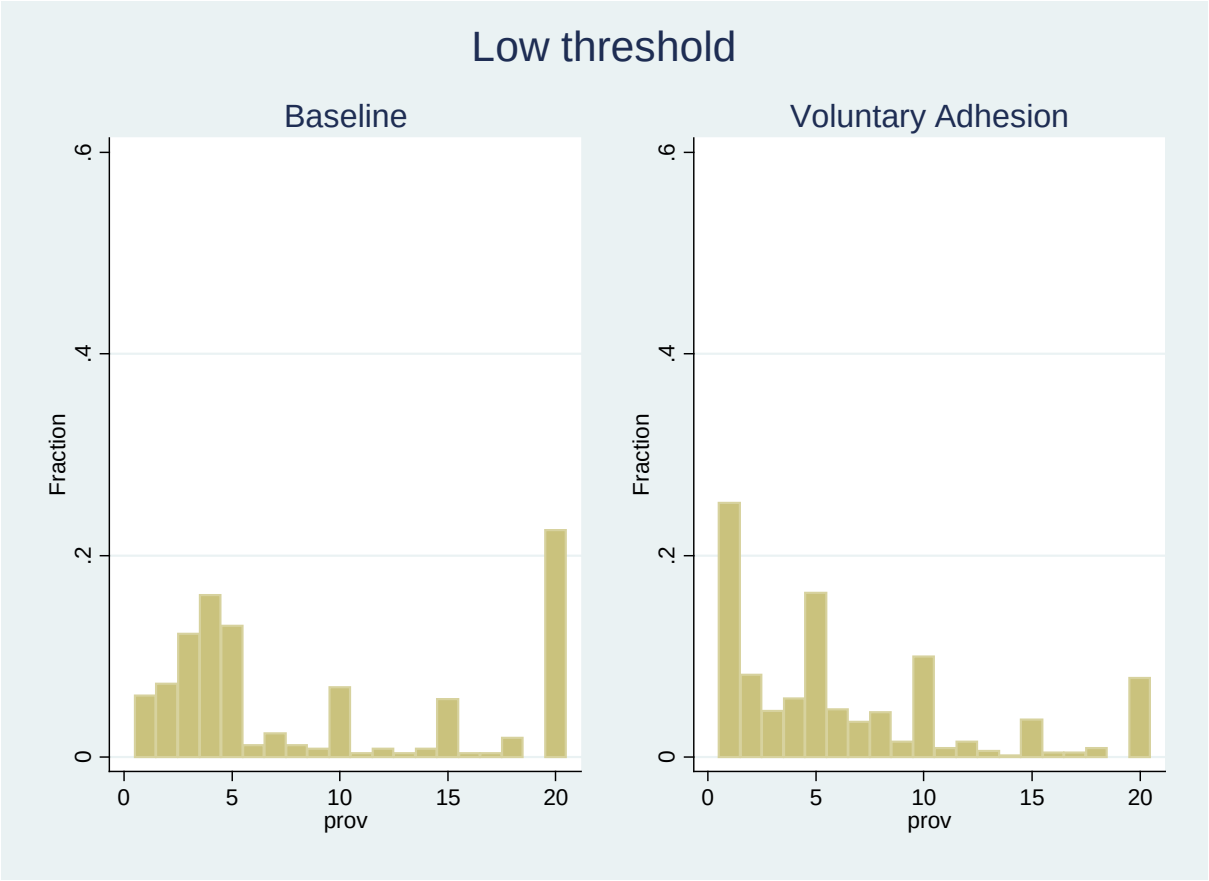
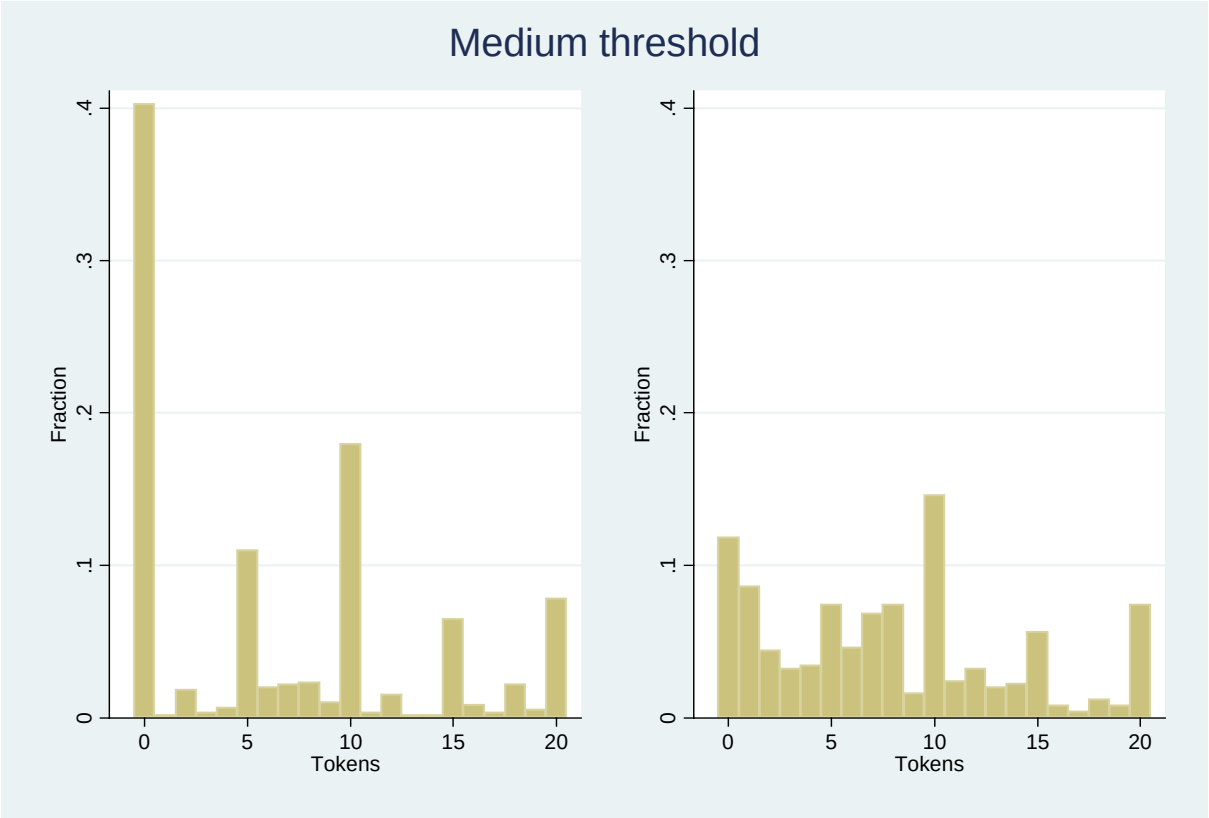
Appendix :
Distribution of tokens contributed collectively






Medium threshold
Fraction
0
.1
.2
.3
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Tokens
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.3
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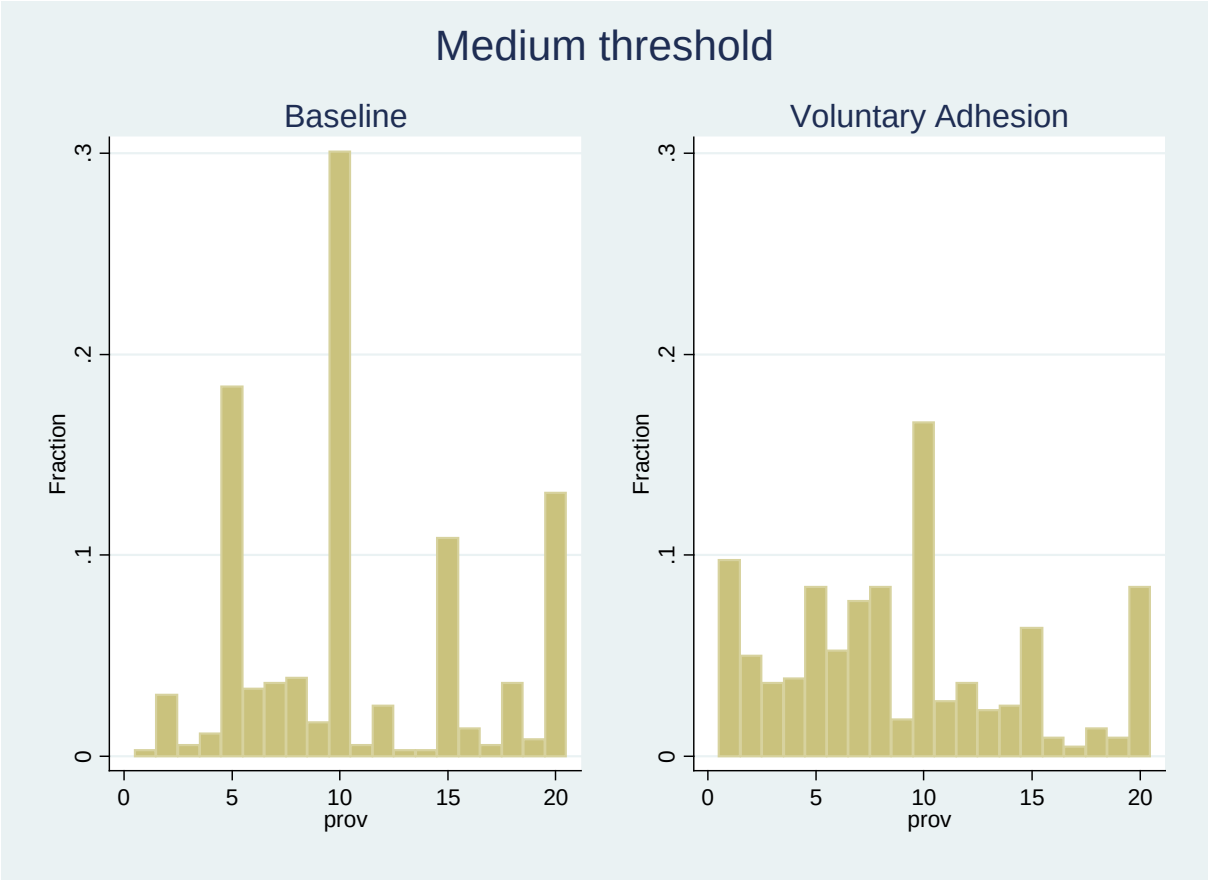
0
5
10
15
20
Tokens


Medium threshold
Baseline
Voluntary Adhesion
Fraction
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.2
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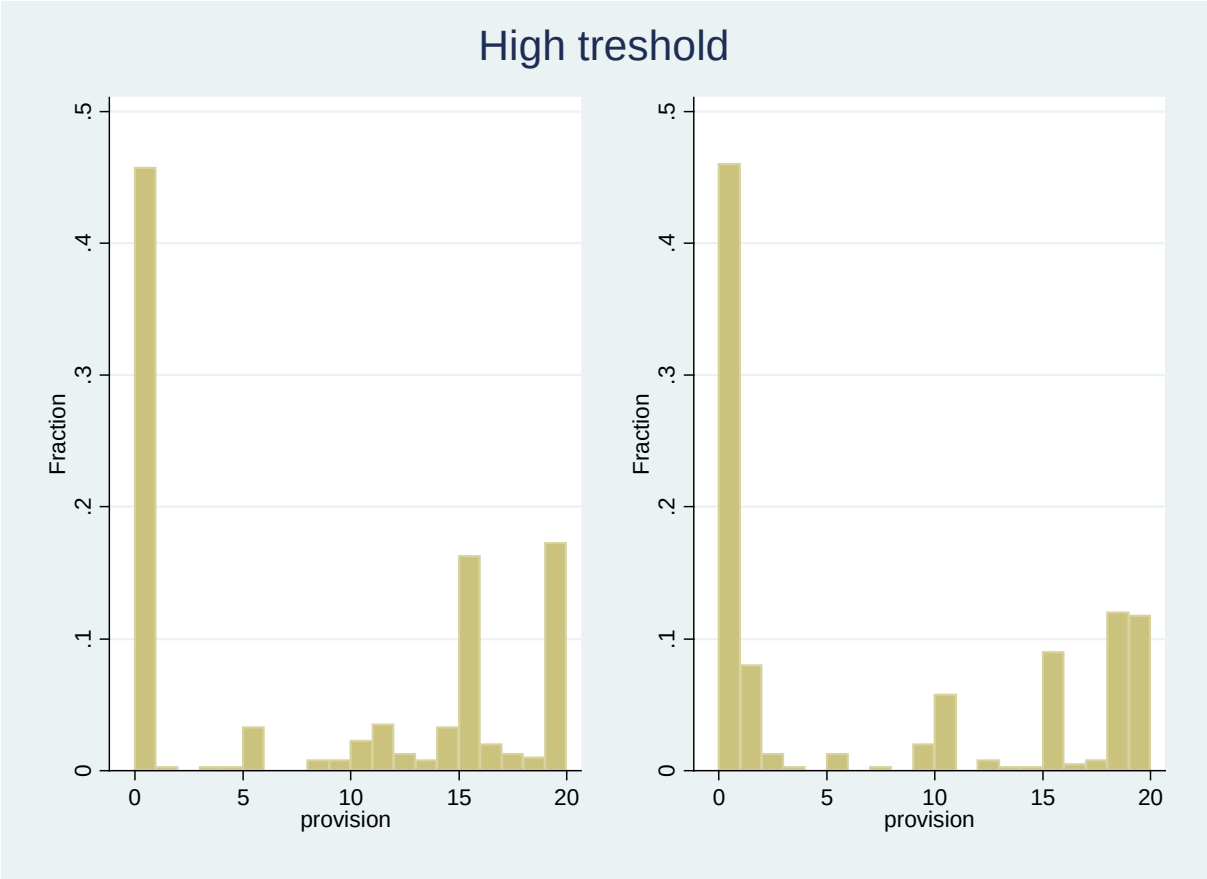
High treshold
Fraction
0
.1
.2
.3
.4
.5
0
5
10
15
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provision
Fraction
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.1
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.3
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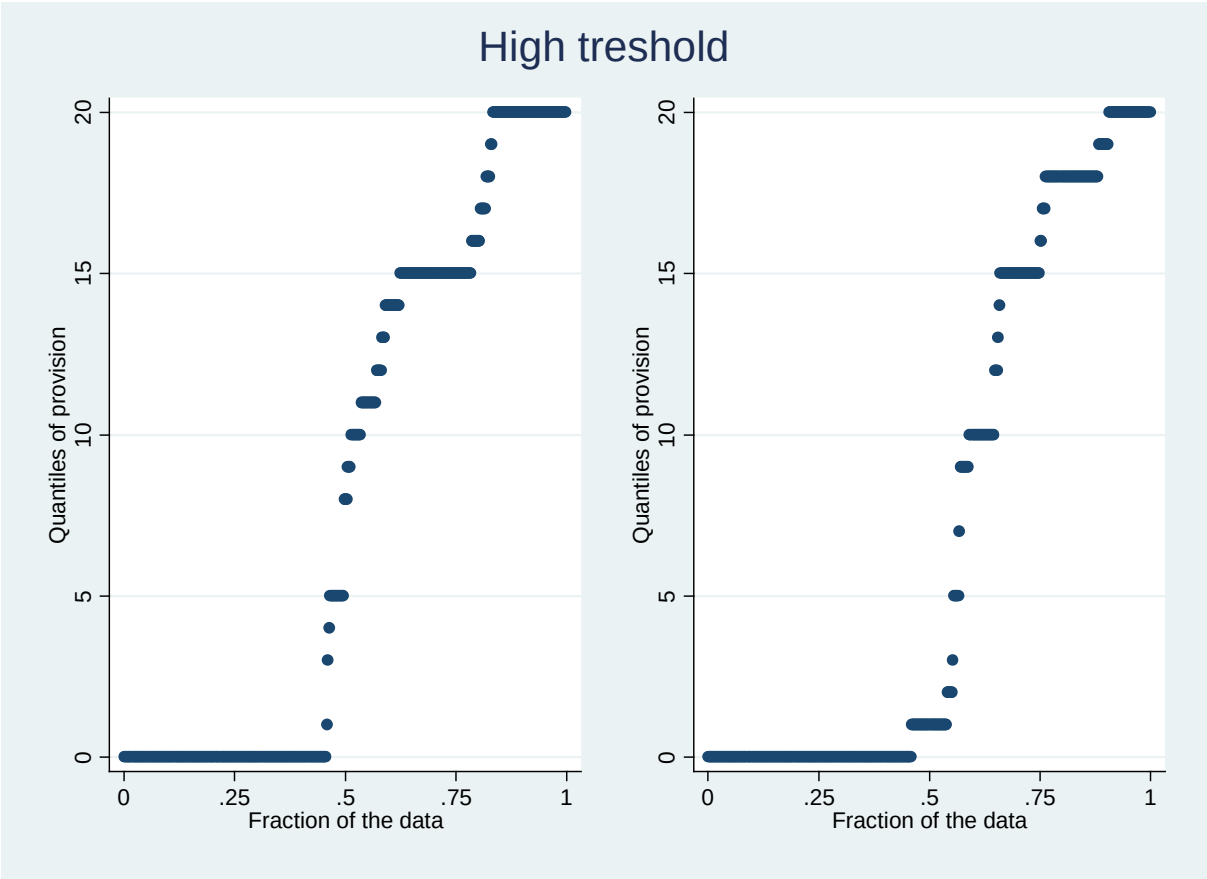
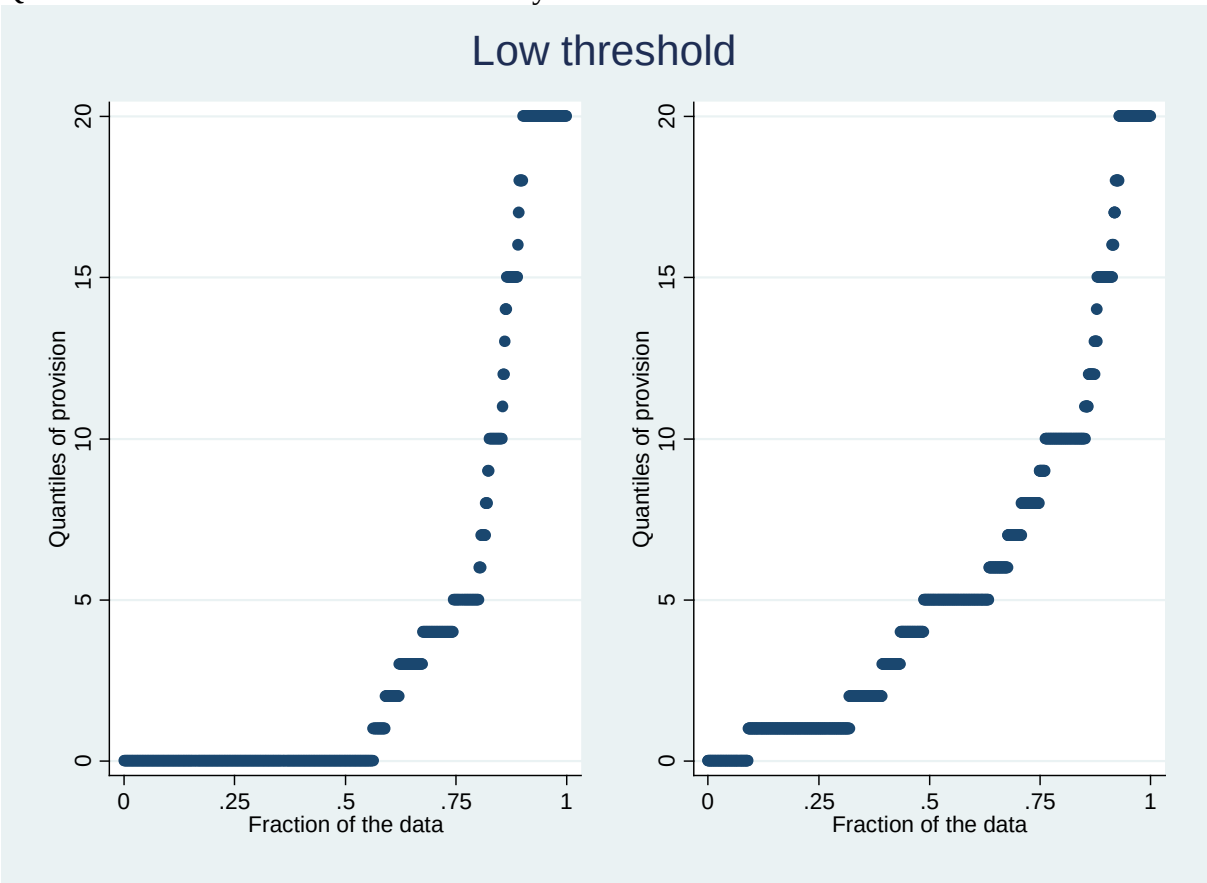
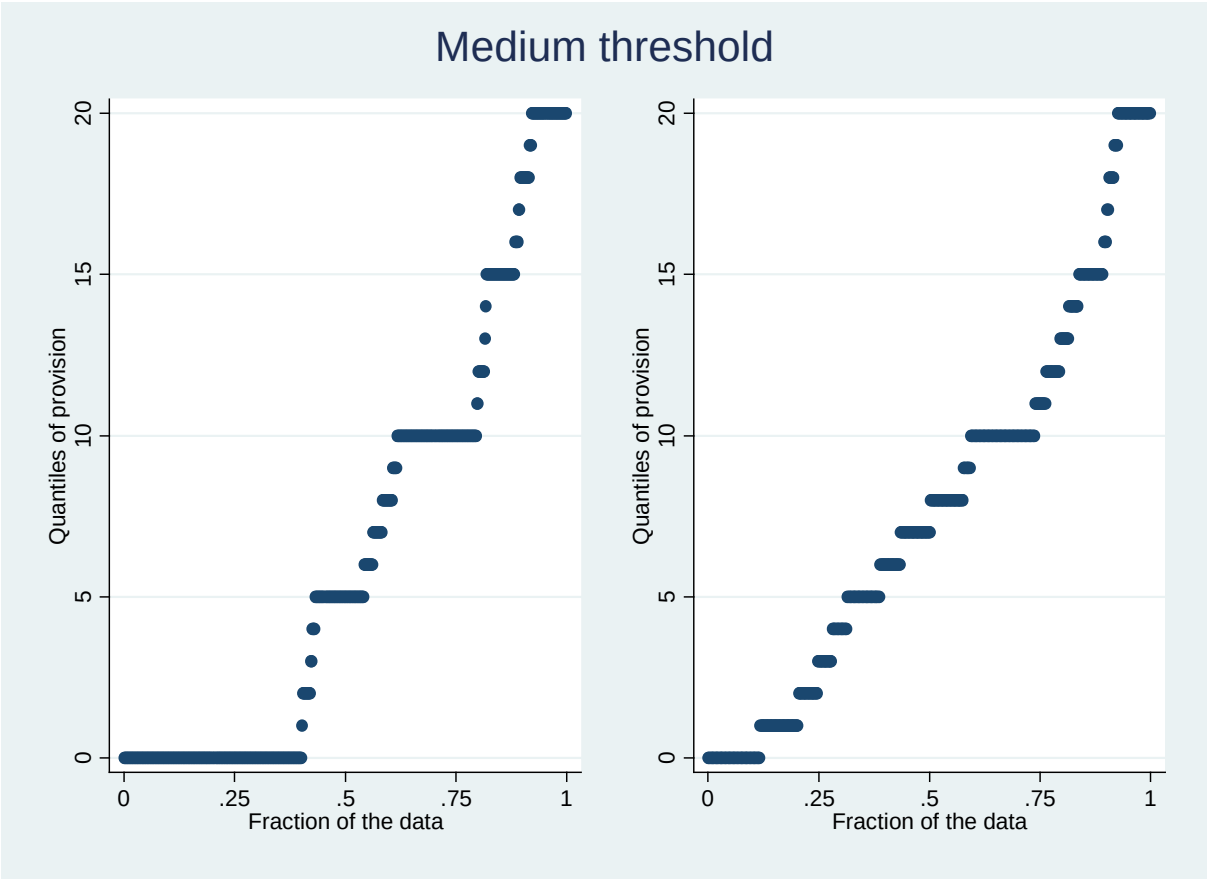
.5
0
5
10
15
20
provision

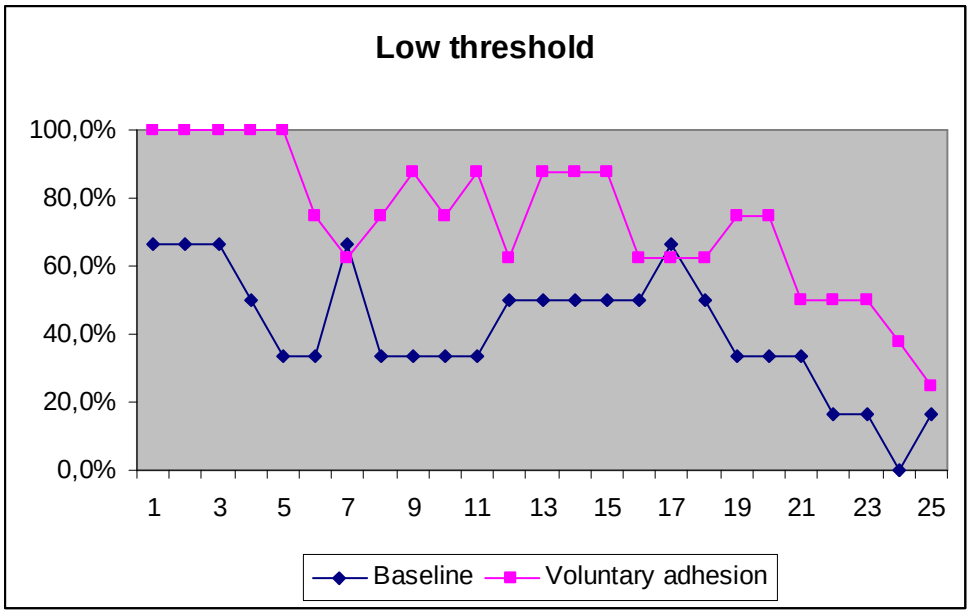

High treshold
Quantiles of provision
0
5
10
15
20
0
.25
.5
.75
1
Fraction of the data
Quantiles of provision
0
5
10
15
20
0
.25
.5
.75
1
Fraction of the data

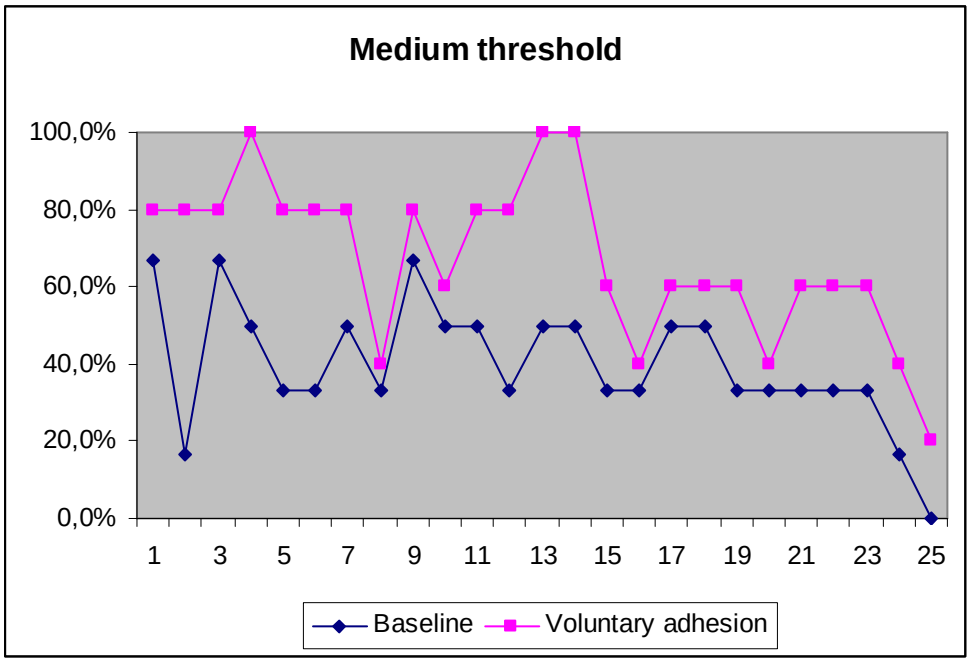
Quantile of tokens contributed collectively





Evolution of the frequency of success of provision





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Contact :

Stéphane MUSSARD : mussard@lameta.univ-montp1.fr