WORKING PAPERS

N° TSE-383

February 2013

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Abstract

We show that introducing a competitive preliminary stage in a sequential public good game helps select one of the more cooperative leaders in the group. Using a modified second price auction, we find that bids have a strong positive predictive power on individual contributions. Moreover, evidence is provided that trust can explain voluntary and cooperative leadership. However, followers reaction to voluntary leaders may rise free riding behaviour, with uncertain effect on total public good provision.

Keywords Public good experiment ·Leadership ·Self-selection ·Cooperation ·Trust ·Public good provision.

JEL classification A13 · C72 · C92 · H41 · Z13

1. Introduction

Why do some individuals voluntary exert costly effort to lead a group without any direct monetary incentive? What kind of group behaviour emerges when a member is disposed to set a good example? Leadership is widespread in a large number of daily situations. For instance, in groups of friends, in organizations and in sports teams and clubs, but also in working places and among relatives.

Although it is difficult to give a clear definition of leadership[1], there are different criteria to define its type: formal versus informal; voluntary versus unintentional; temporary versus permanent. In this paper, we focus on voluntary leaders without coercive powers who give the example to a stable group in a repeated public good game. Our aim is to understand which are the motives underneath voluntary leadership and which are the effects on the contributions and the cooperation of the group.

Leaders are often confused with imposed authority. However, a great source of influence is mostly given by charismatic or enthusiastic individuals who not necessary climbs up the hierarchy ladder[2]. What distinguishes voluntary leaders from other types is the willingness and the determination to influence followers by inspiring them. As they often shares the same benefits of followers; they do not necessarily have an informational advantage; and they do not possess any coercive power, to assure their leadership, they mainly rely on giving the example to potential followers.

In our setting, as in the most part of the literature of leading by example (see, for example, Gächter et al., 2010a,b, Haigner and Wakolbinger, 2010, Güth et al., 2007, Potters et al., 2007, 2005, 2001), the only feature that distinguishes leaders by other group members is the timing of the contribution. They contribute to the public good before others, thus disclosing their actions, giving a benchmark that followers can refer to, but also exposing themselves to free riding or indirect punishment (in the form of reduction of contribution). As a matter of fact, there is the possibility that the leader fails to have a firm grip on

[1]Examples of definitions and characteristics: "A leader is someone with followers. Following is inherently a voluntary activity." (Hermalin, 1998). "The leader of a large organization has many roles. In addition to team-building and developing a mission, a leader is also a motivator and a communicator." Bolton et al. (2010).

[2]We do not exclude the fact that there can be individuals in charge or in some hierarchical position who have also leaders' characteristics. Nevertheless, in this paper, the focus is on the informal role. In this sense, we follow Hermalin (1998), "Leadership is, thus, distinct from formal authority; it is, instead, an example of informal authority".

the group. Because of the lack of coercive power (as punishment, ostracism or reward), volunteers can incur in a large waist of money and/or energy without achieving their scope.

There has already been experimental evidence that voluntary leadership emerges in public good games (Haigner and Wakolbinger, 2010, Rivas and Sutter, 2011, Préget et al., 2012, Arbak and Villeval, 2013, Levati and Neugebauer, 2004). However, in previous experiments, voluntary leadership has been introduced as a deliberate and costless act of subjects. In Préget et al. (2012) and Rivas and Sutter (2011), leaders self-select themselves by contributing to public good faster than other group members. Arbak and Villeval (2013) devise a mechanism which consists in asking directly to subjects, at each period, if they want to move first. Haigner and Wakolbinger (2010) let a randomly selected player to choose to lead (contribute before others) or to follow (contribute after). Levati and Neugebauer (2004) find an interesting evidence on negative leadership: their first movers are those who free ride before others.

Our paper follows this stream of literature that deals with voluntary leadership with a main difference: voluntary leadership is not a costless act. When a substantial number of group members intend to lead, we might expect some form of competition to emerge among them. Competition is linked to effort in achieving the role, so we are introducing a costly mechanism to reveal heterogeneity in the desire to lead of potential competitors. We therefore model leadership as a competitive process. We choose an auction to measure the intention to self-candidate for the role. In fact, if a subject does not want to lead, it is sufficient for him not to bid and, thus, avoid the competition for leadership or, in other words, to *self-select* himself to be a follower.

Another important difference is that, in our framework, leadership is not fleeting. In fact, in all the above mentioned experiments, leaders could change at every period. Differently, our setting allows the voluntary leader to be in charge for the entire game and for the same group, favouring a more stable and complex strategy in leading as well as in the decision to lead.

Formal authority usually emerges through a competitive process that tests individuals' abilities and competences. Selection processes to choose managers and CEOs are based on personal characteristics, work experience and a mixture of particular attributes, abilities and experience skills strength. On the contrary, informal leadership is generally an individual deliberate decision to candidate for the role and to pursue some personal interests. In other situations, leadership may be unintentional or even accidental and the selected leader may try to coordinate the group or may give up the leading-by-example position.

In the present work, we focus on these two latter situations: we compare effectiveness of leadership that is randomly assigned and of leadership that is intentional, namely originated by the competitive auction mechanism. Compared to the existing literature, the amount bid in the auction provides a direct, immediate and continuous measure of the willingness to lead.

Our results confirm the existence of voluntary leadership, and, more importantly, capture the heterogeneity among the agents who are willing to give the example. We devise a mechanism which allows not only to identify self-selected leaders (Arbak and Villeval, 2013, Rivas and Sutter, 2011, Préget et al., 2012) by obtaining a measure of their willingness to lead, but also to evaluate their perception of the first mover advantage.[3] We find that this measure have a strong predictive power on the contributions to the public good all over the repeated game and for all agents (either leaders and followers). This suggests the possibility of considering and investigating more deeply the link between the strength of the willingness to lead and cooperation to the public good.

Why would someone pay for leadership, when there is no direct incentive to move first? There may be many reasons to lead a group. Leadership can be referable to concerns for status (Eckel et al., 2010, Kumru and Vesterlund, 2010); signalling issues (Potters et al., 2001, 2005, 2007, Meidinger and Villeval, 2002); set an example or implement strategic behaviour (Andreoni et al., 2002, Gächter et al., 2010a). In our setting, returns to public good are common knowledge, therefore, no additional information is given to the leader, who is not signalling the quality of the public good as in other contexts. Furthermore, the cost paid by the winner is private information, thus, we rule out the possibility of showing other group members the amount, using Hermalin's terminology, *sacrificed* by the leader. Finally, we can exclude status concerns: status requires that subjects show off the role achieved or ostentate the amount paid for leadership, whereas our setting accounts for anonymity of players and private information about bids. We suggest that the most plausible explanation for the willingness to lead is related to a strategic behaviour of the leader. If a subject believes that his guidance would reduce free riding and increase his payoffs, then

[3] This mechanism can be applied in many other sequential experimental frameworks that can benefit from this type of measure (e.g. oligopoly structures, trust games, etc.).

it is rational for him to bid positively at the auction stage and to pay a cost if he wins. Thus, we expect that subjects who value leadership the most, bid higher values, even if it is costly and there is no (direct) monetary incentive to lead. In our framework, a *strategist* is a subject who believes that others will follow his leadership. This belief does not depend solely on the type of the subject in a simultaneous public good game (whether repeated or not, see Préget et al., 2012). As shown in Cartwright and Patel (2010), a strategist can be a free rider if he is the last player to contribute to the public good. However, he can also be a conditional cooperator whose conjecture is that other players are of the same type as him (or imitators/reciprocators).

While there has already been evidence that voluntary leaders contribute more to the public good than randomly chosen ones, we find that our mechanism of competition gives a better understanding of how much these *volunteers* are willing to renounce to in order to achieve leadership, namely it captures heterogeneity among agents. Moreover, using this heterogeneous measure, we can link bids to subjects' characteristics and to their behaviour in guiding team-mates. In particular, we find that social trust (in a sense that is made clear later in the paper) is generally associated with higher probability of self-selection. As free riders may undo the first mover's effort, the motivation to lead can be related to the belief that other players are conditional cooperators. This result reinforces our contention that leaders belong to the category of strategists: if higher social trust entails the belief that others would contribute to the public good, then it is rational to bid a positive amount in the auction stage.

Finally, the last contribution of the paper is to confirm and stress the importance of considering subjects' asymmetric responses to others' contributions in public good games, as in Ashley et al. (2010), and to take into account the full dynamics of subject's decisions, e.g., the contribution of the leader at time t, does not only depend on her contribution at $t-1$ but also on the average contribution of followers in $t-1$.

In fact, unlike most of the literature on public good game, we find that the trend variable in our regression model is not statistically significant, i.e. it is not related to the decline in contributions towards the end of the game that we observe in the data. While this can be related to our specific experimental design, we stress the fact that this might be due to our complete econometric specification. Under this specification, the decreasing trend in contributions becomes not significant, which implies, in the spirit of Fischbacher and Gächter (2010), that we can fully explain decreasing contributions over time with asymmetric responses to other group members: leader's cooperation efforts are undermined by the tendency of followers to free ride and the decay in contributions spreads over to followers too.

The paper is organized as follows: next section briefly review the literature on leadership in public good games; in section 3, we describe the experimental design; in section 4, we outline our results. First of all, we analyse behaviour in the auction stage, section 4.1, then we move to the discussion of the public good game, section 4.2, and section 4.3. In section 5, we provide some conclusions.

2. Related Literature

Sequential leadership, or leadership-by-example, has been largely studied in public good games both from the theoretical and experimental point of view.

In the standard utility function literature, Varian (1994) first studies the sequential contribution in a two player public good game: the first mover contributes before the other player who observes the contribution and, only then, makes his own choice. The selfish incentive for the leader has been related to a free-riding behaviour of the first mover. The leader overtakes her role of motivator because she wants to exploit first mover advantage and leave to followers the burden of the public good provision. Romano and Yildirim (2001) suggest that players in sequential games may have additional motives to contribute to public goods, which might include warm glow (Andreoni, 1989) and status concerns. When the former case is considered, a selfish leader with altruistic follower may give a high contribution, instead of free ride as in Varian, in order to exploit second mover's upward sloping reaction function. Whenever the two agents care for status, e.g. when the public good represents charity donations, a competition between agents can arise: the larger the contribution, the higher the status in the society. The leader, in this case, has the first mover advantage to rise her contribution, inducing a drop in the second mover's, who loses his interest in the donation. Another interesting paper studying sequential public goods is Bardsley and Moffatt (2007). They found experimental evidence for *strategists* players, namely those who are selfish but might want to contribute to the public good in order to sustain higher provision in the long run. These strategists will contribute to the public good in a sequential setting if they are early enough in the sequence to affect other players; and if they believe there are enough reciprocator in the population (for a theoretical framework on strategists, see also Cartwright and Patel, 2010)[4].

Although the experimental literature on leading-by-example is relatively vast, the part related to voluntary leaders is not widespread.

The closest in spirit to our work is Arbak and Villeval (2013). Their endogenous selection mechanism consists in asking subjects at each period, if they want to move first. They select leaders among these volunteers. They are, therefore, able to class players in three categories: *actual leaders* - those who volunteer for leadership and move first ; *self-selected followers* - those that do not want to become leader; and *eliminated leaders* - those that volunteer for leadership, but were not randomly selected. Their main finding is that volunteers are more cooperative. Actual leaders contribute more than imposed leaders. Moreover, eliminated leaders, who were voluntary but move later on in the game, cooperate more than other followers. Followers react to voluntary leadership with a higher tendency to free-ride. On the one hand, early high provision of leaders crowds-out contributions of second movers; on the other hand, in the imposed leader setting, followers do not have the chance to self-select to be leader, thus, there might be potential leaders among them.

In Rivas and Sutter (2011), at each period, endogenous leaders self-select themselves by contributing to public good faster than other group members. They found that leaders - either voluntary or imposed - contribute more than followers. Follower behaviour is unchanged in the two treatments[5].

A different example of a sequential public good game can be found in Levati and Neugebauer (2004). Agents in each team are synchronized by means of a clock which presents ascending contributions (from zero to total endowment). When an agent makes his contribution decision, it is instantaneously transmitted to his partners. Individual decisions have a double effect: not only setting the personal choice, but also signal level of contribution to other group members. Indeed, authors find evidence of reverse leadership: the first group member who stops contributing, namely the one who free rides first, induces others to do the same. Moreover, leadership fleets, i.e. it is not always the same subject who stops

[4] As a matter of fact, if many subjects behave as strategists, they would compete for the role of leader, to play earlier in the sequence and influence followers which sustains our conclusions to the paper.

[5] In a separate treatment, leaders are endowed with exclusive or reward power. The leader remains in charge for all periods and her coercive power leads to higher contributions with respect to the simultaneous game and to the sequential game without reward power.

contributing first. Finally, they do not detect a significant decline in contributions over time. However, their framework entails a greater variance in between group contributions, with some groups coordinating on the subgame perfect equilibrium and some others on the social optimum. They argue that all these features of their game come from conditional cooperators who react to the person who contributes the least.

3. Experimental design

Our experiment is a 10 periods sequential linear public good game: the leader moves first; then followers observe her contribution and they take their decisions. Subjects are randomly matched in groups of four and keep their role until the end of the game. At the end of each period, subjects are informed about their own earnings and total contribution of the group.

We use standard linear pay-off function that is equal for each player i:

$$\Pi_i(x_i, \sum_{j=1}^{4} g_j) = x_i + 0.5 \sum_{j=1}^{4} g_j$$

where x_i is the private contribution, $G = \sum_{j=1}^{4} g_j$ is the total contribution to the public good and 4 is the size of the group. Players have fixed endowment of 30 tokens to be allocated either in a private account (x_i) or in a common project (g_i). Each token allocated in the common project doubles and it is equally redistributed to the group members: the marginal per capita return is 0.5 for the common project and 1 for the private account. The subgame perfect equilibrium for the followers is to free ride on the leader's contribution. The leader rationally anticipates the free rider behaviour and contributes nothing to the public good.

Subjects who participate in the *endogenous treatment* can use an initial income of 120 tokens in a modified second price sealed-bid auction to compete for leadership. Since there is no monetary incentive for leadership, strictly rational subjects should bid zero, if they believe in a population of strictly rational agents. To keep constant income per treatment, also subjects in the *exogenous treatment* receive the same amount of income (120 tokens) independently of their actions.

In the *exogenous treatment* ($X - Treatment$), a leader is randomly chosen within each group.

In the *endogenous treatment* ($N - Treatment$), all subjects participate with the initial income to a modified second price sealed-bid auction with an ascending clock mechanism to compete for leadership. We are aware that auctions might be an imperfect mechanism for unexperienced subjects, who tend to over-bid[6]. To observe if subjects regret their initial bid, we introduced an unknown stage where they can slightly modify their preliminary choice. As far as we know, this particular framework has not been studied yet in the literature, but it gives us a better understanding of the players' choices.

We model the auction as follows. For each group, the winner of the auction becomes the leader and pays the second highest bid. The auction phase has two stages (subjects are unaware of the second one): a preliminary auction stage and a refinement stage. At the beginning of the former, the screen indicates to players the total amount at their disposal for bidding (i.e. 120 tokens); the current available choice (i.e. a number between 0 and 120); and a countdown clock. In order to make their choice, a red *drop* bottom is drawn at the centre of their screen (see figure 6 in Appendix A). The first stage lasts 2 minutes. Starting from 0, each 10 seconds, the amount on the screen increases by 10 tokens[7]. When the suited amount is reached, the subject will *drop* the auction. However, they will not leave the auction stage till the time expires. That is the reason we refer to our mechanism as a sealed-bid auction. In the subsequent refinement stage, subjects are asked to revisit their bid by choosing any amount in the interval $\{bid - 10, bid + 10\}$ (e.g., if a subject has bid 40 tokens, he can revisit his bid within the interval $\{30, 50\}$). Namely, they can alter previous decisions and/or correct errors upwards and downwards[8]. Should a tie occur, a subject is randomly drawn among those with the highest bid. All subjects are then informed about their role and their own earnings: followers keep initial income; and leaders pay the group second highest bid[9].

The experiment took place at the Ca' Foscari University of Venice in June 2010. We ran 4 computerized sessions with 96 subjects overall (6 groups per session) using the software *zTree* (Fischbacher, 2007). Subjects played in two of the sessions the $X - Treatment$

[6]Auction literature proved that it is due mainly to inexperience of subjects and/or risk loving attitudes (see, e.g., Kagel, 1993).

[7]The time lag has been chosen as a compromise between players to have enough time to drop the auction and to obtain a fine grid of bid. We do not believe this choice can compromise our result as players can refine their bid afterwards.

[8]Trivially, players on the lower (upper) bound can only increase (decrease) their contribution.

[9]The money paid is burned.

followed by a $N - Treatment$; in the remaining sessions, the order was reversed[10]. This mechanism helps identify learning and order effects that may arise during the game. As a result, we have 12 unexperienced (experienced) leaders and 36 unexperienced (experienced) followers for both treatments.

Instructions (see Appendix A) are read aloud at the beginning of each treatment. Subjects answered a short questionnaire to ensure they understood the game[11]. The accumulated tokens were converted at a rate of 2.50 Euro per 100 tokens (average payment 14.13 Euro; average session length 60 minutes).

In the end, subjects were administered a 10 minutes questionnaire. We collected general information about the subject to assess the general traits of players that could shed lights on the role they chose in the game[12].

4. Results

In this section, we discuss the main results of our experiment. We first tackle the outcome of the auction played in the endogenous treatment. Then, we move to the behaviour of unexperienced and experienced subjects in the public good game.

For the sake of clarity, we refer to players with different roles in the endogenous leader treatment and in the analysis as follows:

(i) *Endogenous leaders* are those who obtain the role of leader in the public good game.

(ii) *Potential leaders* are those who have made a bid on strictly positive amounts in the auction, no matter if they are subsequently selected as leaders or not.

(iii) *Eliminated leaders* are those who submit a strictly positive bid, but do not win the auction.

(iv) *Self-selected followers* are those who give in to competition by bidding zero tokens[13].

[10] Subjects knew that only one treatment would have been randomly paid.
[11] Questions were answered privately.
[12] A detailed description of the questionnaire is given in the Appendix A.
[13] Most of the results of the paper are similar when, instead of considering subjects who bid exactly zero only, we define self-selected followers as those subjects whose bids are lower than 10 tokens (e.g. in case of subjects mistakes for low amount).

4.1. The auction stage and endogenous leadership

To present our results about the endogenous selection of leaders, we first show that a large share of subjects is willing to bid a positive amount. Then, we link the amount bid in the auction to the first contribution in the public good game, to prove the positive relationship existing between the two. Finally, we tackle the motives for being leaders: we argue trust is the main driver of players bidding in the auction stage.

The Analysis of Competitive Leadership

Result 1. *Despite the lack of monetary incentives, subjects bid positively to compete for the role of leader. Moreover, distribution of bids is robust to experience on the sequential public good game.*

Competition for leadership arises, although a full rationality assumption would imply that no agent bids a strictly positive amount, as long as the subgame perfect equilibrium of the public good is to free ride.

A considerable percentage of subjects made positive offers to become leader: 66.66% for the unexperienced subjects and 68.75% for the experienced ones. The two distributions of bids, whose frequencies are plotted in figure 1, are not significantly different: the mean bid for unexperienced subjects is 19.94 and the one for experienced is 24.50 (p-value of 0.44 of a Mann-Whitney-U test[14]). The auction, therefore, elicitates preferences for leadership in the same way whether previous experience on the sequential public good game exists or not.

As far as the refinement stage is concerned, a large share of participants did not modify its previous choice: 72% of subjects confirmed their preliminary bid, 3% reduced it and the remaining 25% increased it. The mean bid refinement is 5.30: 6.83 tokens for those who refined the bid above and -7 for those who refined it below. In particular, the refinement stage left unaffected bids for 82% of "preliminary" *self-selected followers*. This result confirms the powerful prediction of the auction: a large fraction of those subjects which are not willing to undertake competition for leadership, if asked to increase their bid (they could change any ones in the interval $\{0, 10\}$), leave it unchanged.

Therefore, by contrast with equilibrium predictions, subjects are willing to bear a cost to achieve the role of leader. Individuals do not only volunteer for leadership, but they continue to elicitate their heterogeneous preferences for the role of leader. This result integrates

[14] If not otherwise stated, all test are Mann-Whitney non-parametric tests.

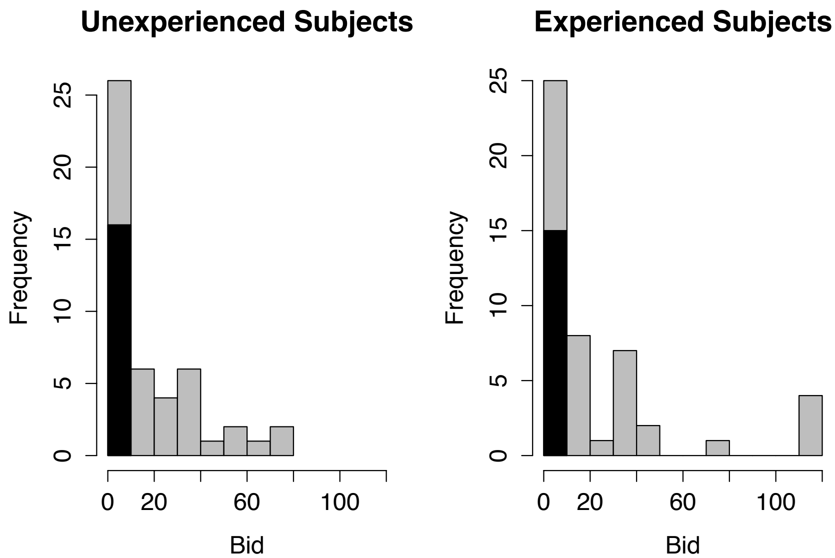

Figure 1: Frequency of Bids for Unexperienced and Experienced Subjects in the Endogenous treatment. The thick black line indicates the number of subjects bidding zero.

findings of previous literature that has already proved voluntary (costless) leadership to be common among subjects[15]. Our setting helps go further and the great variability in bids allows us to have a more detailed measure for the preference on voluntary leadership.

Why do people compete (or do not compete) to become a leader? Despite the fact that leaders *sacrifice* part of their initial endowment, there is neither status nor reward effect in our experimental design. Leaders can not signal either their ability in winning the auction or the quality of their future leadership, because followers never observe their bid. Moreover, we can also exclude that our auction mechanism selects unconditional cooperators, i.e. those subjects whose contribution to the public account is independent of team-mates behaviour. As a matter of fact, these players would not have any incentive to lead the group and waste part of their income in the auction, as long as their behaviour is not affected by the role they cover in the game.

We argue, instead, that *potential leaders* may be strategists and expect their leadership to compensate the loss incurred in the auction stage.

[15]Existing literature has focused mainly on the behaviour of leader and on follower's response to leadership, with little attempt to explain motivations for leadership and differences among leaders. The only exception that we are aware of is Arbak and Villeval (2013), nevertheless the setting used is rather different as we explain in the introduction.

When setting their bids, subjects are unaware of other group members' characteristics[16], thus, they can only rely on their own beliefs[17]. A strategist is a subject that, given his beliefs, maximizes his expected payoff. If a strategist thinks there are subjects that will imitate the first mover and he assumes that, without his leadership, the group would reach lower levels of contribution, then it is rational for him to pay for the right to move first. Since the auction is a second price auction, he would contribute at most the amount of tokens that he believes he would gain by guiding the group. If he bids more than that value (and someone would bid the same amount), he might win and pay an amount that is higher than the potential gain. If he bids an amount lower than his potential gain and he loses the auction, his payoff might be lower than the possible one. Whatever the distribution of bids, subjects should bid their true valuation[18].

If, as suggested by Cartwright and Patel (2010), a strategist expects some of the other players to be imitators (reciprocators or conditional cooperators), she would be herself a high contributor, since she expects her good example to influence followers contributions. Such a higher expected return from leadership should entails higher bids. Thus, we expect higher contributions to be associated with higher bids.

The Bid as a proxy for cooperativeness
Result 2. *The higher the Bid, the higher the first contribution to public good.*

To further explore the positive relationship between contributions and bids, we run a Tobit regression on the first contribution of all players in the $N-Treatment$ against the amount bid in the auction stage. We use first contribution because, in repeated interaction games, behaviour of each players is affected by his team-mates in all periods but the first one. Nevertheless, followers might be influenced by the observed amount played by their leader, hence, to control for this we used a model with leader's contribution.

[16]All players know that in each treatment they will be randomly assigned to a group. Unexperienced subjects are unaware of other players' behaviour, but experienced subjects know their first group behaviour in previous game. Nonetheless, behaviour of leaders and followers is not qualitatively different when experienced or unexperienced.

[17]A potential critique is that endogenous leader behaviour can be affected by the amount paid in the auction. Clearly the two variables display some positive correlation. However, a robustness check shows that the amount paid is unrelated to many of our results. This confirms that neither leaders update their beliefs with the new information conveyed by the second highest bid, nor the price actually paid produces unexpected income effects.

[18]e.g. In a group of free riders, each player would gain 300 tokens plus initial income of 120 tokens. Suppose a leader that bids (and pays) all the initial income of 120 tokens, but believes that she could guide the group out of free riding behaviour to Pareto optimum, she would gain 600 tokens instead of 420.

Model	(1)	(2)	(3)
	1^{st} Contribution All Subjects	1^{st} Contribution Leaders	1^{st} Contribution Followers
Bid	0.1725***	0.1722**	0.1918**
Experienced (dummy)	1.6077	−3.2559	4.8812*
Contribution Leader			0.5332***
Intercept	10.7893***	11.7252**	−0.0747
Obs	96	24	72
Wald-statistic	15.22 on 2 Df	6.11 on 2 Df	19.69 on 3 Df

- *** Significant at 1% level.
- ** Significant at 5% level.
- * Significant at 10% level.

Table 1: First contribution as function of the bid ($N - TREATMENT$)

We find (table 1) that the bid is a good predictor of contribution in the first period, overall model (1) and both for leaders, model (2), and followers (when controlling for leader's first contribution, model (3)). We further notice that experienced dummy is not significant for leaders, suggesting experience be unrelated to leadership behaviour. On the contrary, followers' experience produces a change in the level of contributions and reply to leaders (as we will discuss in further analysis).

This result confirms that the bid is indicating a preference for cooperativeness: subjects who bid more in the auction are also likely to contribute more in the public good game. In that sense, we claim that the auction mechanism selects the person in the group who is willing to set the good example. A more crucial point is that not only bids explain leaders' contributions, but also followers'. This behaviour might be due to the fact that *eliminated leaders* are strategists too. Thus, they are also willing to cooperate more to maintain high level of public good provision and, possibly, to influence other followers in the group.

The Bid and Leader's personal traits

The questionnaire run at the end of the experiment allows us to measure several characteristics of our subjects. We would like to assess whether some relationship exists between positive attributes (fairness, honesty, trust) and the probability to become leader.

However, this analysis can not be based on the characteristic of *endogenous leaders* because a selection bias would arise. Therefore, the core aspect of this methodology is to characterize a *potential* leader, i.e. any candidate for the role of leader in the game. As we have previously discussed, in our game, the bid does not only define the potential leader, but gives also an increasing measure of the willingness to lead. Hence, it seems natural to define a continuous measure of potential leadership using the bid.

We run the analysis on the willingness to lead in two different ways: on the bid ex post, after the refinement stage; on the bid ex ante, computed as the time at which the auction is dropped. In the first random experiment, we compute bootstrap probability of becoming leader and we run a Tobit regression of this probability on player's traits. This bootstrap probability is somehow more informative than the crude value of each bid for several reasons. First of all, since groups are assigned randomly in the game, a player who bids all income does not necessarily have probability one of being leader, as a different random matching could have paired him with other 120 tokens bidders[19]. Second, probability measures relative, rather than absolute, effort. For instance, a player who bids 60 does not become a leader because his bid is high, but because it is higher conditionally on other's behaviour. The new dependent variable would therefore account for all these caveats.

The second approach is based on the *ex ante* observation of the time when the auction was dropped. This *dropping time* is defined in the same interval as the bid but it is a more precise measure as it is recorded every second. If we suppose to start at time 0 with the entire sample, we can check at every second how many subjects are *surviving* the auction stage. We can therefore employ a Cox proportional hazard model (Cox, 1972) on the *dropping time* using player's attributes as covariates. Nevertheless, since the results of the two models are equivalent, we report here a detailed explanation of the former methodology only. Interested reader are referred to appendix B for a discussion and results using the latter approach.

It is worth stressing that the two approaches are not equivalent *stricto sensu*. The endogenous variable in the Tobit model is computed on the final value of the bid, i.e. after players have been asked to refine it; while the endogenous variable in the duration model is related to the behaviour during the auction. The robustness of results can be considered as an indirect test of the consistency of the auction and the refinement stage in our experimental setting.

[19] A similar reasoning can be applied to other bids.

Description of the bootstrap methodology

The bootstrap probability is simply computed from the observed value of the bid and a random rematching. We create a unique sample of 96 players, including both unexperienced and experienced subjects [20] and run 10000 iterations. At each iteration, we draw a sample of four players, compare their bids, and assign to each a probability of winning. The highest bidder is assigned a probability equal to 1. All others receive a probability of 0. In case of a draw, we attribute an equal chance to those players with the highest bid, e.g. if two players out of four are selected, they are assigned a value of 0.5 each. The bootstrap probability of being leader is therefore obtained for each player, as the total sum of his own values over the total number of iterations in which he was drawn.

Result 3. *(Bootstrap) Probability of becoming leader is marginally increasing with respect to trust on others.*

Our regression analysis in table 2 summarizes the result of our model specification. We decide to use a Tobit regression as the probability is bounded in the interval $[0, 1]$. In all models, we control for the dummy experience (i.e., whether the auction is played on the first or the second part of the game); and the ratio of profits obtained by the leader with respect to the followers in the former group, if the auction is played in the second part of the experiment[21]. This latter variable accounts for the fact that followers, whose exogenous leader earned more than the average of the group, might have an incentive to bid more; it also somehow accounts for the fact that these followers might be, on average, more cooperative. We are also controlling for the psychological characteristics measured in the questionnaire.

One specifications out of five is rejected ($p-$value greater than 0.1). The GSS index has a significant and positive effect on the probability to become a leader. However, when we disentangle its three components (trust, helpfulness and fairness), we find that the significance is due to trust only.

The result which links the probability to lead to the trust on others is new to the economic literature, to the best of our knowledge. Gächter et al. (2004) find that trust does not affect contributions in a simultaneous public good game. While helpfulness and fairness

[20] This is possible because the distribution of bids is not significantly different in the two stages. We also run a robustness check doing a separate bootstrap for the two samples but results do not change.

[21] This information is not provided to players, but it can be easily inferred throughout the game.

Probability to become leader					
GSSindex	0.241**				
GSStrust		0.184**			
GSShelp			0.046		
GSSfair				0.106	
Honesty Index					0.137
Gender	−0.029	-0.082	-0.065	-0.054	-0.054
Arts & Literature	0.127**	0.215***	0.179**	0.153*	0.152*
Economics	0.080	0.131	0.076	0.061	0.079
Marketing & Management	−0.143	-0.068	-0.128	-0.142	-0.112
Nash	0.032	0.018	0.042	0.080	0.034
Experimental Experience	0.056	0.078	0.068	0.058	0.053
$Prob > \chi^2$	0.071	0.040	0.095	0.130	0.077

- *** Significant at 1% level.
- ** Significant at 5% level.
- * Significant at 10% level.

Table 2: Determinants of the willingness to lead (Tobit model).

have a significant positive effect on players contribution. Our result is somehow specular to theirs: we find that in a sequential public good game, the probability of being a leader is positively affected by trust on others, but not by their helpfulness and fairness.

However, there is no general consensus on how to interpret the answer to the GSS trust question. Glaeser et al. (2000) find this question to be a measure of trustworthiness rather than trust. By using a large sample of German households, Fehr et al. (2003) find the opposite result: GSS question measures player's trust, but not their trustworthiness.

Sapienza et al. (2007) propose a solution to this puzzle. They distinguish two main components in the concept of trust: *belief-based* trust and *preference-based* trust. *Belief-based* trust measures the expectation about other people's behaviour, given the individual preferences. *Preference-based* trust, instead, measures the preferences of the individual, given the expectation about other's behaviour. Using the strategy method, they find that the GSS trust question measures more the former than the latter.

Furthermore, following Glaeser et al. (2000), we can consider the honesty index as a predictor of individual trustworthiness[22]. The honesty index is positively, but not significantly correlated with the GSS trust answer (correlation coefficient of 0.1244, p-value 0.24). We can therefore conclude that the answer to the GSS question elicits trust rather than trustworthiness.

[22] In our questionnaire, there is not an explicit question about individual trustworthiness. However, Glaeser et al. (2000) conclude that asking about past behaviour is more successful than asking about opinions, as they find that the honesty index predicts realized trustworthiness better than self-reported trustworthiness.

We thus claim that beliefs about others being trustworthy affect positively a subject's willingness to lead[23]. The auction stage seems to select leaders on the basis of their social trust. This is perfectly consistent with our argument suggesting that potential leaders might be strategist. If higher social trust means an expected positive reaction of team-mates to higher contributions in the public good, potential leaders consider worthwhile to burn a share of their initial endowment in order to increase their expected payoff and overall public good provision.

4.2. Unexperienced Subjects

A preliminary idea about the behavioural dynamics of unexperienced subjects, in both the $X-$ and the $N-Treatment$, is given in figure 2. We report, in order, mean total contribution of groups (top left panel); mean contribution of leaders (top right panel); mean contribution of followers[24] (bottom left panel); and mean deviation of followers from leader's contribution, i.e. the mean difference between the contribution of a follower at time t, $c_{f,t}$, and the contribution of his leader at time t, $c_{l,t}$.

As we can observe from the top left panel (figure 2(a)), total contributions are on average higher in $X-Treatment$ with respect to $N-Treatment$ for all periods, except the first one[25]. Although there is high variability in the behaviour from one period to the other, we can observe the well known decay in time in the $N-Treatment$. Surprisingly, in the $X-Treatment$ there is no evidence of decreasing of total contribution over time. If we split behaviour between leaders and followers, we can observe that followers' mean contribution in the $X-treatment$ are not decreasing over time and leader's mean contribution, which starts at a very low value in the first period (mean 9.58), increases over time (last period mean is 16.75). Randomly chosen leaders start by contributing a really low amount, with respect to endogenous leaders (difference 9.75, p-value 0.004), as they might be exploiting first mover advantage and contribute free riding amounts, as suggested by Varian (1994). This behaviour of random leaders crowds-in followers who contribute, on average, above first movers (figure 2(d)) for seven periods over ten. Random leaders increase their contributions in second period to level their contributions with followers. This particular interaction

[23] The answer to the question does not seem to be affected by the earnings in the public good game. Simple rank coefficients between standardized total profits and score in the GSS trust question indicate the absence of correlation between the two.

[24] Where not otherwise stated, followers are broadly defined as second movers in the public good game.

[25] For means and statistical tests see appendix B, table 8.

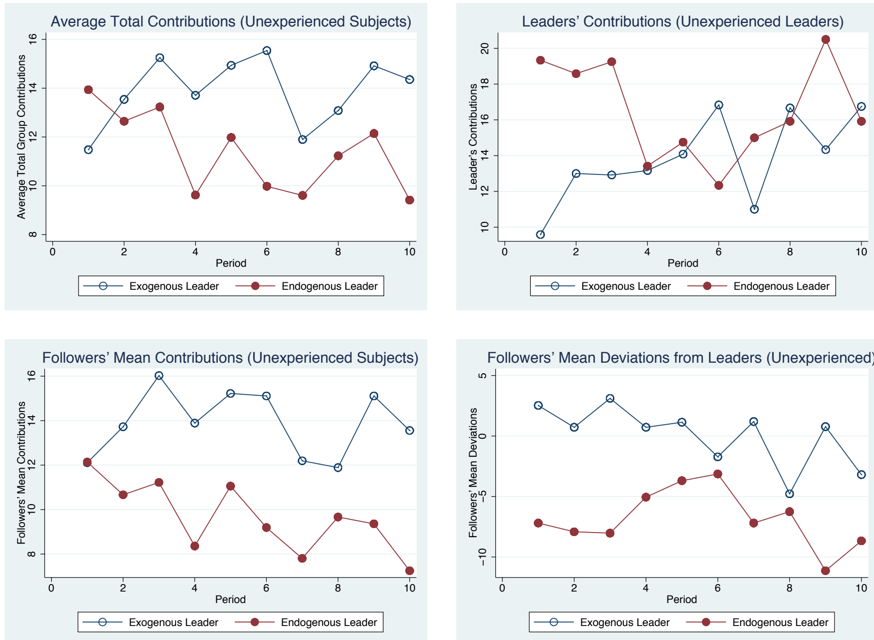

Figure 2: Unexperienced Subjects: Average Total Contribution 2(a); Leaders' 2(b) and Followers' 2(c) Mean Contribution; Followers' Mean Deviation From Leader's Contribution 2(d)

among players could be the explanation for the absence of decay in contributions towards the end of the game in the $X - Treatment$. In contrast, the usual decay in contribution over time is found in $N - Treatment$. As expected, endogenous leaders contribute in mean significantly higher values than randomly chosen ones, especially in the first five periods. However endogenous followers adjust downward (figure 2(d)). Total contributions are lower due to followers not responding to leader's. As a result, leaders reduce their contributions over time.

To stress the difference between endogenous and exogenous followers, we plot in figure 3 non-parametric densities[26] of deviations of followers from leader's contribution. Kernel densities are computed individually for all periods. We can observe that endogenous followers free ride more on leader's contribution than exogenous ones. Difference in means is statistically significant: endogenous followers mean is -6.83 tokens and exogenous followers one is 0.05 (p-value 0.001). As long as in the $X - treatment$ roles are assigned randomly, participants who wish to be leader may turn out to be followers. As these subjects are generally more cooperative, this effect is likely to shrink the difference between leader's and

[26] We use a Gaussian Kernel. Bandwidths are computed using Silverman optimal rule, i.e. $h = 1.059\sigma n^{-1/5}$, where σ is the standard deviation and n is the sample size.

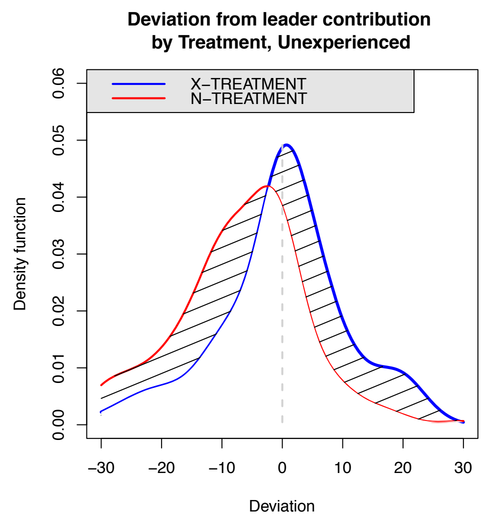

Figure 3: Unexperienced Followers' Deviation from Leader's Contribution

follower's contribution. By the same argument, self-selection of leaders in the $N-treatment$ likely leads to a larger spread between leaders and followers.

Leaders

We present our result using two different model specifications (see table 3). In both specifications, we employ censored Tobit regressions. We express contribution of each leader at time t ($c_{l,t}$) to be explained by individual lagged contribution ($c_{l,t-1}$), by the bid in the endogenous treatment interacted with the endogenous treatment dummy (Bid) and by the period of the game (Period). Moreover, to understand how leaders react to other group members, we used mean lagged contribution of followers ($\bar{c}_{f,t-1}$, in model 1) and the absolute positive or negative deviation of followers from her contribution ($|c_{l,t-1} - \bar{c}_{f,t-1}|$, in model 2).

Result 4. Unexperienced leaders. *Endogenous leaders contribute more than exogenous leaders. Moreover, the higher the bid in the auction stage, the higher the contribution of endogenous leaders.*

Both models in table 3 confirm this result. The marginal effect of the variable Bid is positive and significant, meaning that higher is the amount bid, the higher is the contribution to the public good. Since all leaders in the endogenous treatment have bid positive values to compete for leadership, Bid captures not only an individual fixed effect, but also the endogenous treatment effect[27].

Leader's Contribution ($c_{l,t}$)		
$c_{l,t-1}$	0.4436***	0.7452***
Deviation from group($-$) $\lvert c_{l,t-1} - \bar{c}_{f,t-1}\rvert$ if $c_{l,t-1} < \bar{c}_{f,t-1}$, 0 otherwise		0.0979
Deviation from group($+$) $\lvert c_{l,t-1} - \bar{c}_{f,t-1}\rvert$ if $c_{l,t-1} > \bar{c}_{f,t-1}$, 0 otherwise		-0.3887**
$\bar{c}_{f,t-1}$	0.2792**	
Bid	0.0481*	0.0471*
Period	0.2477	0.2610
Intercept	3.1149	3.6550
Wald statistics	63.3***	64.5***
Observations 216	Left Censored 27	Right Censored 51

- *** Significant at 1% level.
- ** Significant at 5% level.
- * Significant at 10% level.

Table 3: Determinants of public good contributions (Unexperienced Leaders).

We have already seen the explanatory power of the bid for first period contribution (see table 1). One might expect this positive effect not to be significant in the long run, as it may be overwhelmed by group dynamics. However, in models (1) and (2), positive explanatory power of Bid is evident and does hold for the entire game.

Result 5. Unexperienced leaders. *Leaders respond asymmetrically to followers' contributions. If followers contribute on average below her, she adjusts downward her contribution in the following period. If they contribute above, the adjustment is positive, but not significantly different from zero.*

If we observe only model (1), we might conclude that first mover adjusts her contribution in the same direction of followers. A first problem which arises is that leader's contribution at time t influences followers' contributions in the same period, thus the marginal effects are not clear. Furthermore, subjects may respond asymmetrically to other group members' deviations from their early contributions, as already proved in the literature on simultaneous public good games (e.g. Ashley et al., 2010 and Eckel et al., 2010).

As a matter of fact, regardless their previous contributions to the public good, first movers update their decisions according to other group members differently if they con-

[27] We do not use both variables to avoid multicollinearity. Models with only dummy for endogenous treatment instead of the bid give same results, thus, we decide to omit them.

tributed above or below them[28]. When followers contribute on average below the leader ($c_{l,t-1} < c_{f,t-1}$), she levels to second movers, adapting downward her next contribution. This is consistent with a strategic behaviour with updated beliefs: the leader realises that setting the example is costly and reduces cooperation in the next period. Contrary, when followers contribute above her ($c_{l,t-1} > c_{f,t-1}$), she does not change her contribution on average. Again, this is a coherent behaviour. Strategists are payoff maximizers, hence, if they are gaining more than expected from the public good, they would not adjust upward (that is what we might have expected from a reciprocator or a conditional cooperator).

Finally, notice that, unlike the majority of the public good literature, we do not find evidence of decreasing contribution over time: the variable Period is not significant, suggesting that any possible variation with respect to previous contribution in period is given by asymmetric response to followers behaviour and personal characteristics (e.g. bid, previous contributions)[29].

Followers

We now turn to the analysis of unexperienced follower behaviour. Recall that among followers we can distinguish those who were randomly chosen in the $X-Treatment$, those that *self-select* themselves to be followers in the $N-Treatment$ and *eliminated leaders*, who bid positively but not enough to win leadership. In table 4, we used Tobit models clustered by group. We model the followers' choice at time t ($c_{i,t}$) to depend on straight off leader's contribution ($c_{l,t}$), individual lagged contribution ($c_{i,t-1}$), mean lagged contribution of other two followers ($\bar{c}_{-i,t-1}$) and the period of the game (Period). Moreover, in the endogenous treatment not all followers bid positively so, differently from leader analysis, we used both the dummy variable (Dummy auction) and the bid (Bid). Furthermore, in model (2), we would like to observe how previous response to leader affects contribution of follower at time t. In other words, we are interested if there is any tendency of followers to react asymmetrically to lagged contributions of the leader. Hence, similarly to the analysis of leaders' behaviour, we used absolute positive and negative deviations of followers from their leader $|c_{i,t-1} - c_{l,t-1}|$.

[28]This behaviour is consistent for both endogenous and exogenous leaders. We controlled for the interaction between the mean deviation and the dummy treatment: the asymmetry and significance of coefficients for $|c_{l,t-1} - \bar{c}_{f,t-1}|$ is maintained.

[29]This is consistent also when we add a variable as interaction between period and dummy treatment.

Follower's Contribution ($c_{i,t}$)		
`Model`	`(1)`	`(2)`
$c_{l,t}$	0.3345***	0.4158***
Deviation from leader ($-$) $\lvert c_{i,t-1} - c_{l,t-1}\rvert$ if $c_{i,t-1} < c_{l,t-1}$, 0 otherwise		-0.2153**
Deviation from leader ($+$) $\lvert c_{i,t-1} - c_{l,t-1}\rvert$ if $c_{i,t-1} > c_{l,t-1}$, 0 otherwise		0.3557***
$c_{i,t-1}$	0.3960***	0.1738**
$\bar{c}_{-i,t-1}$	0.0996	0.1989***
Dummy auction	-6.8146***	-5.5158***
Bid	0.2008***	0.1983***
Period	-0.3043*	-0.2709
Intercept	3.7674**	3.5095**
Cluster by Group	0.0228	0.0213
Wald statistics	215.8***	237.7***
Observations 648	Left Censored 120	Right Censored 66

- *** Significant at 1% level.
- ** Significant at 5% level.
- * Significant at 10% level.

Table 4: Determinants of public good contributions (Unexperienced Followers).

Result 6. Unexperienced followers. *If the follower has bid a positive amount in the auction stage, he contributes more to the public good. The contribution is also increasing with the bid.*

Ceteris paribus, Bid grasps heterogeneity among eliminated leaders. Therefore, not only a follower is more cooperative when he bids a positive amount in the auction, but his contribution to the public good is constantly higher, the higher his bid. The bid has therefore a positive explanatory power in predicting subject contributions for unexperienced followers in the $N - Treatment$ too.

Although *eliminated leaders* contribute more than *self-selected followers* (as the variable Bid has a marginal positive effect), the total contribution of followers in the endogenous treatment is lower than in the exogenous one.

Result 7. Unexperienced followers. *When subjects are unexperienced, follower contribution is on average higher in the exogenous treatment.*

Followers are sensitive to treatment variables. As we have already argued for figure 2(d) and 3, followers contribute in mean less in the $N - Treatment$ with respect to the

$X - Treatment$. This is mirrored in the regression table by the Dummy auction being negative in model (1), as well as in model (2).

It is crucial to assess the dynamics of followers behaviour. In both models, we can see that individual lagged contribution, $c_{i,t-1}$, significantly, and positivelyx affects present contribution, $c_{i,t}$.

It is also interesting to discuss how information alters follower decisions. The last information that a follower receives, before making his own choice, is the contribution of the leader, $c_{l,t}$. The leader provides her example, and the follower responds in the same direction: the higher is the leader's contribution, the more followers contribute.

However, it is reasonable to expect followers to respond as well to other members in the group[30]. Model (1) suggests followers being unresponsive to the average contribution of other second movers, $\bar{c}_{-i,t-1}$. Yet, this result is not entirely satisfactory.

As long as leader's and other followers' lagged contributions are positively correlated, the standard omitted variable argument applies to the coefficient of $\bar{c}_{-i,t-1}$, which is therefore not significant[31]. As soon as we introduce asymmetries with respect to the leader lagged contribution, the coefficient related to $\bar{c}_{-i,t-1}$ becomes positive as expected (model 2).

Finally, we consider asymmetries in follower's responses to the leader lagged contribution.

Result 8. Unexperienced followers. *Followers have stable preferences for the public good, i.e. if they contribute more (less) than the leader today, this has, ceteris paribus, a marginal positive (negative) effect on their contribution tomorrow.*

A popular result in the literature is that second movers follow the leader but with a tendency to behave selfishly (see, e.g. Gächter et al., 2010b), i.e. they always contribute slightly less than the leader.

However, when controlling for asymmetries in follower's response, we can dig deeply into the matter. Although followers contribute on average less than the leader also in our experiment, they have a stable behaviour throughout the game. Contributing above (below) the leader today entails, everything being equal, a positive (negative) impact on follower's provision tomorrow. This finally implies followers to have stable preferences for public good provision.

[30]In fact, on average other two followers' contributions count for half of the total provision per period.

[31]In a regression model, this refers to the omission of an important causal factor. This produces biased and inconsistent estimates if omitted and included covariates are correlated.

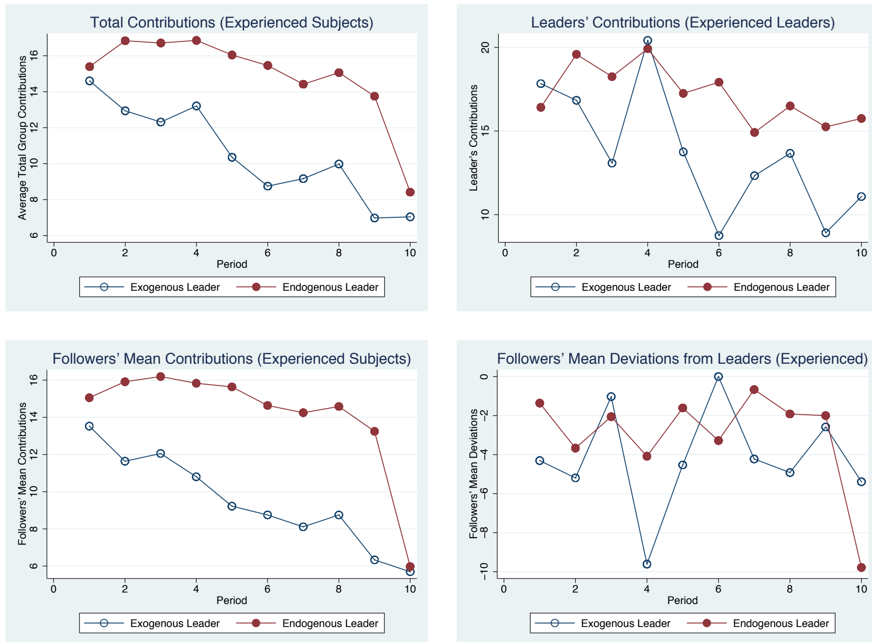

Figure 4: Experienced Subjects: Average Total Contribution 4(a); Leaders' 4(b) and Followers' 4(c) Mean Contribution; Followers' Mean Deviation From Leader's Contribution 4(d)

A final aspect to be noticed is that, although the contribution of followers is steadily decreasing over time as in other sequential and simultaneous public good games, the time variable is significant only in model (1), when we do not control for asymmetries in follower's responses.

4.3. Experienced players

Experienced subjects have already played a ten-period sequential public good, thus, they have familiarity with the game and their contributions are less volatile. A detailed picture of the dynamic behaviour of experienced subjects, in both the $X-$ and the $N-Treatment$, is plotted in figure 4. We again report separately the total contribution (top left panel); the mean contribution of leaders (top right panel); the mean contribution of followers (bottom left panel); and the followers' deviation from the leader (bottom right panel).

As we can observe from the top left panel (figure 4(a)), contrary to unexperienced players, total contributions are higher in the $N-treatment$ for all periods. In the last five periods, there is a difference in contribution of roughly 5 tokens between the two treatments (p-value 0.1, see Appendix B, table 9). Finally, in the last period only, there is a noticeable end-game effect in the $N-treatment$, which makes the total average contribution almost identical between treatments.

Although leaders start from a similar mean contribution, endogenous leader contributions are steady and higher over time, as compared to exogenous leader contributions. Followers behaviour does not change dramatically in the two treatments: they simply adjust their actions to the leader. The slight decrease over time is due to the decay of leader's contributions, as it is confirmed by the analysis of deviations (figure 5). The distributions of deviations in the $X-$ and $N-Treatment$ are in fact statistically equivalent (average are respectively -4.17 and -3.04, p-value 0.23).

We argue that quality of leadership for experienced subject drives the difference between exogenous and endogenous treatment. As a matter of fact, endogenous leaders are more effective in maintaining higher cooperation, with the exception of the last period. Conversely, exogenous leaders do not have a real grip on their followers: for example, in period 4, they try to pull contributions up ineffectively.

A comparison with figure 2 leads to similar conclusions. A more stable leadership has the effect of controlling followers behaviour in the endogenous treatment. For the exogenous treatment, it appears that a change in leadership entails an adjustment in followers. While unexperienced exogenous leaders start from very low contributions and then increase over time, experienced ones have exactly the opposite behaviour. Thus, while followers take over leadership in the unexperienced case, they go after the leader in the experienced one.

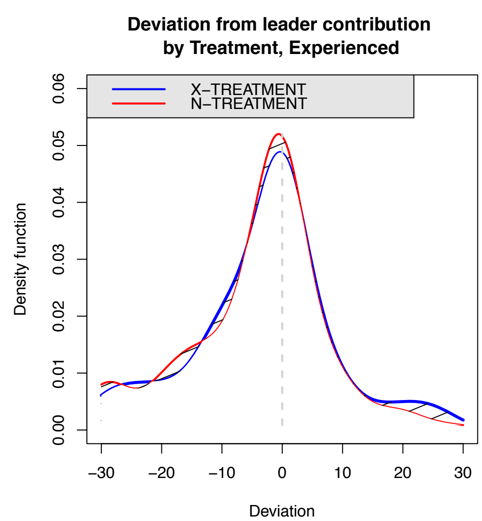

Figure 5: Experienced Followers' Deviation from Leader's Contribution

Leaders

Our main results are robust to experienced subjects.

Result 9. Experienced leaders. *Experienced leaders behave similarly to unexperienced ones. Endogenous leaders contribute more than exogenous leaders. Moreover, the higher is the bid in the auction stage, the higher the contribution of endogenous leaders.*

Leader's Contribution ($c_{l,t}$)		
`Model`	`(1)`	`(2)`
$c_{l,t-1}$	0.4596***	0.7881***
Deviation from group(−) $\lvert c_{l,t-1} - \bar{c}_{f,t-1}\rvert$ if $c_{l,t-1} < \bar{c}_{f,t-1}$, 0 otherwise		−0.1693
Deviation from group(+) $\lvert c_{l,t-1} - \bar{c}_{f,t-1}\rvert$ if $c_{l,t-1} > \bar{c}_{f,t-1}$, 0 otherwise		−0.5448***
$\bar{c}_{f,t-1}$	0.2984*	
Bid	0.1308***	0.1264***
Period	−0.5166	−0.5437
Intercept	5.1599	7.1633**
Wald statistics	88.1***	91.3***
Observations 216	Left Censored 9	Right Censored 32

- *** Significant at 1% level.
- ** Significant at 5% level.
- * Significant at 10% level.

Table 5: Determinants of public good contributions (Experienced Leaders).

We compare results for experienced leaders, table 5, with unexperienced ones, table 3. We notice that there are not substantial differences between the two. The bid has once more a positive effect on contributions. Nevertheless, the marginal effect of the bid more than doubles with respect to unexperienced subjects (coefficient for experienced leaders 0.13 versus unexperienced 0.05). This suggests that when subjects are willing to become leader in the second part of the experiment, for the same bid, their cooperation to the public good is higher.

The other determinants of leader's behaviour are similar in the experienced game. Leaders respond positively to an increase in followers' contribution, in model (1), and to their previous contributions, in both model.

Result 10. Experienced leaders. *Leaders respond asymmetrically to followers' contributions. If followers contribute on average below her, she adjusts downward her contribution in the following period. If they contribute above, the adjustment is still negative, but not significantly different from zero.*

As a matter of fact, when we disentangle the variables affecting leader's response to followers, we find same sign and significance of the coefficient for negative deviations of followers. Experienced leaders are very prompt in reducing their contribution when followers are below them and they have a more negatively sloped reaction curve (coefficient for experienced leaders -0.5448 versus unexperienced -0.3887). The main difference is that now leaders respond on average by adjusting downwards to cooperative followers. However, the coefficient is not significant.

Finally, although with experience there is a tendency to decrease contributions over time, this trend is not significant as for unexperienced leaders. This effect is captured by the response of leaders to followers who contribute below them.

Followers

Last of all, we discuss here results for experienced followers. We use all variables presented in previous analysis. In addition, we replace the Bid, which is not a good predictor of followers behaviour any more, by the dummy variable Eliminated Leaders that takes value 1 if the endogenous follower has bid a positive amount during the auction stage and 0 otherwise. In table 6, we present the result of a censored Tobit regression clustered by group.

Result 11. EXPERIENCED FOLLOWERS. *Experienced followers behave differently than unexperienced followers. Eliminated leaders contribute more to the public good, nevertheless the bid does not explain heterogeneity among them.*

Although the sign of the bid is still positive (models (1) and (3)), it is not significantly different than zero. The bid is not able any more to capture differences among those players who bid positively. Nevertheless, when we plug the dummy variable for eliminated leaders in the $N-Treatment$ (models (2) and (4)), we find that eliminated leaders contribute more to public good compared to other followers.

Result 12. EXPERIENCED FOLLOWERS. *When subjects are experienced, there is no difference in the behaviour of exogenous and endogenous followers, except for eliminated leaders that contribute more to the public good.*

In models (1) and (3), when Bid has no explanatory power, the Dummy Auction captures the difference among treatments. Its positive sign suggests a treatment effect is at work, with endogenous followers contributing more. However, when we replace Bid with a dummy for *eliminated leaders*, the Dummy Auction loses all its predictive power. This rather points out towards no distinctions between treatments. The difference is more likely to come from followers who bid positively. They contribute, in fact, more than both endogenous *self selected followers* and followers in the $X - treatment$.

Follower's Contribution ($c_{f,t}$)				
`Model`	`(1)`	`(2)`	`(3)`	`(4)`
$c_{l,t}$	0.3337***	0.3508***	0.4123***	0.4203***
Deviation from leader ($-$) $\|c_{i,t-1} - c_{l,t-1}\|$ if $c_{i,t-1} < c_{l,t-1}$, 0 otherwise			-0.2863**	-0.2696***
Deviation from leader ($+$) $\|c_{i,t-1} - c_{l,t-1}\|$ if $c_{i,t-1} > c_{l,t-1}$, 0 otherwise			0.2454**	0.2226**
$c_{i,t-1}$	0.6449***	0.6381***	0.4276**	0.4399**
$\bar{c}_{-i,t-1}$	0.1065	0.0839	0.2146***	0.1905***
Dummy auction	2.5432**	0.7092	2.1938**	1.0837
Bid	0.0061		0.0154	
Eliminated Leader		3.5505**		2.4478*
Period	-0.5075***	-0.5139***	-0.5444***	-0.5446***
Intercept	-3.3449	-2.7611	-1.5083	-1.2587
Cluster by Group	0.0588	0.0373	0.0455	0.0324
Wald statistics	407.7***	415.90***	443.9***	447.6***
Observations 648	Left Censored 138		Right Censored 91	

- *** Significant at 1% level.
- ** Significant at 5% level.
- * Significant at 10% level.

Table 6: Determinants of public good contributions (Experienced Followers).

Result 13. Experienced followers. *As unexperienced subjects, followers have stable preferences for the public good.*

As with unexperienced subjects, when we introduce response of follower to previous leader's contribution, we observe a stable behaviour of followers (models (3) and (4)). Those who contribute above (below) the leader have a tendency to have a higher (lower) contribution in the following period. Moreover, while in model (3), lagged mean contribution of other followers do not affect contribution at time t, when we take into account their behaviour with respect to the leader this coefficient becomes significant.

Followers seem to maintain the same behaviour with respect to leader's contribution at time t and their own lagged contribution. However, while the coefficients associated to $c_{l,t}$ and $\bar{c}_{-i,t-1}$ are similar to the unexperienced case, the coefficient of $c_{i,t-1}$ is much higher in all models. This suggests experienced followers having a more stable preferences for the public good.

Finally, time decay is evident from the negative marginal effect of the period variable. Coefficients for this variable are significant in all models and higher than in the unexperienced case. However, if we introduce in all models a dummy for the last period, this time effect disappears, suggesting this result being entirely due to the sharp decrease in contribution in the very last period (see figure 4)[32].

5. Concluding Remarks

Voluntary leadership is generally studied as a costless, deliberate act of subjects. Nevertheless, in real situations, actions directed to achieve the role of first mover could be individually costly, in particular if there is competition among agents. This paper carries on the important need of a deeper understanding of mechanisms and motives underneath self-selection of leaders; and of a better analysis of their behaviour in a social dilemma game.

Using a modified second price auction, we show that a substantial amount of subjects bid to achieve the role of leader. We propose two formal explanations for people to bid: either they are free riders *à la* Varian and they try to exploit first mover advantage; or they wish to become leader to foster cooperation in the group. No matter if we believe the former or the latter to be the most reasonable explanation, we can simply test how much the amount bid in the auction affects contributions in the public good game (or at least the contribution in the first period).

On the one hand, we find that voluntary leaders are more prone to cooperate to the public good than randomly chosen leaders. On the other hand, not only subjects exercise higher effort by bidding positive amounts, but this effort has a positive marginal effect on contributions. This holds for the first period of the public good game and, more generally, as a fixed effect for contributions throughout the game. This sheds lights on the positive link between costly effort to obtain leadership and cooperative behaviour in a public good framework.

As it might seem counterintuitive to pay for achieving a role which can be exploited by free riders, personal characteristics and beliefs of bidders could explain this choice. We, therefore, relate the amount bid in the auction stage with the information gathered in the questionnaire. We show that more social trust induces a higher probability of becoming leader. To the best of our knowledge, trust has never been associated to behaviour in sequential public good game and it leaves open questions for further research in this field.

[32]Results are available upon request.

We argue that more trust implies higher willingness to lead which, in turns, implies higher contributions. If an individual believes others to be trustworthy, it is likely also to believe others to cooperate in the public good game. Thus, we reasonably believe people bid as they expect their leadership to compensate the cost incurred in the auction stage. In this sense, it is not irrational to bid positively and to contribute more as first mover if players are strategist, i.e. they maximize their expected payoff given their beliefs on others' trustworthiness. Whenever beliefs are not fulfilled, namely second movers do not imitate, leaders reduce their contributions (which is consistent with free riding and updating beliefs as in Fischbacher and Gächter 2010 and asymmetric behaviour as in Ashley et al. 2010).

Nevertheless, outcomes regarding the total contribution are unforeseeable. On the one hand, we find an increase of contributions in the endogenous treatment driven by the higher leader's contributions. On the other hand, followers may not cooperate with endogenous leaders, thus the total effect on the provision of public good is unpredictable and depends on followers reaction function. In fact, in sequential public good games, first mover contributions may either have crowd-out and crowd-in effects on second movers.

Hence, a question which is left to understand is how to improve total cooperativeness. Cooperation is of key importance to reach Pareto superior outcomes and the leading example is effective only if followers reciprocate. Through our former findings, we suggest that our mechanism can also be used to single out the most cooperative players. Cluster them in homogeneous groups may be a solution to increase total contribution and reach superior outcomes.

Acknowledgements We wish to thank Michele Bernasconi and Paul Seabright for very insightful remarks on an earlier draft of the paper. We also thank participant to the 2011 ESA World Meeting, Luxembourg, and to the First and Second Toulouse-Lyon joint PhD workshop.

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Appendix A: Instructions and Questionnaire

5.1. Lab Instructions

Welcome Screen

Good morning! You are taking part in an economic experiment about decisional processes. Following the instructions on the screen, you will be asked to make some decisions: please read everything very carefully.

At the end of the experiment, you will be paid cash (up to 22 euros) according to your results. These results depend both upon your decisions and upon the decisions of your group.

During the experiment you will use *tokens*: every token will be converted to 2.5 euro cents.

Your responses will be anonymous relative to other subjects and to the experimenter.

The experiment consists of two separate phases. You will be paid for results of only one of these two phases (at the end of the experimental session, a toss of a coin will randomly determine which one of the two phases will be paid).

If you have any question, please raise your hand. The experimenter will come to clarify your doubts.

IT IS FORBIDDEN TO COMMUNICATE WITH OTHER PLAYERS DURING THE EXPERIMENT. EVERY MISBEHAVIOUR WILL BE PUNISHED WITH EXCLUSION FROM THE EXPERIMENT.

Phase I: Exogenous Treatment

If this phase will be selected, you will receive 120 tokens independently of your choices. Tokens that you will obtain via your choices will be added to the 120 tokens (each token that you obtain will be converted in euros at the end of the experiment).

This first phase consists of 10 periods (from 1 to 10). At the beginning of the phase, you will be randomly assigned to a group of 4 participants selected among the people in this lab. The group stays the same until the end of the first phase.

In each of the periods from 1 to 10, an endowment of 30 tokens will be given to each participant.

You can choose how much to contribute to a common project, from 0 to 30 tokens. Each token invested in the common project, by all members of your group, will be multiplied by

2 and redistributed equally among all four group members (namely, it will have a value of 0.5 tokens for each of member in the group).

Each token that you will keep in your private account (the difference between your endowment and how much you contribute to the common project) will be valued for you 1 token.

Computation of payoffs for each period.. In each of these ten periods, your earnings come from two sources:

- The part of the endowment that you kept on you private account (for example, 30 minus your contribution to the project) will be valued one token for each token that you have in your account;

- The payoff you get from the common project: you will earn 0.5 tokens for each token that the group have contributed to the project.

The earning from each of these periods will be as follows:

- *Example 1*: if the group total contribution is 70 tokens, each subject in that group will earn for the common project: 70/2=35 tokens. If the group total contribution is 10 tokens, each subject in that group will earn 10/2=5 token from the common project.

- *Example 2*: Anna has an endowment of 30 tokens. If Anna contributes 15 tokens to the common project and the total contribution of her group is 60, Anna's payoff for that period is:

$$\boxed{(30\text{-}15) + (60{:}2)=15+30=45}$$

- *Example 3*: Mario has an endowment of 30 tokens. If Mario contributes 30 tokens to the common project and the total contribution of his group is 60, Mario's payoff for that period is:

$$\boxed{(30\text{-}30)+ (60{:}2)=0+30=30}$$

- *Example 4*: Carlo has an endowment of 30 tokens. If Carlo contributes 0 tokens to the common project and the total contribution of his group is 60, Carlo's payoff for that period is:

$$\boxed{(30\text{-}0)+(60{:}2)=30+30=60}$$

Structure of each period.. Every period is divided into two parts:

- In the first part, a participant randomly drawn in each group (called **subject one**) chooses how much to contribute to the common project, from 0 to 30 tokens

- In the second part, the other three participants (called **subjects two**) will simultaneously choose their contribution to the common project, from 0 to 30 tokens, upon observation of the contribution of **subject one**.

After everyone has chosen his contribution, a screen appears, and each participant will be informed about his group total contribution to the common project, and about his payoff for the current period.

Computation of the final payoffs for phase I.. The total payoff for the first phase is computed as the sum of the initial endowment of 120 tokens plus the sum of all tokens earned in the 10 periods of the game, as previously described.

Payoffs are computed the same way for all participants.

Phase I: Quiz

To verify your understanding of the game, please answer to this questionnaire:

1. How many periods are played?
2. Each group is composed by 4 subjects. TRUE or FALSE
3. What is your initial endowment at each period? a) 10, b) 20, c) 30, d) 40
4. *Subject one* observes the choices of other subjects in his group and, only after that, he makes his own. TRUE or FALSE
5. *Subject two* observes the choice of *subject one* in his group and, only after that, he makes his own. TRUE or FALSE
6. If you have chosen to contribute 24 tokens to the common project, how many tokens would you keep?
7. If you have chosen to contribute 5 tokens to the common project and the group total contribution is 90 tokens, how much will be your payoff for that period?
8. If you have chosen to contribute 5 tokens to the common project andand the group total contribution is 40 tokens, how much will be your payoff for that period?

Phase II: Endogenous Treatment (auction only)

If this phase will be selected, you will receive 120 tokens independently of your choices. You can use this initial endowment at period 0 as it will be described in the following.

This second phase consists, as the first one, of 10 periods plus a preliminary part, which we refer to as *period 0*.

At the beginning of phase two, you will be randomly **reassigned** to a group of 4 people. The group stays the same until the end of this second phase.

Periods from 1 to 10 are exactly as explained before: every player has an endowment of 30 tokens for each period and he will have to decide how much to contribute to a common project. In part one, *subject one* contributes to the common project; in part two, *subjects one* observe *subject one*'s contribution and make their own choice.

The only difference is in period 0. You can now choose to use a part of your initial endowment of 120 tokens to become *subject one*.

Period 0: choice of subject one.. You can use part of your 120 tokens to become *subject one* within your group in this second phase. At period 0, a screen will appear indicating an amount to be chosen to become *subject one* and a countdown clock: every 10 seconds, the amount will increase by 10 tokens. That is: from second 120 to 111, the amount will be 0; from 110 to 101, it will be 10; from 100 to 91, it will be 20 and so on until 0 (and beyond) when the amount will be equal to 120. When the amount you wish to chose to become *subject one* appears on the screen, click on the button DROP and stop the countdown.

In this part, you can choose to use any amount between 0 and 120 tokens.

How is subject one chosen? Among the 4 members in your group, *subject one* will be the one who has chosen the highest value between 0 and 120 tokens in period 0. If two or more participants, within the same group, have chosen the same amount, *subject one* will be drawn at random among them. Only the person who finally becomes *subject one* will be asked to give away a part of his participation tokens. All other group members will keep their 120 tokens, no matter the amount they have chosen.

Computations of results at period 0.. All players obtain an initial endowment of 120 tokens.

120 participation tokens - 0 tokens

Subject one will have to give away an amount equal to the difference between his 120 tokens minus the *second highest bid* in the group.

120 participation tokens - second highest bid in the group

At the end of period 0, a screen will inform you about your role in the game, i.e. if you are either a *subject one* or a *subject two*, and you payoff after period 0.

Example:. Suppose that, at period 0, Andrea, Beatrice, Carlo and Dario belong to the same group and they have chosen the following amounts: Andrea=50, Beatrice=30, Carlo=60, Dario=40.

Carlo, who has chosen 60, will be *subject one* in the group. Anna, Beatrice and Dario will be *subjects two*.

Carlo has to pay 50 tokens, that is the second highest amount chosen in his group. Payoffs for period 0 will therefore be: Andrea, 120 tokens; Beatrice, 120 tokens; Carlo, 120-50=70 tokens; Dario, 120 tokens.

Figure 6: Example of screen in Period 0.

Computation of results for Phase II.. The final payoff of Phase II is the sum of the payoff obtained in period 0 plus the sum of all tokens earned in periods from 1 to 10, as previously described.

5.2. The Questionnaire
Description

For our questionnaire, we first used a measure of the *Big-five factors* personality test, so-called *Ten-Item Personality Inventory* (TIPI). The *Big-five factors* test is composed of 60 questions which investigate five broad domains used to describe the human personality: Openness, Conscientiousness, Extraversion, Agreeableness, and Neuroticism. However, we chose to use a brief measure of these five factors which is less accurate, but it reaches adequate levels in terms of convergence between self and observed ratings (see Gosling et al., 2003). Players have to agree on a statement related about their personality on a scale of 1 (disagree strongly) to 7 (agree strongly). The score for each factor is given by the mean score obtained for the corresponding questions.

We further wish to measure players' own degree of honesty, trust and altruism. A measure of the former was acquired using a self-reported honesty index, which is given by the average of a five-question rating frequency of lying to parents, room-mates, acquaintances, close friends and partners on a scale of 1 (very often) to 5 (never). As discussed in Glaeser et al. (2000), this honesty index can be used as a proxy for trustworthiness and it is often more reliable than asking a direct question about personal trustworthiness. Trust has been determined using the *General Social Survey* questions about others' fairness, helpfulness and trust. These questions can be used to evaluate whether a subject is more inclined either to trust or not to trust others. The latter characteristics (altruism) has been assessed via questions about having ever been volunteers and the average amount of money given to charity every year, which are very close in spirit to those used in Glaeser et al. (2000).

Content

(i) Control Questions: gender; age; nationality; parent's nationality; marital status; experimented before; work; major (if student); average monthly income; knowledge of the concept of Nash equilibrium.

(ii) Ten Item Personality Inventory (TIPI): Here are a number of personality traits that may or may not apply to you. Please write a number next to each statement to indicate the extent to which you agree or disagree with that statement. You should rate the extent to which the pair of traits applies to you, even if one characteristic applies more strongly than the other. To answer this question, use the same scale from 1 (strongly disagree) to 7 (strongly agree). I see myself as:

1. Extraverted, enthusiastic.
2. Critical, quarrelsome.
3. Dependable, self-disciplined.
4. Anxious, easily upset.
5. Open to new experiences, complex.
6. Reserved, quiet.
7. Sympathetic, warm.
8. Disorganized, careless.
9. Calm, emotionally stable.
10. Conventional, uncreative.

(iii) GSS Fair: Do you think most people would try to take advantage of you if they got the chance or would they try to be fair?

1. Would take advantage of you.
2. Would try to be fair.
3. It depends.
4. I do not know.

(iv) GSS Help: Would you say that most of the time people try to be helpful, or that they are mostly just looking out for themselves.

1. Try to be helpful.
2. Just look out for themselves.
3. It depends.
4. I do not know.

(v) GSS Trust: Generally speaking, would you say, that most people can be trusted or that you cannot be too careful in dealing with people?

1. Most people can be trusted.
2. Cant be too careful.
3. It depends.
4. I do not know.

(vi) Charity and Volunteering: Have you ever actively been a volunteer (for association, NGO, chuches,etc.)? How much money you donate to charity every year (on average in euros)?

(vii) Honesty Index: How often do you lie to (please answer on a scale from 1, very often, to 5, never):

1. Parents.
2. Roomates.
3. Acquaintances
4. Close friends.
5. Partners.

Data Manipulation

All variables in the questionnaire have been demeaned and normalized by the standard deviation. For the General Social Survey questions, we have been following the procedure in Gächter et al. (2004), so that higher value of the variables correspond to higher level of trust[33]. A *GSS index* has been obtained as the sum of the three questions, normalized into the interval $[0, 1]$. The same procedure has been applied to obtain a *honesty index*, which corresponds to the mean score on the five questions on lying, properly normalized in the interval $[0, 1]$.

We also control for a set of variables, such as gender, past participation to economics experiments, knowledge of the concept of Nash equilibrium and the major of studies (Arts and Literature, Economics or Marketing and Management).

Appendix B: some further analysis and descriptive statistics

5.3. Duration models and the characterization of the leader

As we have discussed in section 4.1, it is possible to give a different characterisation to the model we have used to explain leader's traits.

In particular, we can retrieve information about the time when players drop the auction. This variable can be used to construct a model in which time represents the dependent event.

[33]Subjects dispose of four options to answer GSS questions: "Do not trust"; "Trust"; "Depends" and "Don't know". The option "Depends" in the GSS questionnaire has been taken to have intermediate value between "Do not trust" and "Trust". The option "Don't know" has been eliminated from the sample.

Duration (or survival) models serve as a tool to frame the time elapsed before some events occur (for a review, see den Berg, 2001). A standard example is given by unemployment spells: when we observe a panel of individuals over time, we can compute how many weeks they have been staying jobless. In our particular application, we use a so-called Cox proportional hazard model (Cox, 1972), which relates the underlying event with some exogenous covariates.

In our experiment we observe players entering the game at time 0 and at each second we can assess how many of them are *surviving* the auction stage, i.e. we observe the duration of staying in the auction for each player.

The event "dropping the auction" is the one we want to relate with the characteristics we observe in the questionnaire. We suppose that the intensity of the Poisson distribution which determines the occurrence of this event is constant over time.

Table 7 reports the result of such a regression. Coefficients need to be read with the opposite sign, i.e. a negative coefficient means a positive marginal relation with being a potential leader. As it can be easily inferred, these results are not substantially different from what we have shown in section 4.1. The only difference is that now the model including the GSS index is also significant. The main message still holds true: a higher level of trust decreases the probability of dropping the auction and therefore it increases the probability of being leader.

Time at which the auction to become leader is dropped					
GSSindex	-0.777^{**}				
GSStrust		-0.715^{***}			
GSShelp			-0.211		
GSSfair				-0.269	
Honesty Index					-0.852
Gender	0.254	0.227	0.156	0.112	0.099
Arts & Literature	-0.282	-0.479	-0.116	-0.090	0.015
Economics	-0.619	-0.827^{*}	-0.461	-0.412	-0.481
Mark & Man	0.301	0.029	0.457	0.463	0.254
Nash	0.159	0.348	0.212	0.120	0.286
Experiment	-0.301	-0.404	-0.287	-0.326	-0.202
$Prob > chi2$	0.037	0.034	0.167	0.113	0.167

- *** Significant at 1% level.
- ** Significant at 5% level.
- * Significant at 10% level.

Table 7: Determinants of the willingness to lead (Proportional hazard model).

5.4. Additional tables

Periods		**1**	**1 to 5**	**5 to 10**	**10**
Average Mean contribution	X-TREATMENT	11.48	13.78	13.96	14.35
	N-TREATMENT	13.94	12.28	10.47	9.42
	Difference	-2.46	1.50	3.49	4.93
	$p - value$	(0.225)	(0.356)	(0.094)	(0.088)
Leaders' Mean Contribution	X-TREATMENT	9.58	12.55	15.12	16.75
	N-TREATMENT	19.33	17.07	15.933	15.92
	Difference	-9.75	-4.52	-0.82	0.83
	$p - value$	(0.004)	(0.056)	(0.583)	(0.884)
Followers' Mean Contribution	X-TREATMENT	12.11	14.19	13.57	13.55
	N-TREATMENT	12.14	10.69	8.65	7.25
	Difference	-0.03	3.50	4.92	6.30
	$p - value$	(0.977)	(0.053)	(0.050)	(0.043)
Average Profit Leader	X-TREATMENT	43.37	45.02	42.80	41.96
	N-TREATMENT	38.54	37.5	35.02	32.92
	Difference	4.83	7.52	7.78	9.04
	$p - value$	(0.056)	(0.001)	(0.026)	(0.032)
Average Profit Follower	X-TREATMENT	40.85	43.37	44.34	45.15
	N-TREATMENT	45.74	43.88	42.29	41.58
	Difference	-4.89	-0.50	2.05	3.57
	$p - value$	(0.083)	(0.729)	(0.564)	(0.355)

Table 8: Unexperienced Subjects: Tests on difference between treatments for period 1 (column 1), period 10 (column 4) and the average per individual(group) from period 1 to 5 (column 2) and 6 to 10 (column 3). All test are Mann-Whitney non-parametric tests.

Periods		**1**	**1 to 5**	**5 to 10**	**10**
Average Mean Contribution	X-TREATMENT	14.60	12.68	8.83	7.04
	N-TREATMENT	15.39	16.37	13.42	8.42
	Difference	-0.79	-3.69	-4.59	-1.38
	$p-value$	(0.665)	(0.204)	(0.094)	(0.602)
Leaders' Mean Contribution	X-TREATMENT	17.83	16.38	10.95	11.08
	N-TREATMENT	16.42	18.28	16.07	15.75
	Difference	1.42	-1.9	-5.12	-4.67
	$p-value$	(0.747)	(0.603)	(0.248)	(0.211)
Followers' Mean Contribution	X-TREATMENT	13.53	11.45	7.53	5.69
	N-TREATMENT	15.06	15.73	12.54	5.97
	Difference	-1.53	-4.28	-5.01	-0.28
	$p-value$	(0.954)	(0.149)	(0.165)	(1.000)
Average Profit Leader	X-TREATMENT	41.37	38.98	35.82	33
	N-TREATMENT	44.37	44.45	40.77	31.08
	Difference	-3	-5.47	-4.96	1.92
	$p-value$	(0.506)	(0.126)	(0.248)	(0.325)
Average Profit Follower	X-TREATMENT	45.68	43.92	39.24	38.39
	N-TREATMENT	45.74	47.01	44.30	40.86
	Difference	-0.05	-3.09	-5.06	-2.47
	$p-value$	(0.665)	(0.419)	(0.119)	(0.452)

Table 9: Experienced Subjects: Tests on difference between treatments for period 1 (column 1). period 10 (column 4) and the average per individual(group) from period 1 to 5 (column 2) and 6 to 10 (column 3). All test are Mann-Whitney non-parametric tests.