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# After you—endogenous sequencing in voluntary contribution games

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**Abstract**

We examine contributions to a public good when some donors do not know the true value of the good. If donors in such an environment determine the sequence of moves, two contribution orders may arise as equilibria. Either the uninformed and informed donors contribute simultaneously or the informed contribute prior to the uninformed. Sequential moves result in a larger provision of the public good, because the follower mimics the action of the leader, and in accounting for this response the leader chooses to contribute when it is efficient to do so. An experimental investigation of the game shows that the donors predominantly choose to contribute sequentially, and that the resulting contributions are larger than those of the simultaneous-move game. Although the gain from sequential moves is smaller when the sequence is set exogenously, our results suggest that the involved parties would benefit from having sequential moves imposed upon them.


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## 1. Introduction

In honor of her 100th birthday, the New York Times published an article on the grand dame of American Philanthropy, Brook Astor. Characteristic of Ms. Astor's philanthropic endeavors is that she only gives money to projects that she has personally inspected and visited. Furthermore, it is often the case that after news about her donation, others tend to copy her contribution. "When she gave one donation to the New York Library, for example, three other major gifts—from Bill Blass, Dorothy and Lewis B. Cullman, and Sandra and Fred Rose—all followed, with her generosity cited as the inspiration".[1]

This and similar anecdotes suggest that charitable giving may take place in environments which differ from that described in the classical public-good model. In particular, the standard assumption that donors simultaneously contribute to a public good of a commonly known value does not generally hold. Often the value of the public good is not only uncertain, but donors differ in their degree of uncertainty.[2] Moreover, donors frequently deviate from a simultaneous-giving environment. While some donors wait to see what others give before making their own donations, others, like Brook Astor, take the lead and announce their contribution decisions to those who follow.[3]

The objective of this paper is to analyze a giving environment which relaxes these standard assumptions. Specifically we examine contributions to a public good when some donors are better informed than others about the quality of the public good, and the sequence of contributions is endogenously determined by the potential donors. Theoretically, the interaction between these two elements is very important. When a donor is better informed than others, then all donors are better off in equilibrium when the informed donor makes her contribution prior to those less informed. The reason is that the less informed donors will use the initial contribution to infer information about the public good's quality.[4] In some environments, it may be possible to precisely infer the quality, while in others the initial contribution only reveals a range of values for the quality of the public good.[5] We consider an example of the latter case where an initial contribution reveals that the expected value of contributing is positive. In such an environment,

[1] New York Times, March 30, 2002, p. A13.

[2] For example, one donor may have the skills to determine the quality while another does not, or one donor may have inside information which is prohibitively expensive for others to acquire. In Section 5, we discuss a case where followers choose not to become informed of the public goods' quality.

[3] For theoretical examinations of sequential provision of public goods, see for example Andreoni (1998), Bac and Bag (2003), Bag and Roy (2003), Marx and Matthews (2000), Romano and Yildirim (2001), and Vesterlund (2003). For empirical studies on sequential contributions, see Silverman et al. (1984) and List and Lucking-Reiley (2002).

[4] Some donors make the quality justification for giving specific. For example, when asked why he contributed more than $2 million to Children's Hospital of Pittsburgh Rick Hvizdak simply answered "I think this is the best charity" (Pittsburgh Post-Gazette, October 6, 2003).

[5] Independent of whether the initial contribution is fully revealing, the predicted equilibrium relies on the follower's ability to correctly interpret the leader's contribution, and the leader's ability to anticipate the follower's response. Thus the results from this study are suggestive of what we should expect to see when the initial contribution fully reveals the quality.

uninformed donors will mimic the decision of the informed donor, and anticipating this response a payoff-maximizing informed donor will contribute when it is efficient to do so.

Using experimental methods, we investigate whether the sequential-contribution structure will arise endogenously in actual play of the game, and whether it increases contributions as predicted. In our experimental design, there are two players. One player will, prior to contributing, be informed of the return from the public good; the other player learns only the prior distribution of the return. Before contributing and knowing only the distribution of the public good's return, the two players vote whether they want to make these contributions sequentially or simultaneously. In the former case, the contribution from the informed player is revealed before the uninformed player contributes, whereas in the simultaneous case it is not. There are two equilibria of this game. In one, the informed donor chooses to make the first contribution, while the uninformed donor waits to see this contribution prior to making her decision. In the other equilibrium, the players do not opt for the sequential structure, but instead contribute simultaneously. Thus, both simultaneous and sequential structures can emerge as equilibrium outcomes.

Huck et al. (2002) experimentally examines endogenous timing in a duopoly market with a similar structure. By giving players the option of moving early or late they allow quantity choices to be made either simultaneously (Cournot) or sequentially (Stackelberg). In their model, both Cournot and Stackelberg move structures can arise as equilibria, although only the Stackelberg equilibria are in undominated strategies. They find that in a majority of cases both players choose to move early and make their choices simultaneously. While the sequential-move equilibrium payoff dominates the simultaneous-move one in our study, the equilibria in the Huck et al. environment cannot be Pareto-ranked. Thus, sequential moves may be more likely to emerge in our experiment.

Our results indicate that in the majority of cases, the sequential-donation structure does indeed emerge. As predicted the resulting contributions and earnings in these endogenously generated sequential games are much larger than those found when subjects make donations simultaneously. When the informed player's donation is announced, we not only see that the uninformed player typically mimics her behavior, but also that the informed player correctly anticipates this response. The resulting outcome is therefore close to efficient.

While there are many situations where donors endogenously determine the sequence of contributions there are others where an outside party, such as a fundraiser, is the one who determines this sequence. One may wonder if donations are the same when the timing of contributions is determined endogenously by donors, or exogenously imposed by a third party. To answer this question, we compare observed play in the game with an endogenous-move structure to that in games where the move structure is set exogenously (by the experimenter). As the equilibrium of both the simultaneous- and the sequential-move subgame are unique, the game-theoretic prediction is that it should not make a difference whether the subgame is reached endogenously or exogenously. From a behavioral perspective, however, matters need not be so clear. The mere fact that the other player has chosen to enter a particular subgame may act as a pre-play signal about her intentions. If both players opt for sequential moves, this may reassure them that they both understand and appreciate the efficiency gains that can be obtained in this subgame. If the sequential-move structure is imposed upon the players they will have to do without such a signal.[6]

Our experimental results show that announcements increase contributions independent of how the sequence of moves is determined. Behavior in the exogenous sequential-move subgame is very similar to the behavior we observe when sequential moves arise endogenously. Contribution levels by both the informed and uninformed player are slightly larger in the latter case, but the differences are insignificant. In contrast, simultaneous contributions are significantly larger when the structure is set exogenously rather than endogenously. Thus, a failure to arrive at sequential moves is even worse than having a simultaneous-move structure imposed. Although the gain from sequential moves is smaller in the exogenous treatment, our results show that the involved parties would benefit from having a sequential ordering imposed upon them.

The remainder of the paper is organized as follows. In the next section, we provide a theoretical analysis of the equilibria that may arise when the sequence of moves is endogenously determined. In Section 3, we describe the experimental design we use to examine these games, and in Section 4 report the results. Section 5 concludes.

## 2. Theoretical analysis of the contribution game

We use a simple linear public-good environment with imperfect information to examine the sequence of moves and their effect on contributions. This model will serve as the basis for our experiments.

There are two risk-neutral players, Player 1 and Player 2, each with a unit endowment. Each player must decide whether to allocate her endowment to a private good ($x_i$=0) or a public good ($x_i$=1).[7] The payoff functions are:

$$\pi_i = 1 - x_i + m(x_1 + x_2), \quad i = 1, 2,$$

where $m$, the marginal per capita return from the public good, is drawn by Nature from a commonly known probability distribution. In this environment, a fully efficient outcome (in the sense of joint payoff maximization) requires that no player contributes if $m$<1/2, and both players contribute if $m$>1/2. We make two assumptions about the distribution of

[6] Interestingly, Huck et al. also compare observed behavior in the game with endogenous moves with behavior in games in which the move structure is set exogenously. They find that behavior is significantly affected by whether the move structure is exogenous or endogenous. For example, when the sequential structure emerges endogenously followers are more likely to punish exploitation by the leader than when this structure is set exogenously.

[7] There are a number of reasons why we focus on the two-player binary-choice setting and deviate from the standard public good experimental environment with multiple contributors and contribution levels. First, the literature on sequential giving tends to focus on a two-player environment (see e.g. Romano and Yildirim, 2001; Vesterlund, 2003). Second, the binary choice structure is consistent with the equilibrium predictions under linear payoffs where individuals either contribute all or nothing. Third and foremost, the simple structure is a tractable starting point for analysis of this sort, as failure to achieve the predicted equilibrium would suggest it unlikely that we observe equilibrium play in more complex settings.

$m$. First, we assume that $E[m]<1$. That is, on the basis of the prior distribution the expected value of $m$ is below unity, and contributing to the public good is privately suboptimal. Second, we assume that $E[m|m>1/2]>1$. Hence, if the return from the public good is known to exceed 1/2, then the expected return of the public good exceeds that from the private good, and it is privately optimal to contribute.

There are two stages of the game, a *voting stage* and a *contribution stage*. The sequence of events is as follows. First, both players participate in a *voting stage* where they decide whether Player 1's contribution will be announced ($A$=1) or not announced ($A$=0) to Player 2. Each participant must cast her vote $a_i$, where $a_i$=1 is a vote in favor of announcing Player 1's contribution, and $a_i$=0 is a vote opposing the announcement of the contribution. The outcome of the vote is determined by the rule: $A=a_1a_2$. If $A$=1 Player 1's contribution is announced. Thus sequential moves require unanimity: Player 1 must agree to go first, and Player 2 must agree to go second. At the end of the voting stage, the votes and the resulting sequence are revealed to both players.[8]

Second, the two players participate in a *contribution stage*. At the beginning of this stage Player 1, but not Player 2, is informed of the value of $m$. The remainder of the contribution stage progresses according to the outcome of the vote. If $A$=0, the two players make simultaneous contribution decisions, payoffs are then determined, and the game ends. If $A$=1, Player 1 first chooses her contribution $x_1$, Player 2 is then informed of Player 1's decision (but not of the true value of $m$), Player 2 chooses her contribution $x_2$, payoffs are then determined, and the game ends.

To determine the perfect Bayesian equilibria of this game, we first consider the two subgames after the outcome of the vote is known. When $A$=0 Player 2 must base her contribution decision on the prior distribution of $m$, and given that $E[m]<1$, Player 2's dominant strategy is not to contribute ($x_2$=0). Player 1 on the other hand can base her decision on the realized value of $m$, and maximizes her payoff by contributing when $m>1$ and not contributing when $m<1$. Relative to the efficient contribution levels, Player 2 under-contributes when $m>1/2$ and Player 1 under-contributes when $1/2<m<1$.

Now suppose $A$=1. In this case, Player 2 can make inferences about the value of $m$ from Player 1's contribution decision, and Player 1 will make her contribution decision in anticipation of these inferences. The unique perfect Bayesian equilibrium of the subgame is for Player 2 to mimic Player 1, i.e., $x_2=x_1$, and for Player 1 to choose $x_1$=1 if $m>1/2$ and to choose $x_1$=0 if $m<1/2$. In this equilibrium, no player contributes if $m<1/2$ and both players contribute if $m>1/2$. Thus a fully efficient outcome is attained for every value of $m$.[9] Whether Player 2 is informed about Player 1's contribution thus has an important effect on the total contribution level.

Given the equilibrium contribution profiles in each subgame, it is easy to see that there are two perfect Bayesian equilibria of the two-stage game. In one both players vote for Player 1's contribution decision to be revealed, $a_1=a_2=1$, and the resulting contribution

[8] Note that the equilibria of this game are identical to those that arise when contributors separately choose the period in which to contribute.

[9] The weaker condition that $\Pr\{m>1\}>0$ ensures that signaling will occur in equilibrium, and it leads to higher contributions (and joint payoffs) than in the case when Player 2 is not informed of Player 1's decision. Signaling will only induce a fully efficient outcome if $E[m|m>1/2]\geq 1$.

levels are those described for the sequential ($A$=1) subgame. In the other neither player votes to have Player 1's contribution decision revealed, $a_1$=$a_2$=0, and the resulting contribution levels are those described for the simultaneous ($A$=0) subgame.

Note that the sequential-move equilibrium Pareto dominates the simultaneous one, and that a player in the simultaneous equilibrium is indifferent towards her personal vote. That is, given that the other player is in favor of the simultaneous game, individual $i$ is indifferent between $a_i$=1 and $a_i$=0. For these reasons, one may suspect that the equilibrium with sequential moves is the more plausible outcome. From an empirical perspective, however, this is not so clear, as actual behavior in the two subgames may differ from that predicted. This possibility may be especially relevant to the sequential-move subgame where the issues underlying the contribution profile are subtle and cognitively demanding.[10] The equilibrium requires not only that subjects in the role of Player 2 make inferences from others' decisions and behave accordingly, but also that subjects in the role of Player 1 make their decisions in anticipation of these inferences.[11] Moreover, even if play progresses exactly as described by the equilibria of the subgames, the plausibility of the Pareto-dominant perfect Bayesian equilibrium relies upon subjects correctly anticipating the outcome of both subgames.

## 3. Experiment

Our experiment is based on the public-goods game described in the previous section, and consists of three different treatments. In one treatment, the sequential- or simultaneous-move structure is endogenously chosen through an initial vote by the participants. This treatment allows us to determine which game subjects chose, and whether contributions and earnings are affected by this choice. We refer to this as the *endog* treatment. To determine if contributions are sensitive to how the sequence of play is chosen, we also examine behavior in two treatments where the move structures (sequential versus simultaneous) are exogenously imposed by the experimenter. Specifically, in our *sim_exog* treatment Player 2 does not observe Player 1's contribution prior to making a decision, while in our *seq_exog* treatment she does.

We ran four sessions of each of the three treatments, with 12 subjects in each session, for a total of 144 subjects. Subjects were recruited from a pool of undergraduate students at the University of Nottingham, and randomly assigned to a treatment. No subject participated in more than one session of the experiment.

All sessions used an identical protocol. Upon arrival, subjects were randomly assigned a computer terminal and a role as informed or uninformed which they retained

[10] Earlier signaling experiments suggest that separating equilibria have less drawing power than pooling equilibria, especially when (perfect Bayesian) pooling and separating equilibria exist simultaneously (Cadsby et al., 1990, 1998, Cooper et al., 1997a,b). The case for separation is better when it is the unique equilibrium. Even in this case, however, it may take quite some time for play to develop towards separation (see Cooper et al., 1997b).

[11] This anticipation is necessary because Player 1's payoff depends on Player 2's decision. This dependence is one aspect of the model that distinguishes it from the signaling models of informational cascades. For an experimental examination of informational cascades see, for example, Anderson and Holt (1997).

throughout the session. The experimenter then read a set of written instructions aloud, which described completely this allocation of roles, the information and move structure, and payoffs of the game.[12] As part of the instructional phase, subjects completed a quiz on how to calculate the payoffs of the game. The experimenter checked that all subjects had completed the quiz correctly before continuing with the instructions. Subjects were allowed to ask questions by raising their hand and speaking to the experimenter in private. Subjects could not see other subjects' screens, nor were they allowed to communicate with one another throughout the session, except via the anonymous decisions they entered on their terminal.

The decision-making phase of the session consisted of 18 rounds. In each round each Player 1 was randomly and anonymously paired with a Player 2, with the stipulation that no one played another subject twice in a row, and that no pair of subjects would be matched more than three times.[13] Subjects' identities were never revealed to anyone.

Each round of the exogenous treatments consisted of a *contribution stage*, whereas each round of the endogenous treatment was introduced by a *voting stage* and then followed by a contribution stage. In the voting stage, the two participants were asked whether Player 1's contribution should be shown to Player 2. Unanimity was required for this to be the outcome. At the end of the voting stage, both subjects were informed of the individual votes as well as the outcome of the vote.[14]

In the *contribution stage* of all three treatments, the subjects were given the choice between two actions: A or B. Choosing A gave the individual a certain private return of 40 pence. By choosing B, both players received a return of 0, 30, or 60 pence. In terms of the model in Section 2, choosing A corresponds to not contributing ($x_i$=0) and B corresponds to contributing ($x_i$=1). The return from A of 40 pence corresponds to one payoff unit, and the return from B corresponds to either $m$=0, 0.75 or 1.5 payoff units.

At the beginning of each contribution stage, Player 1s were informed of the return from B and were prompted to chose A or B. When all Player 1s had chosen, Player 2s were either informed (sequential) or not informed (simultaneous) of 1's choice of A or B. Player 2 then made a choice between A and B.[15] At the end of each round, subjects were informed of choices and payoffs in their game, as well as the actual return from B, and they recorded these on a record sheet.

At the end of round 18, subjects were paid their earnings from all 18 rounds in private. All sessions lasted less than an hour and subjects earned an average of £11.37 (with a minimum of £6.90 and a maximum of £14.20).[16]

Assuming that all subjects aim to maximize own earnings and that this is common knowledge leads to the following predictions. In the *seq_exog* treatment, both players

[12] A copy of the instructions for the experiment can be found at http://www.pitt.edu/~vester/.

[13] The matching scheme was randomly generated prior to the experiment and used in all sessions.

[14] If only the outcome of the vote is revealed, then a subject who votes against the sequential-move structure cannot infer the other subject's vote.

[15] Note that all sessions have sequential moves in the sense of priority in time. In fact, in the instructions we refer to Player 1s as "first-movers" and Player 2s as "second-movers".

[16] Average hourly earnings in the experiment are about three times the amount earned in a typical student job. At the time of the experiment 1£ exchanged for $1.45.

Table 1
Predictions (per round)

| | $x_1$ | $x_2$ | $x_1+x_2$ | Expected $\pi_1$ (£) | Expected $\pi_2$ (£) |
|---|---|---|---|---|---|
| Sequential | 0.685 | 0.685 | 1.370 | 0.731 | 0.731 |
| Simultaneous | 0.324 | 0 | 0.324 | 0.465 | 0.594 |

choose A when $m$=0, and both choose B when $m$=0.75 or 1.5. In the *sim_exog* treatment, the uninformed Player 2 always choose A, and the informed Player 1 choose B when $m$=1.5, and A otherwise. In the *endog* treatment, there are two equilibria. In one both players vote for Player 1's contribution to be revealed, and the resulting contributions are identical to those of the *seq_exog* treatment. In the second equilibrium, both players vote not to have Player 1's decision revealed and the subsequent contributions are identical to those of the *sim_exog* treatment.

For each session of the experiment, a total of 108 joint decisions were made (6 pairs×18 rounds). The corresponding sequence of 108 values of $m$ was randomly drawn prior to the experiment, with $m$=0 being observed 34 times, $m$=0.75 a total of 39 times, and $m$=1.5 a total of 35 times. This same sequence provided the values of the return from B for all sessions. From this sequence, it is easy to determine the expected earnings and contributions per round in each treatment of the experiment. Table 1 summarizes these predictions.

Thus predicted contributions and earnings are higher for both Player 1 and Player 2 when contributions are made sequentially.

## 4. Results

In our analysis of the data, we provide answers to the questions posed in Section 2. First, we focus exclusively on the endogenous treatment to determine which sequence of moves the players vote for, and whether sequential play of the game increases contributions and earnings. Second, we compare the results from the exogenous treatments to examine if the method used to determine the sequence of moves affects play in the two subgames and thus the potential gain from announcements. For all statistical tests, we use session averages as our unit of observation. Average contributions and earnings for each treatment are reported in Appendix A.

### 4.1. Do contributors endogenously choose a sequential order?

Individual votes in the endogenous treatment reveal that the vast majority of subjects prefer that the informed player's contribution be announced.[17] Over the course of the four sessions, a total of 432 player pairs decided on the move sequence, and of these, 81%

[17] As described in Section 3, the voting stage occurs prior to Player 1 learning the actual return from the public good.

resulted in a sequential ordering. This percentage is very stable across rounds and suggests that despite being cognitively demanding many subjects recognize from the beginning of the experiment that the sequential-move equilibrium is preferable.[18]

As the incentives for sequential play are substantial in our game, it is perhaps surprising that one fifth of all pairs moved simultaneously. Although simultaneous play may be an equilibrium outcome this requires unanimous agreement: a vote for simultaneous moves is only an equilibrium strategy when the other player also votes for simultaneous moves. The simultaneous plays observed in our game, however, always resulted from the subjects disagreeing on the sequence of moves. Typically the uninformed wanted to observe the informed player's choice, while the informed player was reluctant to have him do so. Of all votes cast by the informed, 82% were in favor of revealing their decision, whereas 99% of the uninformed votes were in favor of observing her choice. With the uninformed consistently voting for sequential moves the informed's desire to conceal her choice is not an empirical best response.

One reason why the uninformed is more likely to play best response may be that subjects are more familiar with situations where they benefit from concealing their actions while observing those of others. Perhaps "Yes" is a more natural response to the question "Do you want to be informed of the first-mover's choice?" than to the question "Do you want the second-mover to be informed of your choice?" Instinctively second movers may view it as unlikely that additional information can be harmful, while first movers may fear that information on their actions can be used against them.

The data reveal a couple of patterns which may explain why some informed players were reluctant to reveal their choice while others were not. Let us define a *simultaneous-voter* as an informed player who voted for simultaneous moves at some point during the last half of the experiment (last nine rounds), and a *sequential-voter* as an informed player who always voted for sequential moves during the second half of the experiment.[19] Using this definition, there are a total of 11 simultaneous-voters and 13 sequential-voters. Looking at their experience with sequential moves in the first half of the experiment we find that the latter group had their own contribution followed by a contribution by the uninformed at a rate of 87%, whereas this is 79% for the first group. Thus simultaneous-voters gained less from moving sequentially and experienced more unequal payoffs when doing so. This slightly worse experience in the first part of the experiment may have discouraged some informed players to vote for sequential moves later (even though sequential moves still were the payoff maximizing option).

The players' contribution decision further reveals differences between the two classes of informed voters. The contribution decisions of the sequential-voters are practically identical to the equilibrium prediction. When moves are sequential these players never

[18] This finding is in sharp contrast to the lack of sequential play observed by Huck et al. (2002). However, one should use caution when comparing the two studies, as the examined games are quite different. In particular, while there is only one sequential-move equilibrium of our game, there are two sequential equilibria of the game examined by Huck et al.; one being the mirror image of the other. Moreover, in our game the sequential equilibrium leads to symmetric payoffs, whereas the payoffs of their sequential-move equilibria are asymmetric, with the leader earning more than the follower. Thus the players in their game face a serious coordination problem, and the theoretical case for sequential moves may be considered stronger in our case.

[19] Only one informed player voted for simultaneous moves in the first half of the experiment and never again.

contribute when $m$=0, always contribute when $m$=1.5, and contribute 91% of the time when $m$=0.75. The decisions of simultaneous-voters differ from the prediction in two respects. First, in sequential-move subgames these players contribute only 59% of the time when $m$=0.75, and, second, in simultaneous-move subgames they contribute only 69% of the time when $m$=1.5.

Focusing on the individual choices, there appears to be three categories of simultaneous-voters. Of the 11 simultaneous-voters, three behave exactly as predicted: in the sequential games they only contribute when $m$=0.75 or 1.5, and in simultaneous games they only contribute when $m$=1.5. Another category of five players follow a strategy, independent of the sequence of play, whereby they only contribute when $m$=1.5. Finally, the remaining three simultaneous-voters appear to follow the equilibrium strategy when their contribution is announced, but they never contribute when it is not announced. Interestingly, the frequency by which the simultaneous-voters preferred simultaneous moves is independent of their category. Over the last nine rounds each category of simultaneous-voters on average voted for simultaneous moves three times. Thus, while it is difficult to determine why given their strategies these players would vote for simultaneous moves it is important to keep in mind that they were more likely to favor sequential moves. In the next section, we analyze in more detail the resulting contribution profiles in the sequential and simultaneous games.

### *4.2. Do announcements increase contributions?*

The equilibrium prediction is that announcements increase contributions of both the informed and the uninformed player. The evidence from the endogenous treatment strongly supports this prediction. As shown in Fig. 1, individual contributions more than double when the informed player's contribution is announced. This increase is significant whether we focus on the entire experiment or the first nine or last nine rounds. In each of the four sessions announcements increase total as well as individual contributions. Using a Wilcoxon matched-pairs signed-ranks test, we therefore reject the null hypothesis that announcements weakly decrease contributions (the probability of observing announcements increase contributions in all four sessions is 0.0625 under the null hypothesis).

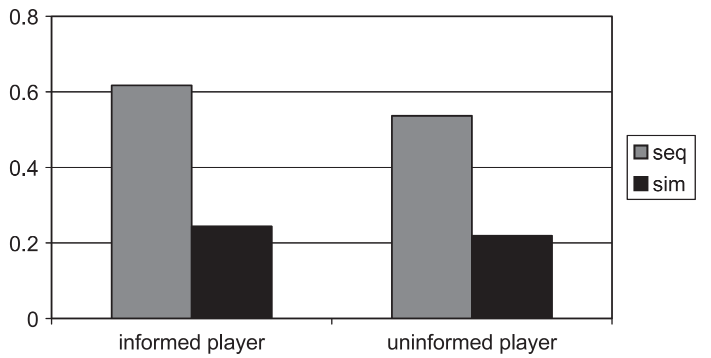


Fig. 1. Average contribution per round (endogenous).

In the simultaneous subgame, the uninformed player cannot condition on the informed player's contribution, and the contribution rate of both the informed and uninformed is less than 25%. The conditioning ability in the sequential game causes both contribution rates to increase. First, our results show that with announcements the uninformed player is very likely to mimic the decision of the informed player. Second, the informed player appears to correctly anticipate this response. When a contribution by the informed player is announced, 85% of the uninformed mimic her behavior. This contribution rate drops to 4% when the informed does not contribute. Hence, in the sequential subgame a contribution by the informed increases the contribution rate of uninformed players by 81 percentage points. Although this increase is smaller than that predicted in equilibrium (100%), it is sufficient to make contributions at $m$=0.75 the payoff-maximizing strategy for the informed player. It is easy to verify that a rational informed player should contribute at $m$=0.75 if she believes that doing so will increase the probability that the uninformed contributes by at least 33 percentage points. The behavior of the informed players suggests that the vast majority of them correctly anticipate the uninformed response.

Fig. 2 illustrates the informed players' frequency of contribution conditional on $m$ in the endogenously chosen sequential versus simultaneous game. In the absence of announcements, only 7% of informed players contribute when $m$=0.75, whereas 80% contribute when the informed's contribution is announced. This suggests that the informed player correctly anticipates the mimicking by the uninformed and therefore recognizes that contributing at $m$=0.75 is a payoff-maximizing choice. With announcements, the informed never contributes when $m$=0 and always contributes when $m$=1.5, thus her behavior is very similar to that of the equilibrium prediction.

It is remarkable that in the simultaneous subgame only 69% of the informed players choose to contribute when it will increase their payoff to do so ($m$=1.5). It is unlikely that this is due to confusion. The zero contribution rate when $m$=0 suggests that the informed players understand the incentives in this subgame quite well. A possible explanation is that this is a selection effect. As shown in Section 4.1, informed players who vote for simultaneous moves usually had a slightly worse experience in the sequential subgame. This may have lowered their willingness to contribute in the simultaneous subgame, especially since a contribution when $m$=1.5 helps the other player more than it helps themselves.

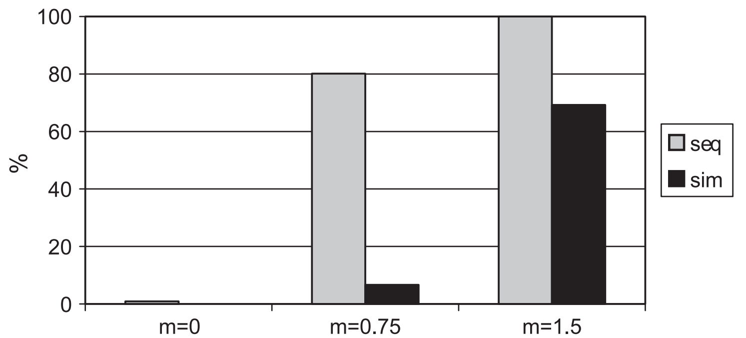


Fig. 2. Frequency of contributions by informed player (endogenous).

Table 2
Average earnings (£) per subject per round

| | | Informed players | Uninformed players |
|---|---|---|---|
| Seq | Predicted | 0.731 | 0.731 |
| | Endog observed | 0.674 | 0.706 |
| Sim | Predicted | 0.465 | 0.594 |
| | Endog observed | 0.529 | 0.539 |

The increase in contributions caused by announcements increases individual as well as total earnings by approximately 30%. Table 2 summarizes the actual and predicted earnings and shows that the earnings opportunities in the sequential game are close to fully exploited. Observed earnings are 94% of the predicted (efficient) level when a sequential structure is chosen. The shortfall from the efficient level is primarily caused by the uninformed mover occasionally failing to mimic the informed player's contribution. As shown in the table, this hurts the informed player more than it hurts the uninformed.

Earnings in the simultaneous subgames also differ slightly from the prediction. Here informed-player earnings are larger than predicted, while those of the uninformed player are smaller than predicted. One reason for lower uninformed earnings is that these players contribute about one fifth of the time in the simultaneous treatment, with one third of these contributions being made when $m=0$, i.e., when the public good is worthless. Each such worthless contribution constitutes a loss of 40 pence for second movers, but has no impact on first-mover earnings. While a 30% difference in earnings was predicted between the informed and uninformed participants of the simultaneous game, the observed earnings differ by less than 2%.

Though joint payoffs are slightly higher than predicted when no announcements are made and lower than predicted when an announcement is made, our results are still consistent with the comparative static prediction that both players enjoy higher earnings when the informed player's decision is announced. Comparing average earnings of the pairs that choose announcements to those that do not, we find that announcements increase total as well as individual earnings in each of the four sessions. Thus we can reject the null hypothesis that announcements weakly decrease earnings.[20] The reason for this success is that the second movers mimic the announced decision of the first mover, and that the first mover correctly anticipates this response.[21]

[20] This result holds whether we examine all rounds or the last nine or first nine rounds. The only exception is for the informed-players' earnings during the first nine rounds. In this case, one session resulted in a marginal decrease in earnings, thus we cannot reject the null as the $p$-value is 0.3125. For the remaining eight tests, the $p$-value is 0.0625.

[21] Another reason why the second mover chooses to mimic the decision of the first mover may be a desire to reciprocate the kindness of the first mover. Potters et al. (2001) investigate both the reciprocity and signaling hypothesis and show that reciprocity is unlikely to be the reason announcements increase contributions. The reason is that announcements have little effect on contributions when the quality of the public good is common knowledge. Other experimental studies that find somewhat stronger evidence for reciprocity in sequential contribution games are Moxnes and van der Heijden (2003) and Meidinger et al. (2002). As shown by Kumru and Vesterlund (2003) a concern for status cause second movers to mimic the actions of first movers.

### 4.3. How do contributions with endogenous choice compare to exogenous choice?

In some circumstances, the potential donors do not determine the order of contributions, rather an outside party, such as a fundraiser, may be the one choosing the sequence of moves. Vesterlund (2003) examines the fundraiser's choice between sequential and simultaneous moves in a more general framework and shows that a fundraiser will prefer to announce initial contributions. In this section, we examine if the behavior in the two subgames and the gain from announcements is robust to an outside party setting the order of contributions.

Both the sequential and simultaneous subgames have unique equilibria. Thus, standard theory predicts that behavior in each of the subgames should be independent of how the subgame is reached. Whether this, in fact, will be the case is less clear. A unanimous agreement to voluntarily move in sequence may act as a pre-play signal, and it may reassure the players that the gains from moving sequentially are well understood, and that both will behave in a manner that helps capture these gains. Conversely, the failure to reach a unanimous vote for sequential play may raise concerns about the rationality or objective of the opponent, and it may affect behavior in a way that would not be possible if the move structure was set exogenously.

Comparing contributions of the *seq_exog* treatment to that of *sim_exog*, Fig. 3 shows that qualitatively the effect of announcements is the same whether the sequence is chosen exogenously or endogenously: announcements increase contributions of both players. Treating each session as the unit of observation we reject the null hypotheses that announcements weakly decrease individual or total contributions (see Table A.3, Appendix A for details).

The quantitative effect of announcements is sensitive to whether the move sequence is exogenously or endogenously chosen. While announcements more than double contributions in the endogenous treatment, we now see that they result in an increase of around 50%. The average contribution gain from announcement in the exogenous treatment is smaller than any of the gains observed in the four endogenous sessions. A binomial test rejects the null that the gain in the endogenous treatments is no greater than the average gain in the exogenous treatment ($p$=0.0625). The reason for the smaller gain

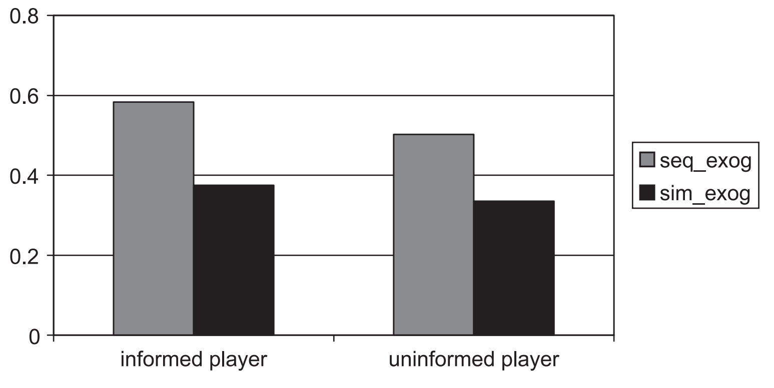


Fig. 3. Average contribution per round (exogenous).

from announcements is twofold. In the exogenous treatments, the simultaneous contributions are larger and the sequential contributions are smaller than in the endogenous treatment. Only the difference in simultaneous contributions is significant (see Table A.3).

To understand the difference in more detail, we compare the endogenous and exogenous treatments for both the uninformed and the informed player and for both simultaneous and sequential moves.

First we examine the behavior of the uninformed player. Similar to the endogenous case we find that when announcements are made the uninformed player is very likely to mimic the decision of the informed: in the exogenous treatment 80.6% of second movers mimic the first mover's decision to contribute, and 92.2% mimic the decision not to contribute. Thus, a contribution by the first mover increases the contribution rate of second movers by 72.8 percentage points. As shown earlier, the corresponding change in the contribution rate is 81 percentage points in the endogenous treatment. We are unable to reject that the uninformed's behavior in the sequential game is independent of the method used to determine the sequence.[22] The uninformed's behavior is, however, affected when moves are simultaneous. Compared to an uninformed contribution rate of 22% in the endogenous treatment, the contribution rate in the exogenous treatment is 33%. This difference is significant at $p$=0.03 (see Table A.3). A possible explanation for this difference is that, relative to the case where simultaneous moves are imposed, the uninformed is less concerned for the payoff of the informed player when the latter fails to vote for the mutually beneficial sequential-move structure.

Next we determine if the informed's contribution is sensitive to exogenous determination of the move sequence. Fig. 4 illustrates the informed players' frequency of contribution in the two exogenous treatments conditional on the value of $m$. This figure can be compared to Fig. 2 for the endogenous treatment. Qualitatively, the two figures are very similar. The main effect of sequential moves is the sharp increase in contributions when $m$=0.75. There are, however, some differences between the two treatments. With sequential moves contributions are slightly lower in the exogenous treatments: the informed contributes at a rate of 75% when $m$=0.75, as compared to 80% in the endogenous treatment, and when $m$=1.5 the contribution rate is 95% rather than the 100% observed in the endogenous treatment. In the exogenous-simultaneous treatment, contributions are significantly higher than in the endogenous treatment ($p$=0.014 see Table A.3): when $m$=0.75 the informed players contribute at a rate of 15% rather than the 7% observed in the endogenous treatment, and when $m$=1.5 the contribution rate is 98% as compared to 69% in the endogenous treatment.[23]

Overall the results reveal that the method by which the move structure is determined matters. If the players enter the sequential subgame by vote, they contribute slightly more than with an exogenous-move structure, and when the simultaneous subgame is reached

[22] Finding no difference in behavior here does not imply that average contribution levels of the uninformed are independent of the method, since these levels also depend on the behavior of the informed.

[23] There are several possible reasons why contributions are lower in the endogenous-simultaneous game. First, there may be a selection effect. Second, the initial vote may serve as a pre-play signal of participants' understanding of the game. Finally, the fact that people in the endogenous-simultaneous disagreed on whether they should move simultaneously or in sequence may be another explanation.

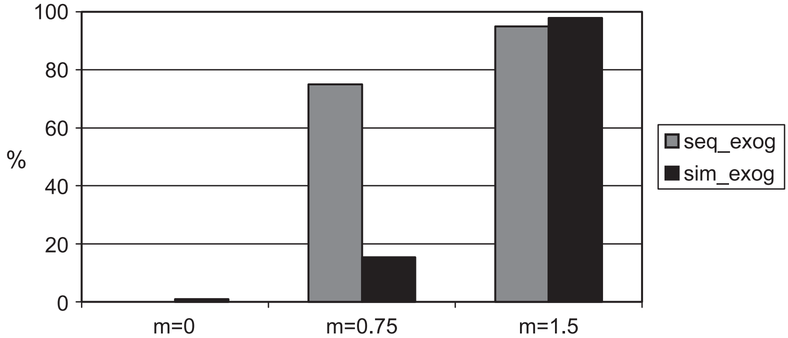


Fig. 4. Frequency of contributions by informed player (exogenous).

endogenously, they contribute less than with an exogenously set move structure.[24] Looking at the aggregate contribution levels only the latter effect is statistically significant. Thus failure to enter the more profitable sequential-move subgame results in a particularly bad outcome.

Viewed from a more applied perspective, the results suggest that it would not hurt if a third party were to impose the sequential structure upon the players. Contributions and efficiency are higher in the exogenous-sequential treatment than in the endogenous treatment (aggregating over sequential and simultaneous subgames). While there is some loss in contributions compared to the case in which the players choose the sequential structure themselves. This loss is more than compensated by preventing the players from moving simultaneously. Hence, if an outside party, such as a fundraiser, is interested in maximizing the level of contributions, it would do best by making the informed donors move first and announcing their contributions to the uninformed. Imposing such a structure does not destroy the beneficial signaling opportunities and may occasionally prevent donors from missing them.

## 5. Conclusion

There are many public-good environments where individuals make their decisions sequentially. In some cases, the sequential structure is imposed from the outside and in others the individuals themselves choose to move in this manner. As shown in the introduction, there are donors such as Brook Astor who are willing to make an initial contribution to a charity, while others prefer to observe the donations of others prior to contributing. When there is uncertainty about the quality of a public good and some donors are better informed

[24] As can be seen in Appendix A, the differences in contributions naturally result in similar differences in earnings. With sequential moves, the players do worse in the exogenous than in the endogenous treatment. With simultaneous moves they do better when the move structure is imposed upon them. The differences are small in size though and not statistically significant.

than others, then it is in everyone's interest that the informed donor makes the first contribution. The reason is that the uninformed followers will use the initial contribution to infer the return from the public good. In the example, we consider an initial contribution provides the follower with an incentive to mimic the behavior of the leader, and in anticipation of this response the leader will choose to give when it is efficient to do so. This incentive to mimic the behavior of an informed leader is present in many environments. For example, Hermalin (1998) shows that members of a team will exert high effort when a well-informed leader first sets an example by exerting high effort.[25]

Our paper not only studies whether an informed leader can use her contribution to convince others of the quality of the public good, but also whether the sequential ordering may arise endogenously. Our experimental study shows that the vast majority of subjects prefer that the contribution of the informed donor be revealed to the uninformed. As predicted the resulting contributions and earnings in these endogenously generated sequential games are much larger than those found when subjects make donations simultaneously. When the informed player's donation is announced, we not only see that the uninformed player mimics her behavior, but also that the informed player correctly anticipates this response.

Given previous experimental evidence on signaling, it is a strong result that subjects from the very beginning of the experiment choose this cognitively demanding equilibrium. One reason may be that the equilibrium is efficient and results in equal payoffs to the players, and thus there is no conflict between own-payoff maximization, efficiency, or equity.[26] It will be of interest to examine similar asymmetric contribution games to determine precisely what role these characteristics play.

An interesting extension which naturally introduces a payoff asymmetry between the two players is to endogenize the information-acquisition decision. If donors are free to purchase information prior to making their donation and the cost of information is neither too high nor too low, then the equilibrium of the sequential game is one where only the first mover acquires information. As the follower may mimic the leader's behavior, the incentive to purchase information is larger for the leader than for the follower. Therefore, if information is not too costly the leader will determine the value of the public good. If at the same time the information is sufficiently costly, the follower will prefer to rely on the information contained in the example set by the leader rather than to purchase it herself. This suggests that there are environments where individuals endogenously choose to remain uninformed. Since partial information is preferred to both full and no information, this may be yet another reason why a sequential-contribution ordering arises endogenously.[27]

The primary purpose of the paper is to illustrate that when there is uncertainty about the quality of a public good, and some donors are better informed, then sequential moves enable donors to credibly share information. This causes contributions as well as

[25] Hermalin (1998) shows that transfer payments to the uninformed team workers is another way of credibly conveying the leader's information.

[26] The importance of equity and efficiency is made clear in the literature on fairness. See Camerer (2003) for an excellent review of this literature.

[27] See Vesterlund (2003) for an examination of the information-acquisition decision.

individual payoffs to increase, and as a result donors prefer that the informed contributor gives first. We rely on a simple example to illustrate this structure, but these will also be the characteristics of more complex models. For example, the structure of the equilibrium is the same when the initial contribution not only reveals that the public good is valuable but also its precise value. The results can also be extended to account for uncertainty about how informed the first mover is. The reason is that such uncertainty will only increase the number of first contributor types, to include both whether an individual is told that the charity is of high or low quality, and whether she is certain or uncertain of this information. Of course with multiple initial-contributor types it is more difficult for each type to choose a contribution that fully separates him from the others; however, as long as there exists a semi-separating equilibrium where the initial contribution allows future donors to improve their evaluation, then sequential moves are still preferred. Similarly it is not a problem to extend the model to account for donors receiving different benefits from the public good, as long as these benefits are positively correlated. Finally, one may want to consider the effects of having many rather than only two donors. While it is straightforward to increase the number of followers, a coordination problem may arise when there are many leaders. The reason is that each leader prefers that others make the initial contribution to convince subsequent donors of the quality. This may be the reason why the number of leaders typically is very small or limited to just one.[28] Overall the basic results of our model appear quite robust.

While the main focus in this paper is on the endogenous determination of contribution orderings, we also compare this case to those in which the ordering, simultaneous or sequential, is set exogenously. This comparison is of relevance to an interested third party, such as a fundraiser, who considers announcing the initial contribution to those who follow. Our results suggest that a contribution maximizing third party also will choose a sequential contribution ordering. Interestingly the gain from announcements is sensitive to whether the contributors themselves choose the sequence of play or if an outside party serves as the mechanism designer. The gain from announcements is smaller when the sequence of play is determined by an outside party. This result not only sheds light on how the choice of the mechanism designer may affect contributions to the public good, it also provides a caveat in terms of experimental methodology. The approach typically used when comparing different institutions or games is to investigate each as a separate treatment and then compare the two. The evidence from our experiment suggests that if we are ultimately interested in examining endogenous choice of institutions or rules of the game, then this standard exogenous approach may be misleading. By allowing the rules of the game to be endogenously determined, we are not only able to examine which game is likely to be chosen, but conditional on this choice we also achieve an appropriate representation of the behavior that results when the institution is endogenously determined.

[28] When information is acquired, the fundraiser's optimal solicitation strategy is one where the wealthiest donor is asked to give first (Vesterlund, 2003). This suggests that it is unlikely that there are many lead contributors when donors are heterogeneous.

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## Appendix A.

Table A.1
Average contribution per round

| | | $x_1$ | $x_2$ | $x_1$+$x_2$ |
|---|---|---|---|---|
| All rounds | seq_exog | 0.5833 | 0.5023 | 1.0856 |
| | sim_exog | 0.3750 | 0.3356 | 0.7106 |
| | seq_endo | 0.6171 | 0.5371 | 1.1543 |
| | sim_endo | 0.2439 | 0.2195 | 0.4634 |
| First nine rounds | seq_exog | 0.5787 | 0.4907 | 1.0694 |
| | sim_exog | 0.4213 | 0.3704 | 0.7917 |
| | seq_endo | 0.6082 | 0.5380 | 1.1462 |
| | sim_endo | 0.2444 | 0.3111 | 0.5556 |
| Last nine rounds | seq_exog | 0.5880 | 0.5139 | 1.1019 |
| | sim_exog | 0.3272 | 0.3041 | 0.6313 |
| | seq_endo | 0.6257 | 0.5363 | 1.1620 |
| | sim_endo | 0.2432 | 0.1081 | 0.3514 |

Table A.2
Average earnings (£) per round

| | | Earnings for 1 | Earnings for 2 | Total earnings |
|---|---|---|---|---|
| All rounds | seq_exog | 0.6507 | 0.6831 | 1.3338 |
| | sim_exog | 0.5597 | 0.5755 | 1.1352 |
| | seq_endo | 0.6743 | 0.7063 | 1.3806 |
| | sim_endo | 0.5293 | 0.5390 | 1.0683 |
| First nine rounds | seq_exog | 0.6644 | 0.6995 | 1.3639 |
| | sim_exog | 0.5829 | 0.6032 | 1.1861 |
| | seq_endo | 0.6971 | 0.7251 | 1.4222 |
| | sim_endo | 0.5689 | 0.5422 | 1.1111 |
| Last nine rounds | seq_exog | 0.6370 | 0.6667 | 1.3037 |
| | sim_exog | 0.5366 | 0.5477 | 1.0843 |
| | seq_endo | 0.6525 | 0.6883 | 1.3408 |
| | sim_endo | 0.4811 | 0.5351 | 1.0162 |

Table A.3
Treatment effects on contributions: $p$-values for test that seq_endog≤sim_endog, seq_endog≤seq_exog, sim_exog≤sim_endog, sim_exog≥seq_exog (Wilcoxon matched-pairs signed-ranks test for the first hypothesis, Mann–Whitney $U$-test for the other three hypotheses; all tests take sessions as the unit of observation)

(A) First contribution

| | sim_endog | seq_exog |
|---|---|---|
| *All rounds* | | |
| seq_endog | 0.0625 | 0.2429 |
| sim_exog | 0.0143 | 0.0143 |
| *First nine rounds* | | |
| seq_endog | 0.0625 | 0.4429 |
| sim_exog | 0.0143 | 0.0143 |
| *Last nine rounds* | | |
| seq_endog | 0.0625 | 0.2429 |
| sim_exog | 0.3429 | 0.0143 |

(B) Second contribution

| | sim_endog | seq_exog |
|---|---|---|
| *All rounds* | | |
| seq_endog | 0.0625 | 0.3429 |
| sim_exog | 0.0286 | 0.0286 |
| *First nine rounds* | | |
| seq_endog | 0.0625 | 0.4429 |
| sim_exog | 0.1000 | 0.0571 |
| *Last nine rounds* | | |
| seq_endog | 0.0625 | 0.4429 |
| sim_exog | 0.1000 | 0.0143 |

(C) Total contribution

| | sim_endog | seq_exog |
|---|---|---|
| *All rounds* | | |
| seq_endog | 0.0625 | 0.4429 |
| sim_exog | 0.0143 | 0.0143 |
| *First nine rounds* | | |
| seq_endog | 0.0625 | 0.2429 |
| sim_exog | 0.0143 | 0.0143 |
| *Last nine rounds* | | |
| seq_endog | 0.0625 | 0.3429 |
| sim_exog | 0.1714 | 0.0143 |

Table A.4
Treatment effects on average earnings per round: $p$-values for test that seq_endog≤sim_endog, seq_endog≤seq_exog, sim_exog≤sim_endog, sim_exog≥seq_exog (Wilcoxon matched-pairs signed-ranks test for the first hypothesis, Mann–Whitney $U$-test for the other three hypotheses; all tests take sessions as the unit of observation)

(A) Mover 1's earnings

| | sim_endog | seq_exog |
|---|---|---|
| *All rounds* | | |
| seq_endog | 0.0625 | 0.1714 |
| sim_exog | 0.3429 | 0.0143 |
| *First nine rounds* | | |
| seq_endog | 0.3125 | 0.2429 |
| sim_exog | 0.1714 | 0.0143 |
| *Last nine rounds* | | |
| seq_endog | 0.0625 | 0.3429 |
| sim_exog | 0.1714 | 0.0143 |

(B) Mover 2's earnings

| | sim_endog | seq_exog |
|---|---|---|
| *All rounds* | | |
| seq_endog | 0.0625 | 0.2429 |
| sim_exog | 0.2429 | 0.0143 |
| *First nine rounds* | | |
| seq_endog | 0.0625 | 0.3429 |
| sim_exog | 0.0286 | 0.0143 |
| *Last nine rounds* | | |
| seq_endog | 0.0625 | 0.0143 |
| sim_exog | 0.5571 | 0.0143 |

(C) Total earnings

| | sim_endog | seq_exog |
|---|---|---|
| *All rounds* | | |
| seq_endog | 0.0625 | 0.1714 |
| sim_exog | 0.2429 | 0.0143 |
| *First nine rounds* | | |
| seq_endog | 0.0625 | 0.1714 |
| sim_exog | 0.1714 | 0.0143 |
| *Last nine rounds* | | |
| seq_endog | 0.0625 | 0.1714 |
| sim_exog | 0.1714 | 0.0143 |

## References


Anderson, Lisa R., Holt, Charles A., 1997. Information cascades in the laboratory. American Economic Review 87 (5), 847–862.

Andreoni, James, 1998. Toward a theory of charitable fundraising. Journal of Political Economy, 1186–1213.

Bac, Mehmet, Bag, Parimal K., 2003. Strategic information revelation in fundraising campaigns. Journal of Public Economics 87, 659–679.

Bag, Parimal K., Roy, Santanu, "Fundraising under Incomplete Information", 2003, working paper.

Cadsby, Charles B., Frank, Murray, Maksimovic, Vojislav, 1990. Pooling, separating, and semiseparating in financial markets. Review of Financial Studies 3 (3), 315–342.

Cadsby, Charles B., Frank, Murray, Maksimovic, Vojislav, 1998. Equilibrium dominance in experimental financial markets. Review of Financial Studies, 189–232.

Camerer, Colin, Behavioral Game Theory: Experiments in Strategic Interaction, Russell Sage Foundation and Princeton Univ. Press, Princeton, 2003.

Cooper, David J., Garvin, Susan, Kagel, John H., 1997a. Adaptive learning vs. equilibrium refinements in an entry limit pricing game. Economic Journal 107, 553–575.

Cooper, David J., Garvin, Susan, Kagel, John H., 1997b. Signaling and adaptive learning in an entry limit pricing game. Rand Journal of Economics 28 (4), 662–683.

Hermalin, Benjamin, 1998. Toward an economic theory of leadership: leading by example. American Economic Review 88, 1188–1206.

Huck, Steffen, Müller, Wieland, Normann, Hans-Theo, 2002. To commit or not to commit: endogenous timing in experimental duopoly markets. Games and Economic Behavior 38, 240–264.

Kumru, Cagri, and Vesterlund, Lise, The Effects of Status on Charitable Giving, 2003, working paper.

List, J., Lucking-Reiley, D., 2002. The effects of seed money and refunds on charitable giving: experimental evidence from a university capital campaign. Journal of Political Economy 110 (1), 215–233.

Marx, Leslie, Matthews, Steven, 2000. Dynamic voluntary contribution to a public project. Review of Economic Studies 67, 327–358.

Meidinger, Claude, Sinclair-Desgagne, Bernard, Villeval, Marie-Claire, "Leadership in Teams: Signaling or Reciprocating", 2002, unpublished manuscript.

Moxnes, Erling, van der Heijden, Eline, 2003. The effect of leadership in a public bad experiment. The Journal of Conflict Resolution 47 (6), 773–795.

Potters, Jan, Sefton, Martin, and Vesterlund, Lise, "Why Announce Leadership Contributions? An Experimental Study of the Signaling and Reciprocity Hypotheses", 2001, working paper.

Romano, Richard, Yildirim, Huseyin, 2001. Why charities announce donations: a positive perspective. Journal of Public Economics 81, 423–424.

Silverman, Wendy K., Robertson, Steven J., Middlebrook, Jimmy L., Drabman, Ronald S., 1984. An investigation of pledging behavior to a national charitable telethon. Behavior Therapy 15, 304–311.

Vesterlund, Lise, 2003. Informational value of sequential fundraising. Journal of Public Economics 87, 627–657.