Seeds to Succeed?

Sequential Giving to Public Projects[1]

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Abstract

The public phase of a capital campaign is typically launched with the announcement of a large seed donation. Andreoni (1998) argues that such a fundraising strategy may be particularly effective when funds are being raised for projects that have fixed costs of production. The reason is that the introduction of fixed costs may give rise to both positive and zero-provision outcomes, and absent announcements donors may get stuck in an equilibrium that fails to provide a desirable public project. Interestingly, Andreoni (1998) demonstrates that the announcement of seed money can help eliminate such inferior outcomes. We investigate this model experimentally to determine whether announcements of seed money eliminate the inefficiencies that may result under fixed costs and simultaneous provision. To assess the strength of the theory we examine the effect of announcements in both the presence and absence of fixed costs. Our findings are supportive of the theory for sufficiently high fixed costs.

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1. Introduction

A rule of thumb commonly followed by fundraisers is that past contributions are announced to future donors. This is perhaps most noteworthy in capital campaigns where the announcement of a substantial seed donation is used to launch the public phase of the campaign. The practice of sequential fundraising is intriguing in light of the analysis of voluntary provision of public goods provided by Varian (1994). Examining a model with continuous production of the public good he compares the contributions that result when donations are made simultaneously versus sequentially. Recognizing that one donor's contribution is a perfect substitute for that of another, he demonstrates that sequential provision enables the initial donor to free ride off subsequent donors, and as a result the overall provision in the sequential contribution game will be no greater than in the simultaneous one.[2]

This inconsistency between common practice and theoretical prediction has brought researchers to identify conditions under which it may be optimal to raise funds sequentially. Andreoni (1998) was the first to propose an explanation. He showed that a sequential fundraising strategy is preferred when there are fixed costs of production. The presence of fixed costs gives rise to increasing returns to production at low contribution levels and this may result in multiple equilibria, some that secure provision of a desirable public project and others that don't. Thus fundraising campaigns that rely on simultaneous giving may get stuck in an equilibrium where donors fail to coordinate on a positive-provision outcome. Interestingly a sequential fundraising strategy helps eliminate such inferior equilibria, as sufficiently large initial contributions enable donors to coordinate on the positive-provision outcome.

List and Lucking-Reiley (2002) use a field experiment to examine this prediction. Raising funds for a number of $3,000 computers they sent out solicitations in which the initial contribution to the non-profit varied between 10%, 33%, and 67% of the computer's cost. Interestingly the likelihood of contributing and the average amount contributed was found to be greatest when 67% of the project had already been provided.[3] In fact they found a six fold increase in contributions when moving from the lowest to the highest seed. Qualitatively the results are very much in line with the predictions of Andreoni's model. However the results are also in line with the predictions made by a number of other models on sequential giving. For example, the

[2] As emphasized by Vesterlund (2003) this result relies on the assumption that initial donors can commit to giving only once. Absent this assumption the contribution level is predicted to be the same in the two games, thus the strict preference for sequential giving remains a puzzle in this case.

[3] A series of field experiments find that giving is influenced by the size of the initial contribution. Frey and Meier (2004) show that contributions to charitable funds at the University of Zurich are affected by information on how many others donated in the past. In a campaign for a public radio station, Croson and Shang (2008) show that donations increase when the donor is informed that others have contributed more than they did in the past. Martin and Randal (2008) change the amount placed in an art gallery's donation box and show that average donations increase when it appears that others have given larger amounts.

increase in giving may also be explained by donors interpreting the initial contribution as a signal of the non-profit's quality (Vesterlund, 2003).[4]

What distinguishes Andreoni's predictions from the alternative models of sequential fundraising is the crucial role played by the presence of fixed costs of production. Unfortunately in a field setting it is not straightforward to keep treatments comparable while varying both the seed and the fixed cost of production. The objective of the present paper is to use laboratory experiments to test the theory by Andreoni (1998). By using the laboratory we can test if the size of the fixed cost plays a critical role in the success of sequential giving.

Our study is designed to answer the following research questions. First, we examine whether fixed costs give rise to inefficient outcomes under simultaneous provision. That is, do contributions decrease when we introduce fixed costs? Where the fixed costs are such that no individual has an incentive to single-handedly provide the good. Second, if such inefficient outcomes exist, does sequential play help eliminate these inefficiencies and increase the likelihood of providing the public good? Third, to examine whether the success of seed money depends on the presence of fixed costs, we ask whether the potential increase in contributions under sequential provision is greater in the presence of fixed costs.

Our results are supportive of the theory for high, but not for low fixed costs. Surprisingly under simultaneous provision we find that the introduction of small fixed costs increases rather than decreases overall provision. Individuals seem uncertain of which equilibrium will be played and opt to increase their contributions to secure that the public good is provided. By facilitating coordination on the positive-provision outcome, seed money effectively removes the risk of underprovision and therefore decreases contributions relative to the simultaneous contribution environment. Consequently, our results suggest that sequential provision has no role when fixed costs are small. However, when fixed costs are high, behavior is in line with the theoretical prediction: individuals often fail to provide the public good in the simultaneous game, and sequential provision successfully eliminates these undesirable outcomes. As a result when fixed costs are high the likelihood of securing provision of the public good and average earnings are much greater when contributions are made sequentially.

The remainder of the paper is organized as follows. We first describe the theoretical insights in a simple version of Andreoni's model, and explain how the derived hypotheses helped shape our experimental design. The results for small fixed costs are presented in section 3. In section 4 we extend the analysis to examine larger fixed costs, and we conclude the paper in section 5.

2. Experimental Design

To demonstrate the insights provided by Andreoni we start by presenting a simple 2-person example of a model of voluntary contributions to a public good. This example has precisely the

[4] See also Andreoni (2006), Potters, Sefton, and Vesterlund (2005, 2007), Komai, Stegeman and Hermalin (2007).

characteristics we want for our experiment and will therefore serve as the basis for our design. We complete the section by describing the parameters and procedures used for the study.

2.1. Theory

Consider the following two-person voluntary contribution environment. A donor, i = 1,2, has an endowment, w_i, which he must allocate between private consumption, x_i, and contributions to a public good, g_i. Let $c(g_i)$ denote i's cost of giving g_i and r(G) i's benefit from a total contribution of $G = g_1 + g_2$. Assuming that the price of the private good is 1, let i's quasi-linear utility be given by

$$U_i(x_i,G) = w_i - c(g_i) + r(G)$$

Let the return from the public good equal m per unit contributed to the public good, provided that the total contribution exceeds a fixed cost of FC.

$$r(G) = \begin{cases} 0 & if\ G < FC \\ mG & if\ G \geq FC \end{cases}$$

Further assume that costs are convex and piecewise linear of the form

$$c(g_i) = \begin{cases} \alpha g_i & if \quad g_i \in [0, l_{NE}] \\ \alpha l_{NE} + \beta(g_i - l_{NE}) & if \quad g_i \in (l_{NE}, l_{PE}] \\ \alpha l_{NE} + \beta(l_{PE} - l_{NE}) + \gamma(g_i - l_{PE}) & if \quad g_i \in (l_{PE}, \bar{l}] \end{cases}$$

Thus the marginal cost of contributing is initially α, then β, and finally γ. To secure an interior Nash and Pareto optimal outcome with FC=0 assume that $0 < \alpha < m$, $m < \beta < 2m$, $\gamma > 2m$, and that $0 < l_{NE} < l_{PE} < w_i$.

In analyzing the game let us start by characterizing the equilibria of the simultaneous game and how they change with the size of the fixed cost. For this purpose it will be beneficial to define the following two fixed cost levels: let FC_1 denote the fixed cost where the return to covering the fixed cost single-handedly equals the cost, i.e., $r(FC_1) = c(FC_1)$, and let FC_2 denote the fixed cost where the return from covering the fixed cost equals the cost of contributing an amount equal to half of the fixed cost, i.e., $r(FC_2) = c(FC_2/2)$.

Absent fixed costs (FC = 0) the dominant strategy for each individual is to contribute, l_{NE}, thus the equilibrium is $(g_1^*, g_2^*) = (l_{NE}, l_{NE})$. This remains the unique equilibrium outcome as long as individuals are willing to single-handedly cover the fixed cost, i.e., $FC < FC_1$. For higher fixed costs, i.e., $FC > FC_1$, a zero-provision equilibrium arises. The reason is that when $FC > FC_1$ the best response to $g_{-i} = 0$ is a contribution of $g_i = 0$, thus for sufficiently high fixed cost, $(g_1^*, g_2^*) = (0,0)$ is a Nash Equilibrium of the simultaneous game. In fact zero provision is the unique equilibrium outcome when $FC > FC_2$. For intermediate value fixed costs, i.e., when $FC_1 < FC < FC_2$, there are

both zero- and positive-provision outcomes. Although all players would prefer positive provision, failure to coordinate may trap contributors at zero provision.

The role of seed money demonstrated by Andreoni (1998) arises when the fixed cost is in the intermediate range where the simultaneous game gives rise to multiple equilibria. He showed that while the simultaneous game may result in zero provision, such inefficiencies are eliminated with sequential play. The reason is that by providing a sufficiently large first donation the first mover can ensure that the second mover is willing to cover the remainder of the fixed cost. Thus for fixed costs in this range the fundraiser can secure positive provision by announcing the first donor's contribution.

2.2. Experimental parameters

We are interested in examining the effect of sequential giving for fixed costs in the intermediate range described above. To determine the interaction between fixed costs and sequential play, we rely on a simple 2x2 design, examining simultaneous and sequential giving with and without fixed costs.

Our design is based on the example presented above as it captures the critical features of Andreoni's model. Furthermore it is relatively simple and has characteristics that are desirable for our experimental design: an interior Nash equilibrium in dominant strategies and an interior Pareto optimal outcome.[5] Thus in contrast to the classic voluntary contribution mechanism (VCM) where the dominant strategy is to give nothing and the Pareto optimal outcome is to give everything, this design allows for participants to not only over-contribute but also under-contribute. Furthermore contributions are not limited to being inefficiently low but may also be inefficiently high. While previous studies have examined environments in which both the Nash and Pareto optimal outcomes are interior, the attraction of our example is that we secure the Nash equilibrium in dominant strategies using piecewise linear payoffs, which are easily explained.[6]

The specific parameters chosen for the study were as follows. Participants interacted in a one-shot manner in groups of two. Provided the fixed cost is covered, the marginal return per unit invested in the public account was 50 cents. The per unit cost of investing was 40 cents for units 1 to 3, 70 cents for units 4 through 7, and finally $1.10 for units 8 through 10. Thus the experimental parameters were: $m = 0.5$, $\alpha = 0.4$, $\beta = 0.7$, $\gamma = 1.1$, $I_{NE} = 3$, and $I_{PE} = 7$. Absent fixed costs it is a dominant strategy to contribute 3, and Pareto efficiency is achieved with each contributing 7. Our use of a group size of two combined with restricting participants to unit

[5] Menietti, Morelli, and Vesterlund (2009) examine a similar payoff structure.

[6] See Laury and Holt (2008) for a review of the literature on VCMs with interior Nash equilibria. Our design also differs from the threshold models where there is no return from exceeding the threshold, and therefore limited ability to examine the effect of the threshold, see e.g., Croson and Marks (2000) for a review. Examinations of sequential giving in minimal contributing set games show greater efficiency in the sequential game (see Erev and Rapoport, 1990, and Cooper and Stockman, 2007).

investments allows the payoffs to be presented in a standard and simple payoff table – an example of the payoff table for the zero fixed cost case is presented in Appendix I.

In selecting the fixed cost we wanted it to be so large that no individual had an incentive to cover the fixed cost single-handedly yet small enough to secure both positive- and zero-provision equilibria of the simultaneous game. We also wanted a fixed cost for which the positive-provision outcome remained the same as in the simultaneous game absent fixed costs. A fixed cost of 6 satisfied both of these criteria. With FC=6 it remains an equilibrium for each to contribute 3 units, yet if the other person contributes zero the best response is to contribute zero as well. This is because the cost of covering the fixed cost alone is \$3.30 (= 3x0.4+3x0.7) which outweighs the benefit of \$3 (= 6x0.5). Thus with simultaneous play and FC=6 there are two Nash Equilibria – one that provides the public good and another that does not. Under sequential provision, however, the zero-provision outcome is eliminated. The reason is that the first mover has an incentive to provide just enough to secure that the second mover will cover the fixed costs. Examining the second mover's incentives we see that the second mover's best response is:

$$g_2(g_1) = \begin{cases} 0 & if \quad g_1 = 0 \\ 6 - g_1 & if \quad g_1 \in \{1,2\} \\ 3 & if \quad g_1 \in \{3,10\} \end{cases}$$

where g_1 denotes the first mover's contribution and g_2 the second mover's contribution. Thus, the first mover can, by contributing 1 unit, secure completion of the project and maximize her own payoff.

A 2x2 design – (FC=0, FC=6) x (simultaneous play, sequential play) – gives rise to the predictions in Table I.

Table I: Equilibrium Predictions (g_1*, g_2*)

	FC=0	FC=6
Simultaneous	(3,3)	(0,0) &(3,3)
Sequential	(3,3)	(1,5)

Of course various forms of other-regarding preferences may give rise to deviations from the predicted equilibria.[7] Altruism may cause contributions to exceed that predicted. The attraction of the fair and Pareto superior outcome may be so strong that we observe no inefficiencies in the simultaneous game with fixed costs. Reciprocity and inequality aversion may cause deviations in the sequential game where small initial contributions can be punished, while large

[7] See Cooper and Kagel (forthcoming) for a review of other-regarding preferences.

contributions can be rewarded.[8] In light of the many behavioral factors that may cause deviations from the equilibrium prediction we refrain from assessing the predictive power of the model by examining adherence to the predicted equilibria, but will instead focus on the predicted comparative statics.

Indeed the comparative statics across treatments enable us to answer the three questions of interest. Comparing the two simultaneous treatments we can determine whether positive fixed costs give rise to inefficiencies and decrease contributions. Comparing the two treatments (simultaneous vs. sequential play) with positive fixed costs we can determine if sequential play increases contributions and the likelihood of provision. Finally, we can determine the role played by fixed costs on the benefit of sequential play by examining the change in behavior from simultaneous to sequential play with and without fixed costs.

2.3. Experimental procedures

The sessions were conducted at the Pittsburgh Experimental Economics Laboratory at the University of Pittsburgh. Three sessions were conducted for each of the four treatments described above. 14 undergraduate students participated in each session for a total of 168 participants. The steps of each session were as follows. First the payoff table and instructions were distributed.[9] Care was taken to make the payoff table as clear as possible. The payoffs to the participant and her group member are distinguished by color and location in each cell. The instructions were read out loud and a short quiz was given to gauge the participants' understanding. The quiz consisted of reporting the payoffs earned by a participant and her group member for several combinations of contribution levels above and below the fixed cost level. To avoid priming the participants, the examples did not include focal outcomes, such as the Nash equilibrium and Pareto optimal outcome. The quiz questions were the same for all treatments, though the answers varied with the size of the fixed costs.

Once all participants had completed the quiz a solution key was distributed. The quiz answers were explained by an experimenter. Screen shots of the experimental software were shown and explained. Participants then began the portion of the experiment that counted for payment. They played fourteen rounds of the public goods game. In each round each participant was randomly paired with another participant, was given a $4 endowment and the opportunity to invest any number of units between zero and ten in a public account.[10]

[8] The characteristics of the equilibrium resemble that of the quasi-linear public good setting examined by Andreoni, Brown, and Vesterlund (2002). The equilibrium prediction in their setting is that only the second mover contributes to the public good. Their experimental data reveal substantial punishments of free riders and substantial deviations from the subgame perfect equilibrium prediction.

[9] See Appendix II for the Instructions.

[10] A consequence of our design is that a participant's cost can exceed their endowment; in effect they borrow against earnings from the group account. We made this clear in the instructions, and participants did not express any concerns about this aspect of the design. They appeared to rely on the payoff table when making their decisions. Only one participant asked how purchases could exceed his endowment. The participant appeared satisfied with the explanation that the cost was taken out of his earnings from the group account.

Contributions were either made "simultaneously" or "sequentially". Effectively decisions were made sequentially in both treatments with half the participants called "First Movers" and the other half "Second Movers". However only in the sequential treatment was the second mover informed of the first mover's contribution before making her decision. The variation in information for the second mover was the only difference between the sequential and simultaneous treatments causing minimal variation in instructions and procedures between the two.[11] The experiment was programmed and conducted using the software z-Tree (Fischbacher, 2007).

When the 14 rounds had been completed we randomly selected three of the rounds to count for payment. Participants were then asked to complete a short questionnaire, following which they were paid in private and in cash. Sessions lasted approximately one hour and average earnings were $22 including a five-dollar show-up fee.

3. Findings

Our experiment is designed to examine the role of sequential fundraising in eliminating inefficient outcomes that may arise in the presence of fixed costs and simultaneous play. In reporting the results we start by determining the effect sequential play may have absent fixed costs, we then see if fixed costs give rise to inefficient outcomes when contributions are made simultaneously, and we conclude the section by examining the effect of sequential play in the presence of fixed costs.

3.1. The effect of sequential play with zero fixed costs

Absent fixed costs the unique equilibrium prediction of both the sequential and simultaneous game is for each member of the two-person group to contribute 3 units. Hence the first hypothesis, H1, we test is:

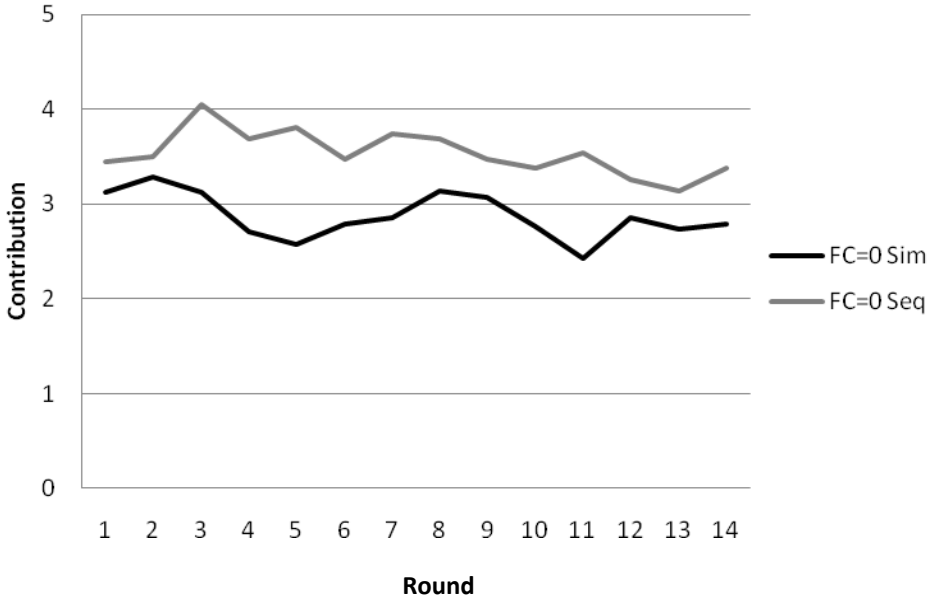
> With zero fixed costs sequential play has *no effect* on contributions.

The average contributions for the simultaneous and sequential games with zero fixed costs are shown by round in Figure I. Focusing first on the simultaneous game we note that average contributions are very close to the 3-unit equilibrium prediction. With a mean contribution of 2.87 we cannot reject that participants contribute the predicted amount ($p=0.382$).[12] This adherence to equilibrium play is in sharp contrast to the behavior in the classic VCM game where contributions substantially exceed the dominant strategy of zero giving.[13] Our study also deviates from the classic VCM studies in that we do not observe a substantial decrease in contributions over the course of the experiment. Although a random-effects regression of individual contributions on round shows that contributions decrease significantly over time, the

[11] See Potters, Sefton and Vesterlund (2005, 2007) for a similar approach.
[12] To account for fact that each individual makes 14 decisions the reported test statistics in our paper refer the results from random-effects regressions. Exceptions will be noted.
[13] See Ledyard (1995) for a review.

coefficient is small (-0.028, p=0.042) in the simultaneous game and corresponds to no more than a one percent decrease in giving per round. It is unlikely that the substantial adherence to equilibrium play can be explained by the dominant strategy being interior, as earlier studies of VCM environments with an interior dominant strategy also find that donors over-contribute and decrease contributions over time (see Laury and Holt, 2008). A possible explanation for why equilibrium play is found to be a good approximation for actual behavior in our study may be that we use a very simple piecewise linear cost function rather than the more complicated quadratic cost function seen in previous studies.[14] There is however one dimension in which our data resemble that of previous VCMs – over the course of the study we too find an increase in equilibrium play. Although average contribution is at the equilibrium level of 3, we observe the frequency of equilibrium play increase from 57 percent during the first half of the experiment to 66 percent during the second half of the experiment.

Figure I
Mean Individual Contributions FC=0



While contributions in the simultaneous game are consistent with the equilibrium prediction, we see greater-than-predicted giving in the sequential game. As shown in Figure I, in every round of the sequential game average contributions exceed the predicted contribution of 3. Indeed the mean contribution of 3.54 differs significantly from the prediction (p=0.00). Note however that 73 percent of all decisions are at the predicted contribution of 3.

Comparing the sequential and simultaneous treatments we find significantly greater sequential giving.[15] Using random effects Table II reports the results from regressing individual

[14] Keser (1996), Sefton and Steinberg (1996) and Van Dijk, Sonneman, and Van Winden (2002) all use quadratic costs. Menietti, Morelli, and Vesterlund (2009) use a linear payoff structure similar to that examined here and find substantial equilibrium play.

[15] This result is likely to be sensitive to the particular parameters chosen. E.g., examining quasi-linear giving environments Gächter et al. (2009) find that sequential giving is higher than with simultaneous

contributions on a "sequential" dummy that takes a value of 1 if the game is sequential and 0 otherwise, and a round number variable "round" which controls for changes in contributions over time, be it due to learning or changes in preferences.[16]

Table II
GLS Random-Effects Regression
Dependent Variable: Individual Contribution, FC=0

	All rounds 1-14	**First seven 1-7**	**Last seven 8-14**
Sequential	.668	.752	.585
	(.001)	(.002)	(.002)
Round	-.030	-.031	-.060
	(.001)	(.238)	(.017)
Constant	3.103	3.048	3.486
	(.000)	(.000)	(.000)
N	1176	588	588
Participants	84	84	84

Note: p-values are in parenthesis.

Table II shows that when pooling the sequential and simultaneous data we continue to see a slight decrease in contributions with round. While the decrease is significant overall and in the last seven rounds, it is not significantly different from zero during the first seven rounds. As expected from Figure I, sequential play is found to cause a significant and substantial 20 percent increase in contributions. This positive effect is robust to breaking the data into first-seven and last-seven rounds. Hence we reject hypothesis H1.[17] When fixed costs are zero, sequential play *increases* contributions.[18]

In describing the experimental design we hypothesized that reciprocity might cause behavior in the sequential game to deviate from the equilibrium prediction, and our data suggests that indeed this may be the explanation. When the first-mover's contribution ranges between zero and three units, second movers opt for the dominant strategy and contribute an average of

movers, whereas Andreoni, Brown and Vesterlund (2002) examine a quasi-linear environment and find lower contributions in the sequential than simultaneous game.

[16] See Muller, Sefton, Steinberg, and Vesterlund (2008) for an attempt to separate these two effects in the classic VCM game.

[17] Session level analysis generates the same result. Mean contributions in the three sequential sessions systematically exceed those of the three simultaneous sessions, whether it be over all rounds, the first seven or last seven rounds of the game. Thus a rank sum test marginally rejects H1 (p-value=0.10).

[18] Our results are robust to controlling for the correctness of the answers provided on the quiz. However the coefficient on the correctness of the quiz is never significant and including it has no qualitative (and most often no quantitative) effect on the estimated coefficients. An explanation for why a participant's initial ability to read the payoff table has no significant effect on behavior may be that the experimenter carefully reviewed and explained the quiz answers prior to the decision phase of the experiment.

2.99. However the average second-mover contribution increases to 3.80 when first movers give more than their dominant strategy. To assess the return from increasing first contributions by one unit, we use random effects to regress second-mover contributions on that of the first mover. When first-mover contributions range from three to seven units we find that a one-unit increase in first-mover contributions increases the second-mover's contribution by 0.29 units. Although the positive coefficient is consistent with reciprocity is it not large enough to make it payoff maximizing for first movers to deviate from their dominant strategy.[19] Nonetheless the incentive for first movers to give is greater with sequential play and average first-mover contributions are found to be significantly higher in the sequential than simultaneous game (3.85 vs. 2.96, p=0.005). To sum, in the case of zero fixed costs, it appears that positive reciprocity generates higher contributions in the sequential than simultaneous game.

3.2. Do fixed costs decrease simultaneous contributions?

Having found that sequential play increases contributions in our baseline, we continue our analysis to determine how behavior responds to the introduction of fixed costs. The primary question of interest is whether in the presence of fixed costs sequential play causes an even greater increase in giving as it eliminates inefficient outcomes. Outcomes that may arise as a result of fixed costs in the simultaneous game. We start by examining the later part of this prediction. That is, we determine whether with simultaneous play the introduction of fixed costs results in zero-provision outcomes and thereby decreases contributions.

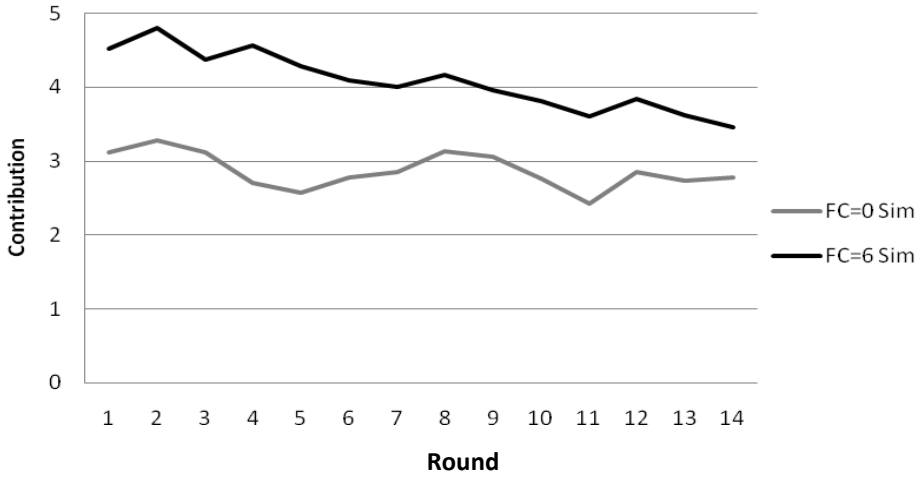
We compare the contributions under simultaneous play when fixed costs are zero and six. As shown earlier, with fixed costs of six the simultaneous game admits two Nash equilibria: (g_1*, g_2*) $\in$ {(0,0), (3,3)}. That is, an inefficient equilibrium with zero contribution emerges along with the previous equilibrium of three-unit contributions by each of the group members. Although the existence of an additional, inefficient, equilibrium does not guarantee it will be played, this is an implicit assumption in the argument for the role of sequential fundraising. If the inefficient equilibrium is played with some positive probability average contributions are predicted to be lower with fixed costs of six, than with fixed costs of zero. This comparative static prediction is summarized in hypothesis H2:

> Average contributions in the simultaneous game with fixed costs of six are *smaller* than with fixed costs of zero.

The potential confirmation of H2 will suggest that under fixed costs there is room for sequential play to further increase contributions. Figure II demonstrates the mean contributions by round in the two simultaneous treatments (with and without the fixed cost).

[19] The net cost of contributing in the 4-7 range is 20 cents, thus it is payoff maximizing to increase first-mover contributions by one unit if it generates an increase in second-mover contributions of more than 0.4 units.

Figure II
Mean Individual Contributions
Simultaneous Game



The contribution pattern is in sharp contrast to the prediction. Rather than decreasing contributions, the introduction of fixed costs is found to significantly increase contributions.[20] Table III reports the results from a random-effects regression of individual contribution on round and a dummy variable (FC=6) that takes a value of 1 for observations with fixed costs of six and 0 for observations with zero fixed cost. We find a positive and significant coefficient for the fixed cost dummy leading us to reject hypothesis H2. All else equal, fixed costs *increase* individual contributions by 1.20 units on average.

Table III
GLS Random-Effects Regression
Dependent Variable: Individual Contribution, Simultaneous Play FC=0 or FC=6

	All rounds 1-14	**First seven 1-7**	**Last seven 8-14**
FC=6	1.204	1.459	.949
	(.000)	(.000)	(.000)
Round	-.059	-.097	-.079
	(.000)	(.002)	(.003)
Constant	3.320	3.310	3.696
	(.000)	(.000)	(.000)
N	1176	588	588
Participants	84	84	84

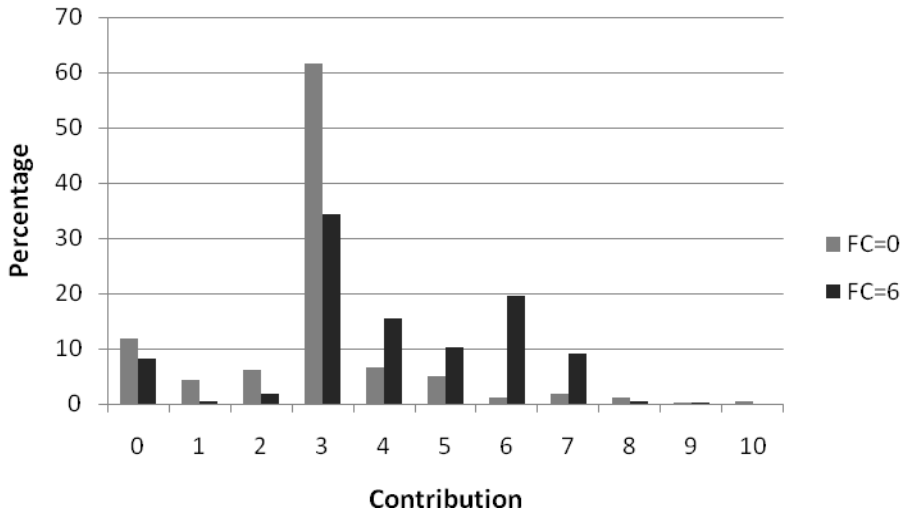
Note: p-values are in parenthesis.

To better understand the deviation from the predicted comparative static we examine the probability distribution of individual contributions. As seen in Figure III the distribution with a

[20] Session level data reveal the same contribution pattern: the simultaneous treatments with fixed costs of six systematically generate larger session averages than that observed with fixed costs of zero.

fixed cost of six first-order stochastically dominates the distribution with a fixed cost of zero. Relative to the zero fixed-cost treatment we see a decrease in the number of contributions of less than three units and an increase in contributions between four and seven units. Contributions in excess of the dominant strategy account for 26 percent of play when there are no fixed costs and increase to 55 percent when the fixed cost increases to six. Perhaps most importantly, and contrary to expectations, the presence of fixed costs is not found to increase the frequency of zero-unit contributions.

Figure III
Probability Density of Individual Contributions
Simultaneous Game with FC=0 and FC=6



We conjecture that the primary cause of the increase in contributions is driven by uncertainty over partner contributions. Contributing all of the fixed costs happens to be a best response for a wide range of beliefs over the partner's contribution. Consider beliefs that only place weight on the partner selecting an action associated with the two Nash equilibria: contributing zero or three units. If the subject is very certain to be matched with someone contributing zero it is a best response to contribute zero as well. Similarly, if she is very certain to be matched with someone contributing three it is a best response to contribute three. However, if the likelihood of being matched with a zero lies in the range of forty to eighty percent, her best response is to contribute six units. Thus absent the ability to coordinate on one of the two Nash equilibria individuals may benefit from single-handedly securing provision of the project.

If this conjecture is correct one would expect equilibrium play to increase as uncertainty about the strategies being employed diminishes. The data is consistent with this prediction, as Table II reveals that the effect of fixed costs decreases from the first to the second half of the experiment. Furthermore, over the course of the experiment we see a decrease in the number of six-unit contributions and an increase in the number of three-unit contributions. During the first seven rounds of the game, three and six-unit contributions each account for 25 percent of

all play. These numbers change for the latter half of the experiment, with 44 percent of all contributions at three and only 14 percent at six.

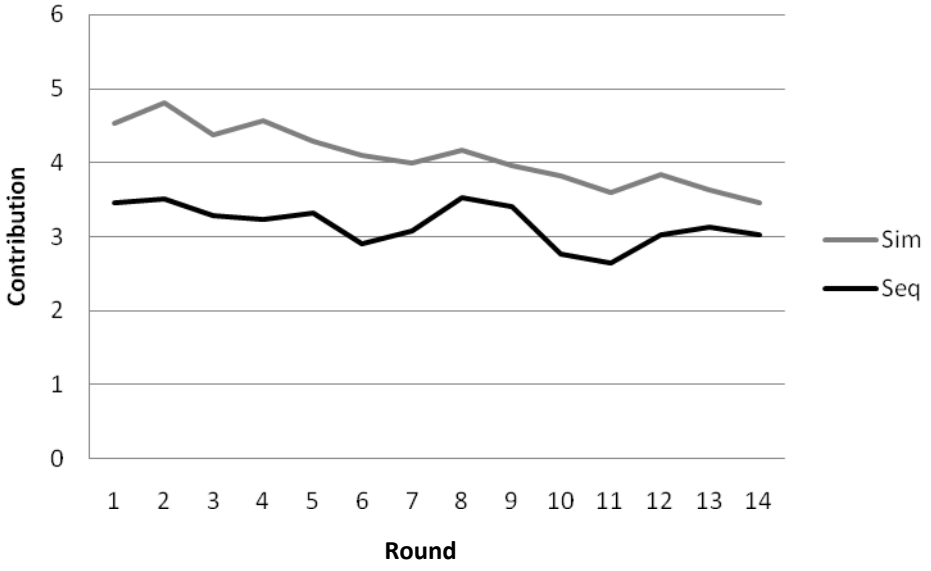
3.3. Does sequential play increase giving when there are fixed costs?

We continue our analysis by examining the effect of sequential play when there are fixed costs. With fixed costs of six the subgame perfect Nash equilibrium of the sequential game is $(g_1, g_2) = (1,5)$: the first mover gives one unit while the second mover gives the remaining amount to cover the fixed cost, i.e., five units. From a theoretical point of view, the sequential game eliminates the inefficient Nash equilibrium outcome of zero provision, potentially increasing contributions (to an average of 3 units). This is summarized in hypothesis H3:

> With a six-unit fixed cost sequential play *increases* contributions.

Our results from the simultaneous game with fixed costs leave one skeptical that support for H3 will be found in our environment. The limited evidence of inefficient outcomes in the simultaneous game with fixed costs leaves little room for sequential play to improve on the simultaneous outcomes. Furthermore we argued that uncertainty with regard to the partner's play helped explain why fixed costs increased contributions in the simultaneous game. As this uncertainty is reduced in the sequential game, contributions may instead decrease to the equilibrium level. Figure IV shows the individual contributions by round in the sequential and simultaneous game with fixed costs.

Figure IV
Mean Individual Contributions, FC=6



In contrast to the predicted comparative statics we see that mean contributions are lower with the sequential than simultaneous play. Table IV presents a random-effects regression analysis of individual contributions for FC=6. As before, the dependent variable is individual contribution and the explanatory variables are whether the game is sequential or simultaneous, and the number of rounds. The effect of sequential play is found to be negative and significant. All else

equal sequential play reduces individual contributions by almost one unit. Thus we reject H3, with fixed costs of six sequential play *decreases* the mean contribution.[21]

Table IV
GLS Random-Effects Regression
Dependent Variable: Individual Contribution, FC=6

	All rounds 1-14	**First seven 1-7**	**Last seven 8-14**
Sequential	-0.917	-1.129	-0.704
	(.000)	(.000)	(.008)
Round	-0.064	-0.097	-0.082
	(.000)	(.004)	(.002)
Constant	4.560	4.767	4.678
	(.000)	(.000)	(.000)
N	1176	588	588
Participants	84	84	84

Note: p-values are in parenthesis.

The rejection of H3 is not caused by behavior in the sequential game. In fact we cannot reject that the average contribution of 3.16 in the sequential game equals the predicted three-unit mean contribution (p=0.380). Instead the deviation from the predicted comparative static (H3) is driven by the higher-than-expected contributions in the simultaneous game.

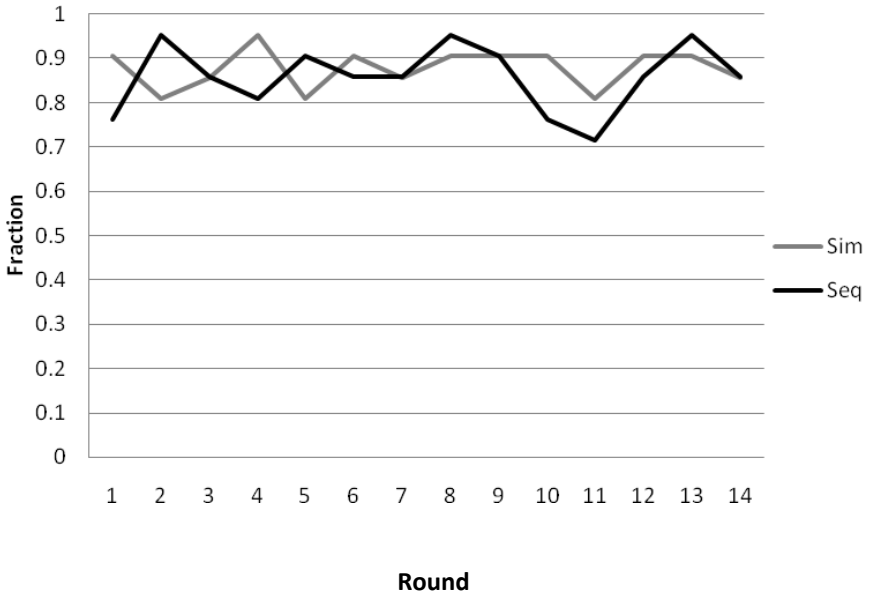
Since sequential play decreases giving in the presence of fixed costs and increases it in the absence of fixed costs, it is no surprise that contrary to expectations, we do not find sequential play to be more successful in increasing contributions when fixed costs are present.[22]

Before we draw any conclusions on the relative advantages of sequential versus simultaneous play, we should examine the actual provision of the public good. After all donors benefit from provision rather than contribution, thus contributions may be misleading when selecting between fundraising techniques. For example, it is possible that individual giving of five in the simultaneous game is matched with a contribution of zero causing the public good not to be provided. Figure V below presents the fraction of cases in which the public good was provided, by round and by treatment (simultaneous vs. sequential).

[21] Session level data reveal the same contribution pattern with the sequential treatments systematically generating lower session averages than that observed with fixed costs of zero.

[22] A random-effects regression of individual contributions reveals coefficients of 0.668 on a sequential dummy, 1.20 on a fixed cost dummy, -1.59 on an interaction term of the sequential and fixed cost dummies, -0.0047 on round, and 3.23 as the constant, with all coefficients being significantly different from 0 at the one percent level. Thus the introduction of fixed costs is found to *decrease* rather than increase the effect of sequential play.

Figure V
Fraction of Public Good Provision, FC=6



The provision rate is high and in excess of 80 percent in both treatments. Despite the coordination problem associated with simultaneous giving, the 30 percent of contributions that are large enough to guarantee public good provision in the simultaneous game helps secure similar provision rates in the two treatments. The high provision rate combined with the larger average contributions in the simultaneous treatment implies that individual earnings are slightly lower with sequential than simultaneous play. Using random effects to regress individual round earnings on a sequential treatment dummy and round number we find that sequential play reduces participant earnings by about 25 cents per round.[23] While this only corresponds to a 4 percent decrease in earnings, the difference is highly significant, and contrary to the expectation we do not find evidence to suggest that participants on average get higher earnings in the sequential treatment when the fixed cost equals six.

4. Sensitivity to Fixed Costs

Our analysis of contributions with a six-unit fixed cost did not show the expected increase in contributions from sequential play. This result was largely driven by the larger than expected contributions in the simultaneous game. We argued that uncertainty about the partner's contribution could help explain this behavior. Single-handedly covering the fixed cost was found to be a best response for individuals who believed that their partner either contributed nothing or covered half of the fixed cost, as long as the individual believed that the probability of the other group member contributing nothing was between 40 and 80 percent.

[23] For round 1-14 we get a constant of 5.969 (.000), coefficients of -0.245 (.004) on sequential and -0.018 (.033) on round. For rounds 1-7 the constant is 6.024 (p=.000), and the coefficients are -0.279 (.008) on sequential and -0.030 (.253) on round. Finally, rounds 8-14 the constant is 6.014 (p=.000) and the coefficients are -0.221 (.000) on sequential, and 0.023 (.323) on round.

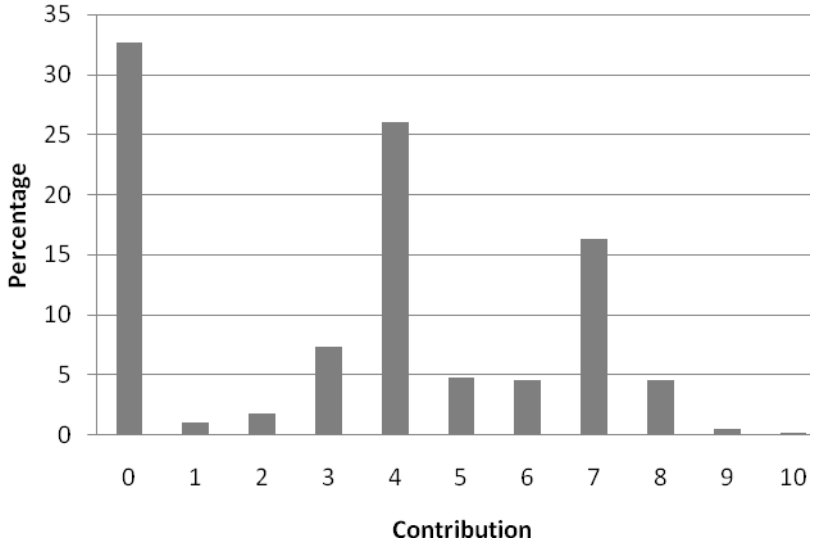
Our experimental findings may have been more in line with the theory had we opted for a fixed cost where single-handedly covering the fixed cost is not a best response when uncertainty is of the form described above. That is when the other group member is believed to either contribute nothing or cover half the fixed cost, the costs would be high enough to guarantee that there is no such belief which renders full coverage of the fixed costs a best response. By expanding our design to the case with fixed cost of eight we can examine such an environment and determine how sensitive our results are to the fixed cost. We ran four sessions with an eight-unit fixed cost – two sessions of simultaneous play and two sessions of sequential play. 14 participants participated in each session for a total of 56 additional participants.[24]

By increasing the fixed cost beyond six units we also increase the number of possible Nash equilibria in the simultaneous game. In particular there are now four Nash equilibria: (3,5), (4,4), (5,3) and a zero-provision equilibrium of (0,0). Introducing sequential play leads to a unique subgame perfect equilibrium of (2,6) and eliminates the inefficient (0,0) equilibrium.[25] Thus we form the following hypothesis (H4):

With an eight-unit fixed cost sequential play *increases* contributions.

Crucial for this prediction is of course that participants in the simultaneous game play the zero-contribution equilibrium with some positive probability. We examine the contribution distribution in the simultaneous game in Figure VI.

Figure VI
Probability Density Function of Individual Contributions, w/ simultaneous and FC=8



As with fixed costs of six a substantial fraction of contributions are found to cover half of the fixed cost (four), and a fair number of contributions are at the efficient level (seven). However in sharp contrast to our earlier fixed-costs findings it is rare to see individual contributions that can

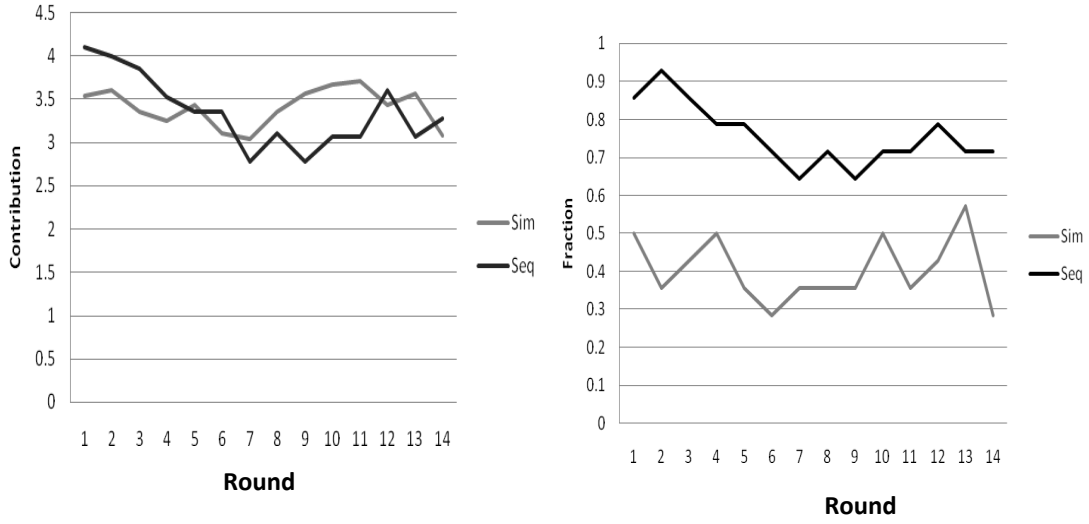
[24] See Appendix I for the payoff table when FC=8.
[25] Note that the characteristic of this subgame perfect equilibrium is similar to that of the ultimatum game where the proposer offers the smallest *non-zero* amount possible and the responder accepts.

cover the fixed costs and the modal choice is now to contribute nothing. A third of all contributions are at zero. Thus behavior in the simultaneous game suggests that there is room for sequential play to improve outcomes. Note that with fixed costs of eight there are two ways in which sequential play may increase contributions, first through the elimination of the zero-contribution equilibrium, and second by alleviating the coordination problem associated with selecting one of the positive contribution equilibria in the simultaneous game.

Figure VII Panel (a) compares the mean individual contributions in the sequential and simultaneous game by round. Despite the high frequency of zero-unit contributions in the simultaneous game the means are found to be quite similar. The similarity in mean contributions is further supported by a random-effects regression of individual contributions on a sequential dummy and rounds. The coefficient on sequential is found to be small and insignificant whether it is examined overall, or during the first or second half of the experiment.[26] Thus contrary to hypothesis H4, sequential play *does not significantly increase* individual contributions.

Figure VII: Fixed Costs of Eight

Panel (a): Mean individual contribution Panel (b): Likelihood of provision



While the mean contributions are not found to vary by treatment the frequency of zero contributions in the simultaneous game causes both the provision frequency and earnings to be smaller in the simultaneous game. The large difference in provision rates is seen in Figure VII Panel (b). With provision rates of 76 percent in the sequential game and 40 percent in the simultaneous one, sequential play almost doubles the likelihood of providing the public good. The effect on payoffs is substantial. Using random effects to regress individual round payoff on a sequential dummy and rounds we find in Table V that sequential play increases earnings by approximately $1.20 per round, corresponding to a 27 percent increase in earnings. Thus, consistent with the theory we find that sequential play helps eliminate inefficient outcomes and increases individual payoffs.

[26] The sequential coefficient equals: -0.051 (p=0.91) over all 14 rounds, 0.240 (p=0.61) for the first seven rounds, and -0.342 (p=0.49) for the last seven rounds.

Table V
GLS Random-Effects Regression
Dependent Variable: Individual Earnings, FC=8

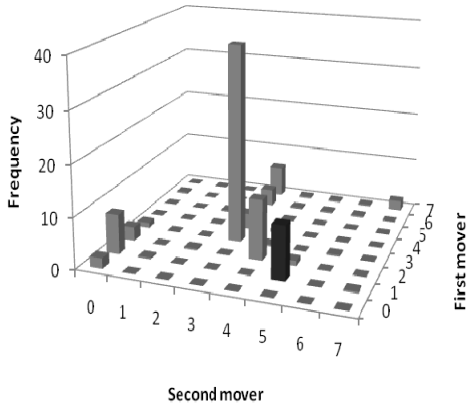
	All rounds 1-14	**First seven 1-7**	**Last seven 8-14**
Sequential	1.178	1.339	1.016
	(.000)	(.000)	(.000)
Round	-0.013	-0.074	0.026
	(.390)	(.102)	(.545)
Constant	4.414	4.565	4.069
	(.000)	(.000)	(.000)
N	784	392	392
Participants	56	56	56

Note: p-values are in parenthesis.

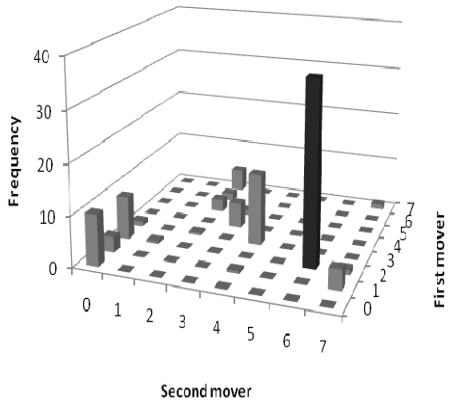
While the two sequential fixed-costs treatments (FC=6 and FC=8) are not directly comparable, the provision rates are nonetheless quite similar: the provision rate is 86 percent with fixed cost of six and 76 percent with fixed cost of eight. Despite the similarity there are large differences in how provision is secured in the two treatments. As seen in Figure VIII panel (a), with a six-unit fixed cost participants shy away from the highlighted subgame perfect equilibrium (1,5), and the modal outcome is instead for the first and second mover to each contribute three units. By contrast as seen in panel (b) with fixed costs of eight the modal outcome is the highlighted subgame perfect equilibrium of (2,6). The difference in the frequency of equilibrium play is intriguing as in both cases the subgame perfect equilibrium involves the first player free riding off the second player's desire to secure provision.[27]

Figure VIII: Contribution Frequency

Panel (a): Six-unit fixed cost



Panel (b): Eight-unit fixed cost



[27] Examining sequential public goods games, Cooper and Stockman (2007) and Andreoni, Brown and Vesterlund (2002) also find that free riding by a first mover causes subsequent subjects to not give, even when it is a dominant strategy to do so.

An explanation for the difference may be that second movers view it as more unfair when the first mover contributes one out of six, rather than two out of eight, thus it may therefore be easier for the second mover to accept the inequality associated with the subgame perfect equilibrium in the latter case.[28] Indeed with a fixed cost of six and an initial contribution of one there is a 40 percent chance that the second mover selects a contribution which is insufficient to secure provision. By contrast with a fixed cost of eight and an initial contribution of two there is only a 20 percent chance that the project fails to be provided. Interestingly the differences in behavior between the case where fixed costs are six and eight imply that only in the latter case do we find a significant first-mover advantage. The random-effects regression below shows that there is no significant first-mover advantage when fixed costs equal six, however, as seen by the interaction term, the fixed cost of eight generates a significant and substantial first-mover advantage. With an eight-unit fixed cost first movers earn on average $1 more per round than second movers. The advantage to the first mover is relatively robust over the first and second half of the experiment.

Table VI
GLS Random-Effects Regression
Dependent Variable: Individual Earnings, FC=8

	All rounds 1-14	**First seven 1-7**	**Last seven 8-14**
First_mover	-0.068	-0.156	0.019
	(.660)	(.407)	(.909)
FC=8	-0.565	-0.460	-0.670
	(.001)	(.029)	(.000)
FC=8*first_mover	0.937	0.883	0.991
	(.000)	(.003)	(.000)
Round	-0.022	-0.054	-0.006
	(.017)	(.052)	(.828)
Constant	5.787	5.917	5.601
	(.000)	(.000)	(.000)
N	980	490	490
Participants	70	70	70

Note: p-values are in parenthesis.

[28] Note that it is not only the perceived fairness of the equilibrium that may change when moving from a subgame perfect equilibrium of (1,5) to one of (2,6). The cost of punishing is also higher in the (2,6) equilibrium. Most games where distributional concerns may play a role have the characteristic that an improvement in fairness also increases the costs of punishment. Andreoni, Harbaugh and Vesterlund (2003) is an exception as they keep the cost of punishment and rewards constant while allowing the distribution of payoffs to vary.

5. Conclusions

Our study was designed to examine whether the frequent use of sequential fundraising and seed money, may be explained by the presence of fixed costs of production. We find support for this claim for sufficiently high fixed costs, but not for low fixed costs.

More specifically, the theoretical argument made by Andreoni (1998) is that in the presence of fixed costs, giving simultaneously to a public good may result in both positive- and zero-provision equilibria. Thus absent information on what others give, donors may get stuck in an inefficient equilibrium with zero provision. The attraction of sequential giving is that it eliminates such inefficient outcomes and guarantees provision of desirable public projects. Thus sequential fundraising is predicted to increase giving and individual payoffs.

For small fixed costs we do not find support for this claim, instead sequential play is shown to decrease both contributions and individual payoffs. The reason for this deviation from theory is found in the simultaneous game where, surprisingly, the introduction of fixed costs increases rather than decreases contributions. The explanation for the larger-than-expected contributions is due to the coordination difficulties of the simultaneous game combined with the relatively low fixed costs. Interestingly, uncertainty over which equilibrium the partner is playing often makes it a best response to contribute an amount large enough to single-handedly cover the fixed cost. The sequential game, however, lifts the coordination problem and participants can "safely" contribute less and still secure provision of the public good. Thus for low fixed costs we find that contributions in the simultaneous game exceeded those of the sequential game. While this result was not anticipated it is not difficult to envision a case where the cost from contributing is so low and the benefit from provision so high that individuals in a simultaneous move game will contribute an inefficiently large amount.[29]

In the case of large fixed costs, behavior was found to be more in line with the theory. Although sequential play did not increase contributions, it did increase the likelihood of provision and most importantly individual earnings. As predicted, with simultaneous play many participants did not contribute to the public good, or failed to coordinate to meet the fixed costs. In this case we found sequential play to improve on the simultaneous outcome through two channels: not only does it eliminate the zero contribution outcomes, it also eliminates the inefficiencies that result when participants fail to coordinate on one of multiple positive contribution equilibria of the simultaneous game. Thus the success of sequential play with large fixed costs is in part explained by the fact that the coordination problem is greater in this case.

While sequential play may improve outcomes one needs to be wary of the risk associated with allowing for too low an initial contribution. The presence of fixed costs enables the first contributor to free ride off the second contributor, and to fully extract the second mover's benefit from provision. Full exploitation of this advantage may cause second contributors to object to the unequal division of the burden and result in failure to provide the public good.

[29] Perhaps the excessive contributions seen in connections with the September 11 attacks in 2001 and the Asian Tsunami in 2004 would have been smaller if donations had been made in a more sequential manner.

Examining the sequential game with both low and high fixed costs we find that the success of the sequential play in our case was sensitive to the share of funds provided by the first contributor.

Research has proposed several explanations for why fundraisers rely on sequential solicitation strategies. Many of these reduce the first contributor's inherent ability to free ride off second contributors in a public good game.[30] By contrast the introduction of fixed costs increases the first-mover advantage inherent in the public good game and a potential risk of sequential play is that provision may fail unless the fundraiser is successful in convincing initial contributors to donate a fair share. Perhaps this concern for equality helps explain why fundraisers have specific goals for how large seed money needs to be as a share of the overall fundraising goal.[31]

[30] For example, to signal that a charity is of high quality the first player will have to contribute an amount which is larger than what would have been needed had the charity been known to be of high quality.

[31] As noted in Andreoni (2006) Lawson, 2007, p 756 states "the lead gift should be at least 10% of the overall goal." Hartsook in *Fund Raising Management* (August 1994, p. 32) advises that ''the leadership commitment . . . should represent no less than 20 percent of the capital campaign goal.''

Appendix I:

Payoff table with FC=0

		Other Group Member										
		0	1	2	3	4	5	6	7	8	9	10
You	0	4.0, 4.0	4.5, 4.1	5.0, 4.2	5.5, 4.3	6.0, 4.1	6.5, 3.9	7.0, 3.7	7.5, 3.5	8.0, 2.9	8.5, 2.3	9.0, 1.7
	1	4.1, 4.5	4.6, 4.6	5.1, 4.7	5.6, 4.8	6.1, 4.6	6.6, 4.4	7.1, 4.2	7.6, 4.0	8.1, 3.4	8.6, 2.8	9.1, 2.2
	2	4.2, 5.0	4.7, 5.1	5.2, 5.2	5.7, 5.3	6.2, 5.1	6.7, 4.9	7.2, 4.7	7.7, 4.5	8.2, 3.9	8.7, 3.3	9.2, 2.7
	3	4.3, 5.5	4.8, 5.6	5.3, 5.7	5.8, 5.8	6.3, 5.6	6.8, 5.4	7.3, 5.2	7.8, 5.0	8.3, 4.4	8.8, 3.8	9.3, 3.2
	4	4.1, 6.0	4.6, 6.1	5.1, 6.2	5.6, 6.3	6.1, 6.1	6.6, 5.9	7.1, 5.7	7.6, 5.5	8.1, 4.9	8.6, 4.3	9.1, 3.7
	5	3.9, 6.5	4.4, 6.6	4.9, 6.7	5.4, 6.8	5.9, 6.6	6.4, 6.4	6.9, 6.2	7.4, 6.0	7.9, 5.4	8.4, 4.8	8.9, 4.2
	6	3.7, 7.0	4.2, 7.1	4.7, 7.2	5.2, 7.3	5.7, 7.1	6.2, 6.9	6.7, 6.7	7.2, 6.5	7.7, 5.9	8.2, 5.3	8.7, 4.7
	7	3.5, 7.5	4.0, 7.6	4.5, 7.7	5.0, 7.8	5.5, 7.6	6.0, 7.4	6.5, 7.2	7.0, 7.0	7.5, 6.4	8.0, 5.8	8.5, 5.2
	8	2.9, 8.0	3.4, 8.1	3.9, 8.2	4.4, 8.3	4.9, 8.1	5.4, 7.9	5.9, 7.7	6.4, 7.5	6.9, 6.9	7.4, 6.3	7.9, 5.7
	9	2.3, 8.5	2.8, 8.6	3.3, 8.7	3.8, 8.8	4.3, 8.6	4.8, 8.4	5.3, 8.2	5.8, 8.0	6.3, 7.4	6.8, 6.8	7.3, 6.2
	10	1.7, 9.0	2.2, 9.1	2.7, 9.2	3.2, 9.3	3.7, 9.1	4.2, 8.9	4.7, 8.7	5.2, 8.5	5.7, 7.9	6.2, 7.3	6.7, 6.7

Payoff table with FC=6

		Other Group Member										
		0	1	2	3	4	5	6	7	8	9	10
You	0	4.0, 4.0	4.0, 3.6	4.0, 3.2	4.0, 2.8	4.0, 2.1	4.0, 1.4	7.0, 3.7	7.5, 3.5	8.0, 2.9	8.5, 2.3	9.0, 1.7
	1	3.6, 4.0	3.6, 3.6	3.6, 3.2	3.6, 2.8	3.6, 2.1	6.6, 4.4	7.1, 4.2	7.6, 4.0	8.1, 3.4	8.6, 2.8	9.1, 2.2
	2	3.2, 4.0	3.2, 3.6	3.2, 3.2	3.2, 2.8	6.2, 5.1	6.7, 4.9	7.2, 4.7	7.7, 4.5	8.2, 3.9	8.7, 3.3	9.2, 2.7
	3	2.8, 4.0	2.8, 3.6	2.8, 3.2	5.8, 5.8	6.3, 5.6	6.8, 5.4	7.3, 5.2	7.8, 5.0	8.3, 4.4	8.8, 3.8	9.3, 3.2
	4	2.1, 4.0	2.1, 3.6	5.1, 6.2	5.6, 6.3	6.1, 6.1	6.6, 5.9	7.1, 5.7	7.6, 5.5	8.1, 4.9	8.6, 4.3	9.1, 3.7
	5	1.4, 4.0	4.4, 6.6	4.9, 6.7	5.4, 6.8	5.9, 6.6	6.4, 6.4	6.9, 6.2	7.4, 6.0	7.9, 5.4	8.4, 4.8	8.9, 4.2
	6	3.7, 7.0	4.2, 7.1	4.7, 7.2	5.2, 7.3	5.7, 7.1	6.2, 6.9	6.7, 6.7	7.2, 6.5	7.7, 5.9	8.2, 5.3	8.7, 4.7
	7	3.5, 7.5	4.0, 7.6	4.5, 7.7	5.0, 7.8	5.5, 7.6	6.0, 7.4	6.5, 7.2	7.0, 7.0	7.5, 6.4	8.0, 5.8	8.5, 5.2
	8	2.9, 8.0	3.4, 8.1	3.9, 8.2	4.4, 8.3	4.9, 8.1	5.4, 7.9	5.9, 7.7	6.4, 7.5	6.9, 6.9	7.4, 6.3	7.9, 5.7
	9	2.3, 8.5	2.8, 8.6	3.3, 8.7	3.8, 8.8	4.3, 8.6	4.8, 8.4	5.3, 8.2	5.8, 8.0	6.3, 7.4	6.8, 6.8	7.3, 6.2
	10	1.7, 9.0	2.2, 9.1	2.7, 9.2	3.2, 9.3	3.7, 9.1	4.2, 8.9	4.7, 8.7	5.2, 8.5	5.7, 7.9	6.2, 7.3	6.7, 6.7

Payoff table with FC=8

You \ Other Group Member	0	1	2	3	4	5	6	7	8	9	10
0	4.0, 4.0	4.0, 3.6	4.0, 3.2	4.0, 2.8	4.0, 2.1	4.0, 1.4	4.0, 0.7	4.0, 0.0	8.0, 2.9	8.5, 2.3	9.0, 1.7
1	3.6, 4.0	3.6, 3.6	3.6, 3.2	3.6, 2.8	3.6, 2.1	3.6, 1.4	3.6, 0.7	7.6, 4.0	8.1, 3.4	8.6, 2.8	9.1, 2.2
2	3.2, 4.0	3.2, 3.6	3.2, 3.2	3.2, 2.8	3.2, 2.1	3.2, 1.4	7.2, 4.7	7.7, 4.5	8.2, 3.9	8.7, 3.3	9.2, 2.7
3	2.8, 4.0	2.8, 3.6	2.8, 3.2	2.8, 2.8	2.8, 2.1	6.8, 5.4	7.3, 5.2	7.8, 5.0	8.3, 4.4	8.8, 3.8	9.3, 3.2
4	2.1, 4.0	2.1, 3.6	2.1, 3.2	2.1, 2.8	6.1, 6.1	6.6, 5.9	7.1, 5.7	7.6, 5.5	8.1, 4.9	8.6, 4.3	9.1, 3.7
5	1.4, 4.0	1.4, 3.6	1.4, 3.2	5.4, 6.8	5.9, 6.6	6.4, 6.4	6.9, 6.2	7.4, 6.0	7.9, 5.4	8.4, 4.8	8.9, 4.2
6	0.7, 4.0	0.7, 3.6	4.7, 7.2	5.2, 7.3	5.7, 7.1	6.2, 6.9	6.7, 6.7	7.2, 6.5	7.7, 5.9	8.2, 5.3	8.7, 4.7
7	0.0, 4.0	4.0, 7.6	4.5, 7.7	5.0, 7.8	5.5, 7.6	6.0, 7.4	6.5, 7.2	7.0, 7.0	7.5, 6.4	8.0, 5.8	8.5, 5.2
8	2.9, 8.0	3.4, 8.1	3.9, 8.2	4.4, 8.3	4.9, 8.1	5.4, 7.9	5.9, 7.7	6.4, 7.5	6.9, 6.9	7.4, 6.3	7.9, 5.7
9	2.3, 8.5	2.8, 8.6	3.3, 8.7	3.8, 8.8	4.3, 8.6	4.8, 8.4	5.3, 8.2	5.8, 8.0	6.3, 7.4	6.8, 6.8	7.3, 6.2
10	1.7, 9.0	2.2, 9.1	2.7, 9.2	3.2, 9.3	3.7, 9.1	4.2, 8.9	4.7, 8.7	5.2, 8.5	5.7, 7.9	6.2, 7.3	6.7, 6.7

Appendix II:

Instructions

Introduction

This is an experiment about decision making. There are fourteen people in this room participating in the experiment. You must not talk to the other participants or communicate with them in any way. If you have a question raise your hand and a monitor will come to where you are sitting to answer it.

The experiment consists of fourteen rounds. In each round you are randomly paired with one other participant. Your round earnings depend on the decisions made by you and by your group member for that round. Your decisions are anonymous; no one will be able to determine which decisions were made by you. At the end of the fourteen decision rounds we will randomly select three rounds for payment. You will be paid, in private and in cash, the sum of your earnings from the three selected rounds plus $5 for showing up to the experiment.

Investments

In each round you will be given $4. You can keep the $4 or you can invest in the group account. The cost of investing in the group account depends on the number of units you invest. The payoff from the group account depends on the sum invested by you and by your group member. Your earnings in each round will equal your initial $4 plus the payoff from the group account minus the cost of your individual investment.

Payoff from the group account

[**Threshold:** Provided the total amount invested by you and by your group member equals or exceeds 6 units, you and your group member will each get a payoff of 50 cents per unit invested in the group account. Thus if a total of 4 units are invested in the group account, then neither you nor your group member will get a payoff from the group account.] [**No Threshold:** You and your group member will each get a payoff of 50 cents per unit invested in the group account. Thus if a total of 4 units are invested in the group account, then you and your group member will each get a payoff of 4x0.5=$2 from the group account.] If you and your group member invests a total of 20 units in the group account, then you and your group member will each get a payoff of 20x0.5=$10. Your payoff from the group account depends only on the total amount invested in the group account by you and your group member.

Cost of investing in the group account

The cost of investing in the group account depends on the number of units you invest. If you invest 3 units or less the cost per unit invested is 40 cents. Every unit you invest between 4 and 7 units will cost you 70 cents per unit. Finally, every unit you invest in excess of 7 will cost you $1.10 per unit. If you invest 9 units your costs are 40 cents per unit for each of the first three units (3x0.4=$1.2), 70 cents per unit for the fourth through seventh unit (4x0.7 = $2.8), and $1.1 per unit for the eighth through the ninth (2x1.1=$2.2). Thus the total cost of your nine unit investment is 1.2+2.8+2.2=$6.2. You can at most invest 10 units in the group account. With you

and your group member each investing anywhere from 0 to 10 units, the total investment in the group account will range from 0 to 20 units.

Earnings

To determine the round earnings from the possible investments please take a look at the payoff table. Your earnings are reported in blue at the top left corner of each cell, the earnings to your group member are reported in orange at the lower right corner of each cell.

Let us examine two examples to better understand the payoff table and how earnings are determined.

Example 1:

[**Threshold:** Suppose you invest 2 units and your group member invests 0 units. With a total investment of 2 units, the investment in the group account is below the threshold and you and your group member will each get $0 from the group account. The per unit cost of your 2-unit investment is 40 cents for a total cost of 80 cents. Thus your earnings from this round equal $4 plus $0 from the group account minus your cost of $0.8 for a total of $3.2. Since your group member has zero investment cost he/she earns $4. These earnings are shown in the 0-column and 2-row cell, your earnings of $3.2 are listed in blue, and the $4 earnings to your group member is listed in orange. If the investment by your group member increases to 1 unit the payoff from the group account does not change because the total investment is still less than 6; while your earnings stay constant at $3.2 the earnings of your group member decreases by 40 cents from $4.0 to $3.6 to cover the 40 cent investment cost (see the 1-column and 2-row cell). If instead you increase your investment by 6 units, then the total investment of 8 is above the threshold and the payoff from the group account increases from $0 to $4 (0.5x8). However the cost of the additional investment is $4.3(=1x0.4+4x0.7+1x1.1). Therefore your earnings decrease by $0.3 dollars from $3.2 to $2.9, and the earnings to your group member increase by $4 from $4 to $8 (see the 0-column and 8-row cell).]

[**No Threshold:** Suppose you invest 2 units and your group member invests 0 units. With a total investment of 2 units, you and your group member will each get 2x0.5=$1 from the group account. The per unit cost of your 2-unit investment is 40 cents for a total cost of 80 cents. Thus your earnings from this round equal $4 plus $1 from the group account minus your cost of $0.8 for a total of $4.2. Since your group member has zero investment cost he/she earns $5. These earnings are shown in the 0-column and 2-row cell, your earnings of $4.2 are listed in blue, and the $5 earnings to your group member is listed in orange. If the investment by your group member increases to 1 unit the payoff from the group account increases by $0.5; while your earnings increases by $0.5 to $4.7 the earnings of your group member increases by 10 cents from $5.0 to $5.1 to cover the 40 cent investment cost (see the 1-column and 2-row cell). If instead you increase your investment by 6 units, the payoff from the group account increases from $1 to $4 (0.5x8). However the cost of the additional investment is $4.3(=1x0.4+4x0.7+1x1.1). Therefore your earnings decrease by $1.3 dollars from $4.2 to $2.9, and the earnings to your group member increase by $3 from $5 to $8 (see the 0-column and 8-row cell).]

Example 2: Suppose you invest 8 and your group member invests 6. With a total investment of 14 units, you each earn $7 (14x0.5) from the group account. Your investment costs for the 8 units are: 40 cents per unit for each of the first three units (3x0.4=$1.2), 70 cents per unit for the fourth through seventh unit (4x0.7 = $2.8), and $1.1 for the eighth unit. Thus the total cost of your eight unit investment is 1.2+2.8+1.1=$5.1. As shown in the 6-column and 8-row cell you earn 4+7-5.1=$5.9, and your group member earns $7.7. Increasing your investment by one unit increases the payoff from the group account by 50 cents and costs you $1.1. Thus as seen in 6-column and 9-row cell, your earnings decrease by 60 cents (0.5-1.1=-$0.6) to $5.3, your group member' earnings increase by 50 cents from $7.7 to $8.2.

Order of Investments

Seven participants will have the role of first mover, the other seven will have the role of second mover. The computer randomly assigns you to be either first or second mover. You are informed of your role at the beginning of the experiment, and you remain in this role throughout the experiment. Your role will appear at the top of your screen. It will either say "You are a FIRST mover" or "You are a SECOND mover", depending on your role.

In each round, each first mover will be anonymously and randomly paired with a second mover. In subsequent rounds you are randomly paired with a new participant.

In the first stage of a round the first mover decides how much to invest. Then, in the second stage, the second mover decides how much to invest. Before making his or her investment decision the second mover will not be informed of the first mover's investment decision.

Summary

In making your investment decisions, you will benefit from looking at the payoff table, or from recalling how earnings are determined.

1. In each round your earnings equal $4 plus your group-account payoff minus your investment costs.
2. First movers are randomly paired with second movers in each round. First movers make their investment decisions first, and second movers make their investment decisions second. The second mover will not be informed of the first mover's investment prior to making his or her decision.
3. **[Threshold:** Provided the total amount invested by you and by your group member equals or exceeds 6 units, the per unit payoff from the group account is 50 cents.][**No Threshold:** the per unit payoff from the group account is 50 cents.] That is $0.5 x [the investment by you + the investment by your group member].
4. The cost per investment unit is:
    a. 40 cents per unit between 1-3
    b. 70 cents per unit between 4-7
    c. $1.1 per unit between 8-10

Before we begin the experiment we want to make sure that you know how to read the payoff table. We therefore ask you to take a little quiz to help you understand the payoffs. Once you have finished the quiz, we will go over the correct answers. Your answers to the quiz will not influence your earnings.

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