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Jason A. Aimone
Baylor University

Laurence R. Iannaccone
Chapman University

Michael D. Makowsky
Johns Hopkins University

Jared Rubin
Chapman University, jrubin@chapman.edu

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Endogenous Group Formation via Unproductive Costs*

Jason Aimone
George Mason University

Laurence R. Iannaccone
Chapman University

Michael D. Makowsky
Towson University

Jared Rubin
California State University, Fullerton

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Abstract

We demonstrate that unproductive costs facilitate group formation and mitigate free riding. We conduct an experiment that allows groups to form endogenously by having subjects reveal their willingness to "sacrifice" a fraction of their private productivity within a voluntary contribution mechanism public goods game. The sacrifice mechanism, previously identified in the theory of religious clubs, functions in the lab absent any group identity or shared doctrine. We find that groups which emerge from subject preferences for higher rates of sacrifice screen out free riders, attract conditional cooperators, increase contributions to the public good, and offer potential welfare gains for members.

Keywords: Endogenous Group Formation, Laboratory Experiment, Free Riding, Public Goods Game, Voluntary Contribution Mechanism, Sacrifice, Unproductive Costs

JEL Codes: C92, D71, H41, Z12

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1. Introduction

Many individuals belong to groups that foster cooperation amongst members – social clubs, religious organizations, gangs, fraternities, social movement organizations, and the like. In such groups, each member contributes to a club good with positive externalities bestowed on the other group members. Group members have incentive to free ride, since it is difficult to exclude them from reaping the benefits of the group's actions. Some groups overcome the free-rider problem through monitoring, repeated interaction, or sanctions and rewards. Such mechanisms, however, are difficult to employ when inputs are not perfectly observable or groups are large enough that the threat of cutting off repeated interaction is limited (Olson 1971). Cooperation can be difficult to maintain even in small group settings, especially where enforcement institutions are lacking (Ostrom 1990). Nonetheless, groups facing these obstacles manage to successfully foster cooperation amongst their members every day. For example, contributions (or lack thereof) made to communes or religious services by any single member are often unobservable and hence difficult to sanction, reward, or track through time – yet such groups are ubiquitous. Why is this, and how do they form in the first place?

Iannaccone (1992) was the first to suggest that unproductive costs could increase the production of club goods and the net welfare of members. He proposed that "sacrifice and stigma" – unproductive costs – are mechanisms that religious groups employ to mitigate free riding by rational members. Religious groups face particularly vexing free rider problems, as exclusion is antithetical to proselytization goals and contributions are often difficult to monitor. The use of unproductive costs mitigates free-riding in two dimensions. First, it screens out individuals who are likely to free ride. Second, it changes the relative prices of group and non-group goods for members, hence increasing their level of contribution to the group good. The sacrifice and stigma theory thus provides a rational-choice explanation for the seemingly irrational behavior of voluntarily incurring unproductive costs. In the economics of religion literature alone, these insights have been employed to explain the behavior of radical religious groups (Berman 2004, 2009; Berman and Laitin 2005; Iannaccone 2006; Iannaccone and Berman 2006; Makowsky 2010), "strict" churches (Iannaccone 1994; Stark and Iannaccone 1997), Ultra-Orthodox

Jews (Berman 2000), Israeli kibbutzim (Abramitzky 2008), and 19th century utopian communes (Sosis 2000).

Yet, in each of these cases, numerous phenomena could be at work. For example, it is possible that individuals join groups with sacrifice or stigma requirements simply because they have idiosyncratic preferences for sacrifice or stigma (or the group identity associated with these actions). Such an alternative explanation cannot be disproven empirically without detailed information regarding individuals' motivations. If idiosyncratic preferences are indeed the primary factors driving such behaviors, then groups are not endogenously forming to screen out free-riders, but instead are separating based on desire for sacrificing or stigmatizing. This is an important difference, as a key insight of the sacrifice and stigma theory is that *unproductive* costs can be employed for economically *productive* purposes.

We propose the use of a laboratory experiment, absent any group identity or doctrinal construct, to separate the rational choice explanation proposed by Iannaccone from a preference-driven approach. We test whether imposing unproductive costs is an effective mechanism for endogenously forming groups which screen out free-riders. To this end, we employ a variant of the standard public goods game, the voluntary contribution mechanism (VCM), where subjects are granted an endowment and asked to split the endowment between themselves and the group. The VCM game is ideal for testing the theoretical problems associated with club goods, as the same problems arise in each: the Nash equilibrium prediction is that everyone free rides (gives nothing to the group), while the socially optimal solution is for everyone to give everything to the group. Our variant of the VCM game allows subjects to *endogenously* form groups by choosing a level of sacrifice (the unproductive cost) that is imposed on their private (non-group) good and the private good of each of their group members. From this, we gather what "types" of individuals enter high-sacrifice groups and how they act with respect to group contributions once in these groups.

Our experiment offers a chance to test the impact of unproductive costs on group sorting, group productivity, and member welfare. It also allows us to delineate between screening and relative price effects. We observe that sacrifice acts as a screening mechanism whereby subjects more prone to cooperation separate themselves from free riders. That is, subjects who are willing to give more to the group screen out free riders *endogenously* via unproductive costs. Moreover, differences in relative prices (of the public and private goods) between high-sacrifice and low-sacrifice groups encourage greater contributions to the public good in high-sacrifice groups and hence greater overall earnings.

Cooperation norms observed in laboratory experiments have long been recognized as generating levels of cooperation that exceed equilibrium theory (Davis and Holt 1993; Ledyard 1995). Yet, while whole families of social norms and market constructs have been offered as potential mechanisms for staving off reversion to free riding behavior, few are concerned with how these mechanisms arise *endogenously*. For example, Gunnthorsdottir et al. (2000) found that exogenous sorting, where free-riders less frequently interacted with defectors, was highly effective at slowing the decay rate of contributions. Likewise, Swope (2004) found that excludability of the public good through exogenously set minimum rates of contribution in the standard VCM setup was effective in curtailing free-riding but unable to consistently improve overall welfare. Other mechanisms tested in the laboratory include punishing defectors with sanctions (Masclet et al. 2003; Houser et al. 2008; Noussair and Tucker 2005; Anderson and Putterman 2006) and rewarding cooperators with greater rewards (Bohnet and Kubler 2005).[1]

Endogenous group formation (and partner selection in two player games) is a recent addition to the story of free rider mitigation (Coricelli et al. 2004; Page et al. 2005). Bohnet and Kubler (2005) achieve quasi-self sorting by auctioning off the right to play a more attractive form of a prisoners' dilemma, which offers insurance against defection. They find that cooperation increases temporarily but decreases over time. Ahn et al. (2008) find that restricted entry through admissions voting by current members who can observe past contribution rates of applicants can effectively increase contribution rates. Our results add to this literature by inducing endogenous group formation – through

[1] Sanctions and rewards have both been found effective in increasing contributions, but with strong caveats regarding magnitudes, perceptions of intent, and signal erosion over repeated play. Social institutions maintain the VCM game narrowly defined, but augment it via information, interaction, or group formation. Examples of social institutions tested in the laboratory, beyond VCM games, include communication before game play (Isaac and Walker 1988) and after game play (Xiao and Houser 2005), voting, exogenous sorting/matching of players (Burlando and Guala 2005), and the option of not playing (Orbell and Dawes 1993). For reviews of the relevant literature, see Laffont (1987) and Ledyard (1995).

a mechanism found *ubiquitously* in the real world – with a simple modification to a standard public goods game.

Results from our experiment strongly support the hypothesis that unproductive costs can successfully engender higher rates of cooperation amongst group members and do so in an anonymous laboratory setting absent any group identity or doctrine. We find that changes in relative prices (between private and public goods) act to screen out free-riders and that subjects who choose high-sacrifice groups contribute more to the public good once in these groups. Our results suggest that members of high sacrifice groups experience positive expected welfare gains, but with greater risk of net losses relative to low sacrifice groups.

2. Experiment

2.1.Normal VCM Game

Our experiment employs a variant of the standard voluntary contribution mechanism (VCM) public goods experiment (Davis and Holt 1993; Ledyard 1995). In the "Normal" VCM game, each subject is randomly placed into a group with three other subjects. Each subject independently makes a decision on how to divide a personal endowment of ten tokens between two accounts: a "private account" and a "group account." A subject gets one Experimental Dollar (E$) for each token they place in their own private account, and each of the four subjects in a group receives a return, of r E$s, for each token placed into the group account by any group member. A subject i's earnings in the experiment are therefore:

(1) $$\prod(g_i,g_{-i}) = (10 - g_i) + r \cdot (g_i + \sum g_{-i})$$

where g_i is the amount that i gives to the group. Each subject receives 0.40 E$s for every token any of their group members (including themselves) place into the group account, or $r = 0.40$.

The subgame-perfect Nash equilibrium is that all players free-ride and contribute nothing to the group (each token returns 1.00 E$s from being placed into a private account). However, the socially optimal solution is for all players to contribute everything to the group account (each token returns 0.40 E$s to each of the four subjects in the group, for a total return of 1.60E$s for each token placed into a group account). In actual experimental settings, players routinely contribute resources greater than zero, although repeated play of the game routinely reveals a steady decay of contributions (Davis and Holt 1993).

2.2.Sacrifice VCM Game

We introduce a "Sacrifice" VCM game, in order to capture subjects preferences predicted in the Iannaccone (1992) sacrifice and stigma model. The group account return in the Sacrifice VCM game is the same as in the Normal VCM game ($r = 0.40$). The difference between the Sacrifice and Normal VCM games is that the former allows subjects to indicate their preference for groups based on the private account return that all group members receive. While the return to the private account in the Normal VCM game is fixed at 1.00 E$ per token, subjects in the Sacrifice VCM choose a level of sacrifice, s_i, by choosing a private account return ($1 - s_i$) in the range {0.55, 0.60, 0.65, 0.70, 0.75, 0.80, 0.85, 0.90, 0.95} E$s per token (restricting the implied sacrifice preference of each subject, s_i, to the range [0.05, 0.45]). The private account return choices of the subjects are then ordered from highest to lowest. The four subjects with the highest private account return choices (lowest sacrifice preferences) are placed in a group together, the four subjects with the next highest private account return choices are placed in a group together, and so on (with all ties broken randomly).

The private account return in each group is then set to ($1 - s^*$) E$s for every token a subject places in their private account, where s^* is the average sacrifice level (s_i) chosen by the members of a particular group. Equation 2 shows how sacrifice affects subject earnings.

(2) $$\prod(g_i, g_{-i}) = [(10 - g_i) \cdot (1 - s^*)] + r \cdot (g_i + \sum g_{-i})$$

Since $1 - s_i$ is restricted to the range [0.55, 0.95], the private account return ($1 - s^*$) is guaranteed to be greater than the group account return (since $r = 0.4$). Hence, the Nash equilibrium in the Sacrifice VCM is equivalent to the Nash equilibrium in the Normal VCM game: each player contributes nothing to the group account and everything to the private account. It follows that that choosing the minimum possible sacrifice, $1 - s_i = 0.95$, is a Nash equilibrium action.

2.3.Implementation of the VCM games

We implement each of the VCM games using the Fischbacher et al. (2001) type elicitation method. As in Fischbacher et al.'s public goods experiment, individuals make both a conditional contribution decision (conditional on the average choice of the group members) and an unconditional contribution decision. For their conditional contribution decision, subjects indicate how many tokens they would like to contribute to the group account conditional on each possible average contribution of the other three group members (from 0 to 10 tokens). The conditional contribution of one randomly selected subject in each group is used in the experiment, and the remaining subjects use their unconditional contribution.

Each subject participates in multiple one-shot VCM games, though subjects are not told how many games they play. We use two different treatment orderings of the Normal and Sacrifice VCM games. In the first treatment, henceforth referred to as the "Experienced" ordering, subjects complete a Normal VCM first and a Sacrifice VCM second (named because subjects have experienced a completed VCM game before making their sacrifice decisions). In the second treatment, henceforth referred to as the "Inexperienced" ordering, subjects complete a Sacrifice VCM first and a Normal VCM second.[2] After playing the two VCM game rounds, subjects in both treatments play a second Sacrifice VCM game (see the instructions in Appendix A).

3. Theory and Predictions

3.1.Setup

Iannaccone (1992) suggests that sacrifice encourages optimal participation in a club good by increasing the implicit (or shadow) price of the non-club good.[3] It may also serve as a mechanism whereby those with lower opportunity costs of contributing to the group good screen out free riders by imposing higher costs on the private good. In this section, we develop a model that extends these hypotheses in the context of the experiment.

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[2] In the Experienced ordering, subjects read the additional instructions associated with the Sacrifice VCM after completing the Normal VCM round. In the Inexperienced ordering subjects read the additional instructions associated with the Sacrifice VCM immediately following the basic game instructions. We do this so that subjects would approach the first VCM game as a one-shot game without the anticipation of the second round game.

[3] In this case, we are discussing a positive congestion club good, where greater participation by an individual is always a net positive for the other members of the club.

The population consists of N players who choose groups to join. These groups contain the features of classic club goods. Each player derives utility from the contributions of other players in their club, with utility increasing in total contributions – similar to the VCM game described in section 2.

We begin by assuming that subjects differ along one dimension – the utility they derive from giving, in this case to other club members. There are two types of players: those who receive utility from giving and those who do not.[4] This utility may arise from "warm glow", altruism, expected reciprocity, and the like (Andreoni 1990). As in the experiment, the model is not intended to distinguish between altruism, "warm glow", reciprocity, and the like. It merely fleshes out the implications of sacrifice given that any or all of these phenomena enter the utility function.

Before the game begins, each player i receives a realization of their "type", H or L. H-type players derive utility from giving to the group and L-type players do not. H-type players receive $u(g_i,\bar{g})$ for every g_i dollars they give to the group (on top of their monetary return), where $\bar{g}$ is the amount given to the group by the other group members. We assume that $u(0,\cdot) = 0$, $u_1 > 0$, $u_{11} < 0$, and $u_{12} \geq 0$. $u_{12} \geq 0$ means that players receive (weakly) more utility from giving when others in their group give more. L-type players receive zero additional utility from giving to the group (that is, $u = 0$).

At the beginning of the game, players receive an endowment which they split between their personal consumption and group contribution (as in the classic VCM game or in any club setting). As in the experiment, groups differ on the basis of the level of (unproductive) sacrifice to private productive activities that are made as a cost of joining the group. In the real world, this can be thought of as religious groups with varying sacrifice requirements or fraternities with differing levels of hazing. Player i announces that she would like to join a group $s_i \in S$, where s_i is the sacrifice level i would like the group to impose. $S = \{s_0, s_1, \ldots, s_M\}$, and it maps onto the sacrifice level of the group with whom the player actually plays the game.

Players are grouped (in groups of size G) with other players who choose similar values of s_i. Grouping works as follows: players are ordered from lowest to highest

[4] We have verbally sketched out a version of this model where the utility derived from giving is a continuous random variable and there is a continuum of types. That model provides similar, though less tractable, insights and is available upon request.

choice, and the first G are grouped together, then the next G, and so on (as in the experiment). Denote s^* as the group that player i joins, which is a function of the sacrifice she selects (s_i).

Players divide their endowed wealth (normalized to 1) into their private account, which yields a constant return, and a group account, which yields a return based on the sum of the contributions of all group members. The amount that subject i puts into the group account is denoted g_i, and she thus puts $1 - g_i$ into its private account. Players choose g_i in order to maximize their expected equilibrium utility, U:

(3) $$U = v((1 - g_i)(1 - s^*) + r(g_i + (G - 1)\bar{g})) + u(g_i, \bar{g}).$$

r represents the return from group contributions and v is a standard von Neumann-Morganstern utility function. Assume that $r < 1 - s^*$, $r > 1/G$, $v' > 0$, and $v'' < 0$. The assumption $r < 1 - s^*$ ensures that the money-maximizing Nash equilibrium is always to free ride and give zero to the group, while $r > 1/G$ ensures that giving the entire endowment to the group is Pareto optimal.

The equilibrium amount given to the group is 0 for L-types and is equal to $\max\{0, g_i^*\}$ for H-types, where g_i^* is defined implicitly by the equation: $u_I = (1 - s^* - r)v'$.

Players then choose a sacrifice level which maximizes their expected payout. Again, denote the chosen sacrifice level as s_i, which in turn helps determine the sacrifice level played, s^*. Expected utility, given s_i, is:

(4) $$E[U|s_i] = E[v((1 - g_i)(1 - s^*) + r(g_i + (G - 1)\bar{g}))|s_i] + E[u(g_i, \bar{g})|s_i].$$

There are two fundamental sources of uncertainty for each player. The first is that she does not know how much the other players will give to the group. The amount given is a function of the other subjects' types, which are unobservable. Secondly, the subject does not know the mapping of s_i (the sacrifice level chosen) onto s^* (the sacrifice level played), since this depends on the choices of the other subjects. Thus, g_i^* is a random variable (from the perspective of player i) because it is a function of s^*, while $\bar{g}^*$ is a random variable because it is a function of both s^* and the types of the players in the group.

3.2.Solving the Model

Three broad classes of equilibria exist. In this section, we show the conditions under which each type of equilibrium exists. We then derive predictions associated with each type of equilibria which are tested in the experiment.

3.2.1. Pooling Equilibrium

A pooling equilibrium occurs when all subjects pool into one group, denoted s_P^*. In this group, H-type players receive the following expected utility:

(5) $$E[U] = \Pr(\text{no L in group})\cdot[v((1-g^*(s_P^*))(1-s_P^*) + rGg^*(s_P^*)) + u(g^*(s_P^*),(G\text{-}1)g^*(s_P^*))] + \Pr(\text{one L in group})\cdot[v((1-g^*(s_P^*))(1-s_P^*) + r(G-1)g^*(s_P^*)) + u(g^*(s_P^*),(G-2)g^*(s_P^*))] + \Pr(\text{two L in group})\cdot[v((1-g^*(s_P^*))(1-s_P^*) + r(G-2)g^*(s_P^*)) + u(g^*(s_P^*),(G-3)g^*(s_P^*))] + \ldots + \Pr(\text{all others L})\cdot[v((1-g^*(s_P^*))(1-s_P^*) + rg^*(s_P^*)) + u(g^*(s_P^*),0)]$$

Meanwhile, L-type players receive the following expected utility:

(6) $$E[U] = \Pr(\text{one L in group})\cdot v(1-s_P^* + r(G-1)g^*(s_P^*)) + \Pr(\text{two L in group})\cdot v(1-s_P^* + r(G-2)g^*(s_P^*)) + \ldots + \Pr(\text{all L in group})\cdot v(1-s_P^*)$$

The conditions under which this equilibrium holds are seen by considering the decision made by L-type players.[5] If an L-type player deviates and chooses some group s_D, she will end up in a group with sacrifice level $s_D^* = \frac{s_P^*(G-1)+s_D}{G}$, and she will be placed with a random draw of $G-1$ players. Thus, her expected utility from deviating is:

(7) $$E[U] = \Pr(\text{one L in group})\cdot v(1-s_D^* + r(G-1)g^*(s_D^*)) + \Pr(\text{two L in group})\cdot v(1-s_D^* + r(G-2)g^*(s_D^*)) + \ldots + \Pr(\text{all L in group})\cdot v(1-s_D^*)$$

Since the probabilities are the same in both cases, it follows from (6) and (7) that a necessary, but not sufficient, condition for an L-type player to deviate is:[6]

(8) $$s_D^* - s_P^* > r(G-1)[g^*(s_D^*) - g^*(s_P^*)]$$

Equations (6), (7), and (8) indicate that when price effects ($\frac{\partial g^*}{\partial s^*}$) are large, a pooling equilibrium can only exist when there are a sufficiently large number of H-type players and $s_D < s_P^*$. This is true for all possible deviations (s_D), so the only pooling equilibrium that can emerge is in the highest sacrifice group – where a large number of H-type players who give a lot to the group provide incentive to stay in the group despite

[5] The decisions made by H-type players follow a similar logic and provide the same qualitative results.
[6] An L-type will deviate only when the left hand side of (8) is sufficiently larger than the right hand side.

the high level of sacrifice. Conversely, (6), (7), and (8) indicate that when price effects are small, a pooling equilibrium can only exist when there are a sufficiently large number of L-type players and $s_D > s_P^*$. This is true for all possible deviations, so the only pooling equilibrium that can emerge is in the lowest sacrifice group – where a large number of L-type players who give nothing to the group provide incentive to stay in the group and not deviate for a higher group payout in a higher sacrifice group.

These results suggest that if we see pooling in the experiment, it should either be in the highest or lowest sacrifice groups. If it is in the highest sacrifice group, subjects should exhibit significant price effects, while if it is in the lowest sacrifice group, price effects should play little role in the behavior of the subjects.

3.2.2. Perfect Screening Equilibria

In the other classes of equilibria, more than one sacrifice group is chosen in equilibrium.[7] We denote one of these classes a "perfect screening equilibrium" since H-type players screen out all L-types by choosing high sacrifice groups, while L-type players choose low sacrifice groups. This equilibrium holds under some conditions because H-type players give more to the group and thus lose less from high sacrifice.

For analytical simplicity, ignore the one mixed group that may emerge if H and L-types do not fit evenly into groups. In equilibrium, L-types must choose the lowest sacrifice level possible, denoted s_L^*. Otherwise, an L-type would have incentive to deviate to a lower sacrifice level. Hence, L-types receive utility $v(1 - s_L^*)$ in equilibrium.

Meanwhile, all H-types choose the same group (since they have the same objective function), denoted s_H^*, where $s_H^* > s_L^*$. If L-types deviate to s_H^*, they receive utility $v(1 - s_H^* + r(G - 1)g^*(s_H^*))$. Hence, the equilibrium only holds if:

(9) $$s_H^* - s_L^* > r(G - 1)g^*(s_H^*).$$

Conversely, H-types derive the following utility in equilibrium:

(10) $$v((1 - s_H^*)(1 - g^*(s_H^*)) + rGg^*(s_H^*)) + u(g^*(s_H^*), (G - 1)g^*(s_H^*))$$

However, if H-types deviate to s_L^*, they receive:

(11) $$v((1 - s_L^*)(1 - g^*(s_L^*)) + rg^*(s_L^*)) + u(g^*(s_L^*), 0)$$

[7] Makowsky (2010) offers an alternative variation on the club theory of religion that produces an outcome with successful groups employing a range of sacrifice rates. In a similar manner to the model presented here, Makowsky distinguishes between "weak" screening and "strong" screening.

Comparing (10) with (11), it is clear that a perfect screening equilibrium cannot hold if price effects are sufficiently small. Otherwise, H-types do not receive a great enough return from the group to make up for the amount lost to sacrifice. Combined with (9), this suggests that a perfect screening equilibrium can only hold if price effects are not too large or too small. More formally, there is some range over which price effects must fall in order for a perfect screening to exist. The intuition behind this result is that if price effects are large (and H-types give a significant amount to the group), L-types will have incentive to enter the group consisting of only H-types, even though this entails more sacrifice. Conversely, if price effects are small and H-types give little to the group (relative to how much they give at lower sacrifice levels), H-types have incentive to enter the low sacrifice group, foregoing a slightly higher group payout in order to receive a lower sacrifice rate.

The primary prediction emerging from this analysis is that if a perfect screening emerges, then higher sacrifice groups will have higher group payouts. However, the overall payout (group + private) will be greater in the low sacrifice groups.

3.2.3. "Imperfect" Screening Equilibria

Is it possible for an equilibrium to exist if free-riders (L-types) are not "perfectly" screened out? In reality, it is rare that mechanisms which are employed to reduce free-riding will eliminate all instances of free-riding – a successful mechanism merely needs to *reduce* free-riding. In this section, we analyze the conditions under which some, but not all, free riders (L-types) are screened out of sacrifice groups.

Perfect screening equilibria do not exist when price effects ($\frac{\partial g^*}{\partial s^*}$) are sufficiently large. In this case, L-type players have incentive to join high sacrifice groups and obtain the higher group payout while giving nothing to the group. Such actions may be part of an "imperfect" screening equilibrium, however. We denote L-types who enter high sacrifice groups as "infiltrators", formally defined as:

Definition 1: *An **infiltrator** is an L-type player who joins a high sacrifice group.*

An "imperfect" screening equilibrium arises when some L-type players infiltrate high sacrifice groups. When this happens, sacrifice groups are less attractive to other potential infiltrators for two reasons. First, the expected group payout from these groups is lower. Secondly, the riskiness of joining these groups is greater, since there is a nontrivial probability the one will join a group with an infiltrator and receive both a lower private *and* group payout. However, there is a limit to the number of infiltrators that can join any one high sacrifice group. If there are too many infiltrators, the expected payout in the high sacrifice groups will be too low and infiltrators have incentive to leave the group.

If free-riders are imperfectly screened, some L-type players choose a low sacrifice group (s_L^*) and some L and all H-type players choose a high sacrifice group (s_H^*). The conditions under which such an equilibrium hold are seen by analyzing the decision of the L-types. If they enter the low sacrifice group, they will be placed with other L-types and receive utility $v(1 - s_L^*)$. If they "infiltrate" the high sacrifice group, they receive expected utility:

(12) $$E[U] = \Pr(\text{one L in group})\cdot v(1 - s_H^* + r(G-1)g^*(s_H^*)) + \Pr(\text{two L in group})\cdot v(1 - s_H^* + r(G-2)g^*(s_H^*)) + \ldots \Pr(\text{all L in group})\cdot v(1 - s_H^*)$$

It is clear by comparing (12) with $v(1 - s_L^*)$ that as long as H-types contribute enough for at least one L-type to deviate, an "imperfect" screening equilibrium will always exist. Moreover, the bigger that $g^*(s_H^*)$ is, the more infiltrators there will be in equilibrium. The intuition is that when H-types give more to the group, it makes infiltrating more desirable. However, each additional L-type infiltrating makes infiltrating less desirable, since it decreases the expected return from joining the high sacrifice group. An equilibrium number of infiltrators thus emerges that balances out these two forces.

Since the payout associated with infiltrating is risky, it must also be true that the expected payout is greater for both types in high sacrifice groups than it is in low sacrifice groups. An equilibrium emerges only when infiltrators receive a "sacrifice premium" where a balance is struck between higher expected payouts in high sacrifice groups and lower risk in low sacrifice groups. Indeed, there must be some positive probability of infiltrators decreasing there earnings by entering high sacrifice groups – otherwise, infiltrating is always a best response.

This logic entails that in an "imperfect" screening equilibrium, the following predictions arise.

Hypothesis 1 (Price effects and screening I): Average contributions to the group account will be higher in high sacrifice groups than in low sacrifice groups.

Hypothesis 2 (Price effects and screening II): The total payout (group + private) will be greater for players in high sacrifice groups than in low sacrifice groups.

Hypothesis 3 (Sacrifice Premium): A small premium will be available (for free-riders) from joining high sacrifice groups relative to low sacrifice groups.

Hypothesis 4 (Payout Risk): There is a positive probability of obtaining a lower total payout by infiltrating high sacrifice groups relative to low sacrifice groups.

Hypothesis 5 (Infiltrators): There will exist a positive number of "infiltrators" – that is, subjects who choose high sacrifice groups and then contribute little to the group.

4. Results

The experiment was conducted at the Interdisciplinary Center for Economic Science (ICES) at George Mason University. Subjects were randomly recruited from the George Mason student body. In addition to any amount earned in the experiment, each subject received five dollars for arriving to the laboratory on time. Subjects spent about two and a half hours in the laboratory and earned about $23 on average (including quiz and show-up fees). We report data from 120 subjects in eight sessions of the experiment as well as data from 40 subjects in three additional control sessions (reported in Section 4.3). 60 subjects participated in each of the two possible orders of play: "Experienced" (Round 1 Normal VCM; Round 2 Sacrifice VCM; Round 3 Sacrifice VCM) and "Inexperienced" (Round 1 Sacrifice VCM; Round 2 Normal VCM; Round 3 Sacrifice VCM).[8] All control session subjects participated in the "Inexperienced" game. Before making their VCM game decisions, subjects read the instructions while an experimenter read the instructions out loud. Subjects answered graded quiz questions and received $0.25 for each correct answer.[9] Subjects were unaware each round whether there would be a subsequent round, though they were informed they would play that round only once with their current set of group members.

[8] Each ordering consisted of three sessions of 16 subjects and one session of 12 subjects.

[9] On average (in Experienced and Inexperienced sessions) subjects answered 7.5 questions right out of 9 on their first try.

In the following sections, we consider the 5 hypotheses associated with the "imperfect" screening equilibrium denoted in the model. Although it is not clear *ex ante* which equilibrium will emerge, the "imperfect" screening equilibrium has by far the least restrictive conditions and is also the one most commonly found empirically.

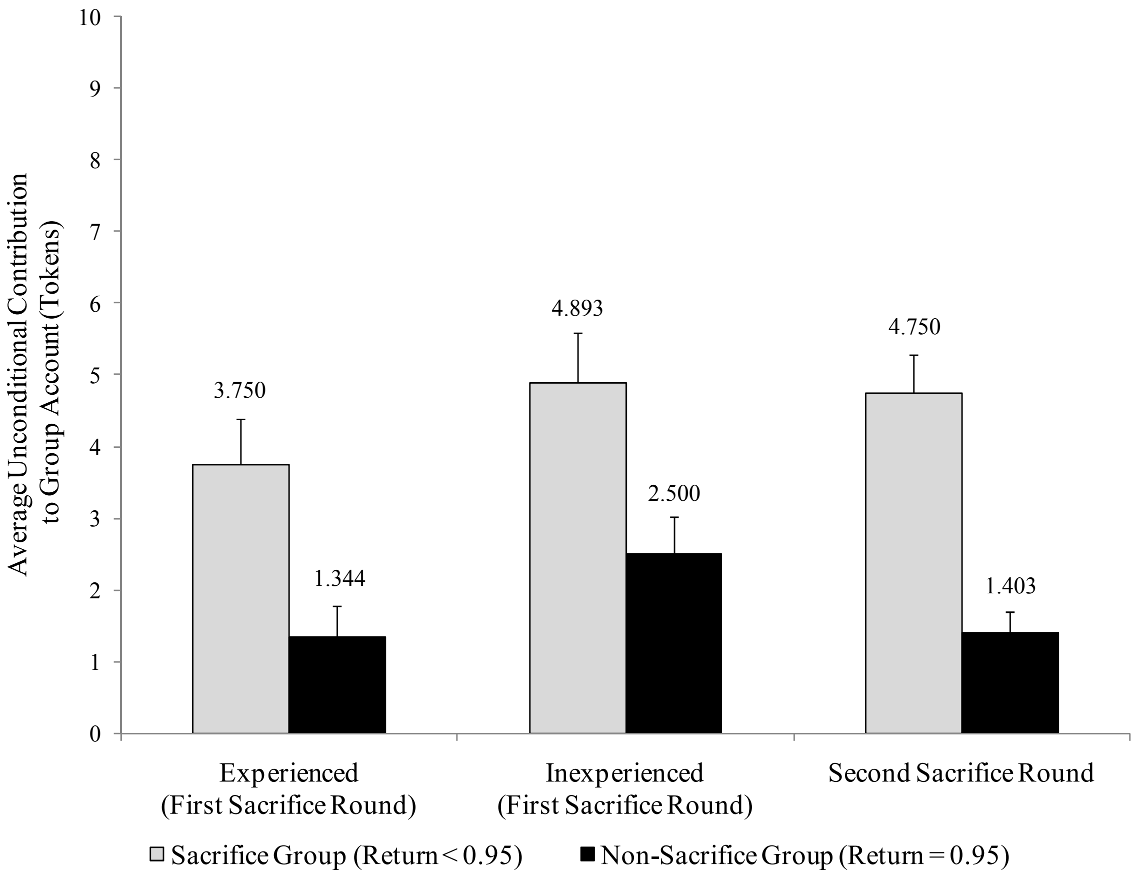
4.1. Unconditional Contributions

Average unconditional contribution rates provide initial insight into the effect of sacrifice. As discussed in the previous section, we expect subjects to endogenously form two general types of groups: 'non-sacrifice' groups (those with private account return rates $1 - s_i = 0.95$E$s) and 'sacrifice' groups (those with private account return rates $1 - s_i < 0.95$ E$s).

Hypothesis 1 of the model predicts that the average unconditional contribution to the group account is higher in sacrifice groups than in non-sacrifice groups. This is what we find. As illustrated in Figure 1, subjects in sacrifice groups contributed significantly more to the group account, regardless of game-play order.[10] In the second round, subjects in sacrifice groups also (unconditionally) contributed more to the group account. The lighter shaded bars show that subjects in sacrifice groups in the first sacrifice round of the Experienced ordering contributed an average of 3.75 E$s to the group account while subjects in non-sacrifice groups each contributed an average of 1.34 E$s. This difference is significant at a 1% level (2-sided Mann-Whitney test, p-value < 0.01). The difference between contributions made by those in sacrifice versus non-sacrifice groups is also significant in both the first sacrifice round of the Inexperienced ordering ($p < 0.01$) and the second sacrifice round ($p < 0.01$).

[10] All reported results are based on the sacrifice level used by subjects. The results are qualitatively similar if broken down by sacrifice level chosen. That is, the mechanism that we employ to group subjects is not driving the results. The results broken down by sacrifice level chosen are available upon request.

Figure 1: Average Unconditional Contribution to Group Account in Sacrifice VCM Round



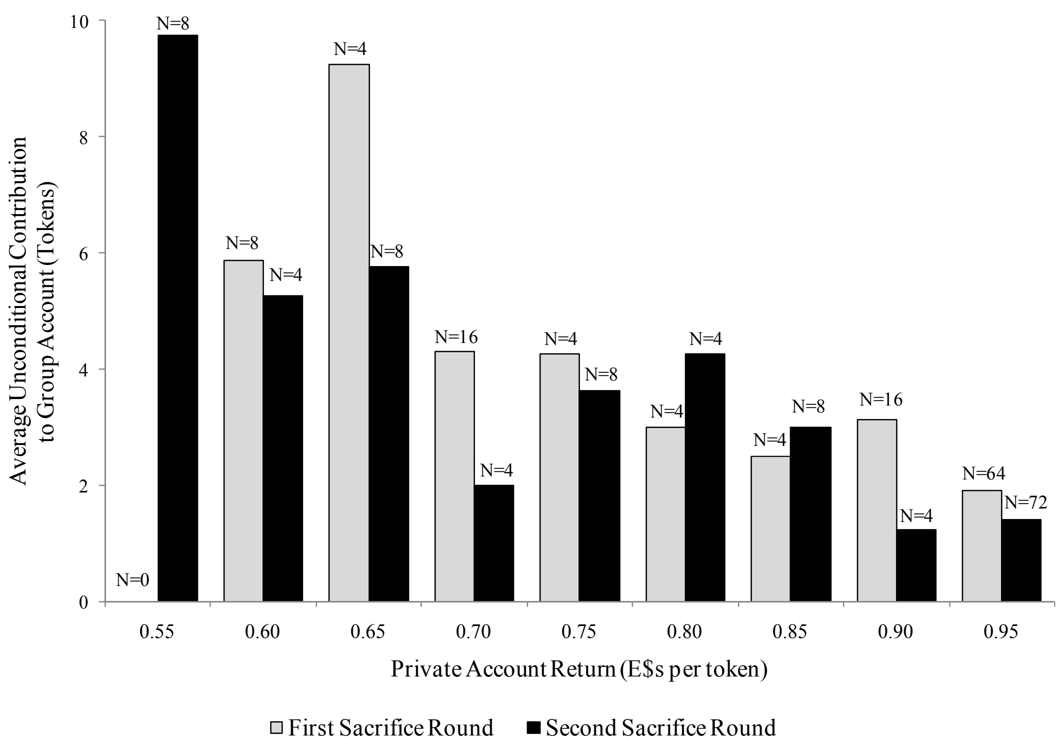
In both the Experienced and Inexperienced ordering, we observed the formation of seven sacrifice groups ($1 - s^* < 0.95$) and eight non-sacrifice groups ($1 - s^* = 0.95$). 35 (34) subjects in the Experienced (Inexperienced) order chose a private account return rate of 0.95 E$s per token while 25 (26) chose a private account return rate of less than 0.95 E$s per token.[11] The distribution of private account return choices by subjects is not significantly different between the Experienced and Inexperienced orderings (Kruskal-Wallis test, p=0.72). Moreover, there is no statistically significant difference in the average difference between the amount given to the group by those in the sacrifice versus

[11] Within each treatment, one session involved only 12 participants, instead of 16. These sessions both broke up into two non-sacrifice groups and one sacrifice group. We observed 2 subjects who chose sacrifice yet participated in groups with a private account return rate of 0.95, and 4 subjects who chose $1 - s = 0.95$, yet participated in groups with private account return rates of less than 0.95.

non-sacrifice group in the first round (the average difference is 2.41 in the Experienced ordering and 2.39 in the Inexperienced ordering). These results indicate that order effects are not driving the observed outcomes.

Next, we consider the relationship between the unconditional contribution and the sacrifice level across all sacrifice levels. Hypothesis 1 suggests that there should be a negative (positive) correlation between group return (sacrifice level) and group contribution. This is confirmed in Figure 2, which displays the average unconditional contribution to the group account for each observed level of private account return rate for a group. As the private account return used by a group increases, the observed decreasing trend in average unconditional contributions is significant at a 1% level. The trend is significant for Experienced (Cuzick trend test, $p < 0.01$) and Inexperienced ($p < 0.01$) orderings separately or pooled ($p < 0.01$), as well as the second sacrifice round (pooled, $p < 0.01$).

Figure 2: Average Unconditional Contribution to Group Account

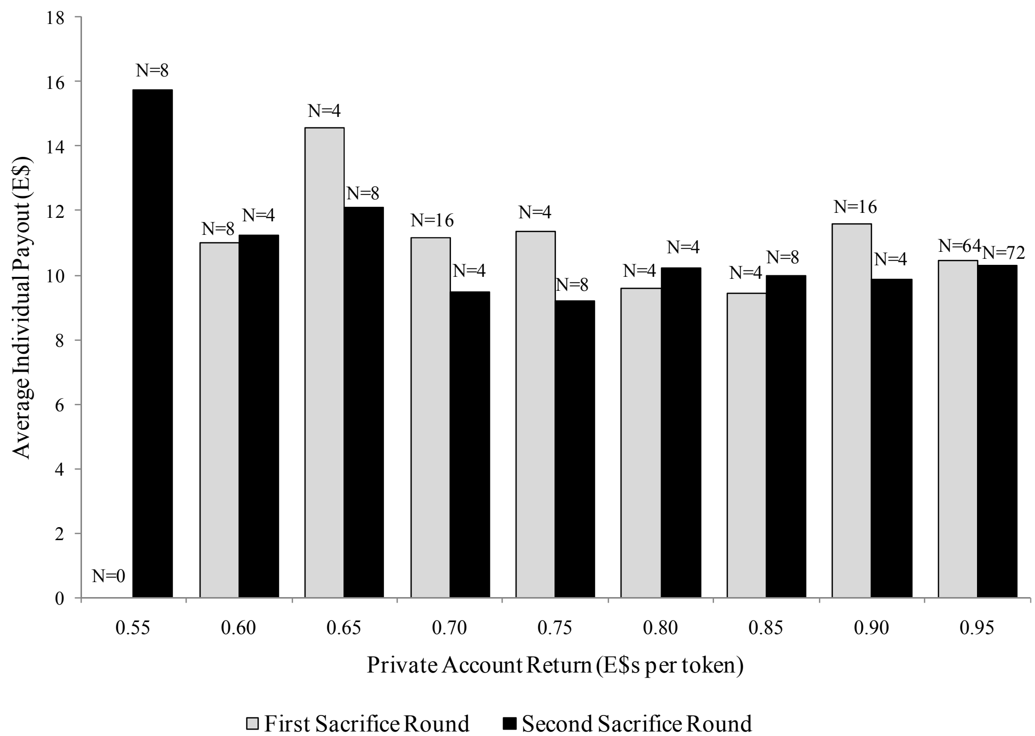


Next, we consider Hypothesis 2, which states that the total payout (group + private) will be greater for players in high sacrifice groups than in low sacrifice groups, but not by much. In the model, this outcome arises because the gains from joining high sacrifice groups cannot be too large (or infiltrating would be optimal and no one would join low sacrifice groups) or negative (otherwise no one would join high sacrifice groups, which have riskier payouts).

Figure 3 supports this hypothesis. This figure shows the average payout – the return from the group plus private account – in the first (pooled) and second (pooled) sacrifice rounds. The trend is slightly negative. The negative trend is statistically significant in the second sacrifice round(Cuzick trend test, $p < 0.01$) and marginally significant ($p = 0.08$) for the first round. Indeed, the model predicts that the slope should be negative but not very steep (though how steep the slope needs to be for equilibrium to hold is dependent on the model's parameters). Hence, these results suggest that the average individual payout is slightly increasing (decreasing) in sacrifice (private account return rate).[12]

[12] Analysis of the first and second sacrifice rounds without pooling the Experienced and Inexeperienced subjects provides further evidence that the trend is only slightly negative. In the first sacrifice round the marginally significant payout trend exists only with the Experienced subjects ($p = 0.08$) but not with the Inexperienced subjects ($p = 0.37$). Similarly, the decreasing trend in the second sacrifice round occurs only with the inexperienced subjects ($p < 0.01$) and less so with the experienced subjects ($p = 0.12$).

Figure 3: Average Individual Payout

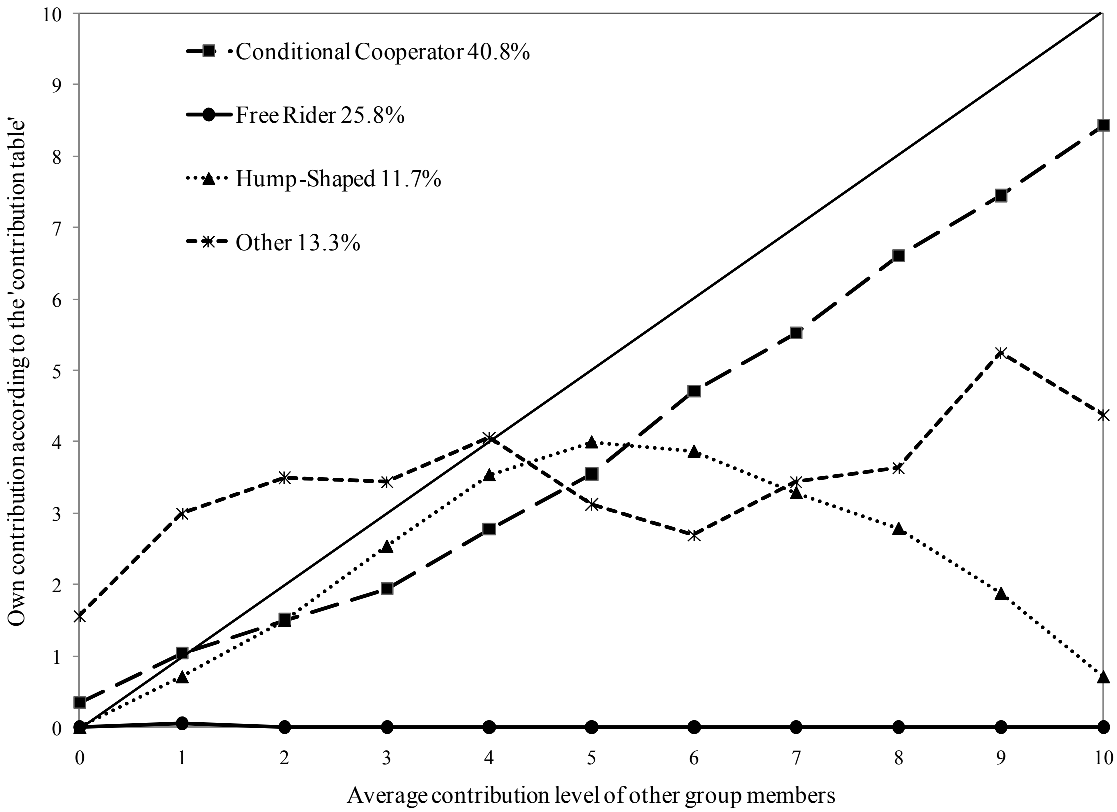


4.2.Conditional Contributions

The use of the Fischbacher et al. (2001) style VCM game in our experiment allows us to observe a subject's unconditional contributions and conditional contributions to the group account. The conditional contributions permit us to determine whether each subject is a conditional cooperator, a free-rider, a 'hump-shaped' contributor (a.k.a. 'triangle' contributor), or an 'other' type, as found in Fischbacher et al. (2001). For each of the three rounds of a session, we typed each subject, using procedures based on those outlined in Fischbacher et al. (2001).[13]

[13] A "conditional cooperator" is a subject whose conditional contributions to the group account are increasing and (weakly) monotonic or has a positive significant (1%) Spearman rank correlation coefficient. Free-riders are subjects who never contribute anything to the group account (a few subjects are typed as free-riders who gave a total of 1 over all 11 possible average other contributions). 'Hump-shaped' contributors are subjects whose conditional contributions followed a general triangular path, with contributions that increase (like a conditional cooperator) but then decrease as the average contribution level of other group members gets high. 'Other' combines subjects whose decisions do not follow one of the other three types well. Supplementary documents, available by request, indicate precisely how each subject was typed.

Figure 4: Subject "Types" and Conditional Contributions



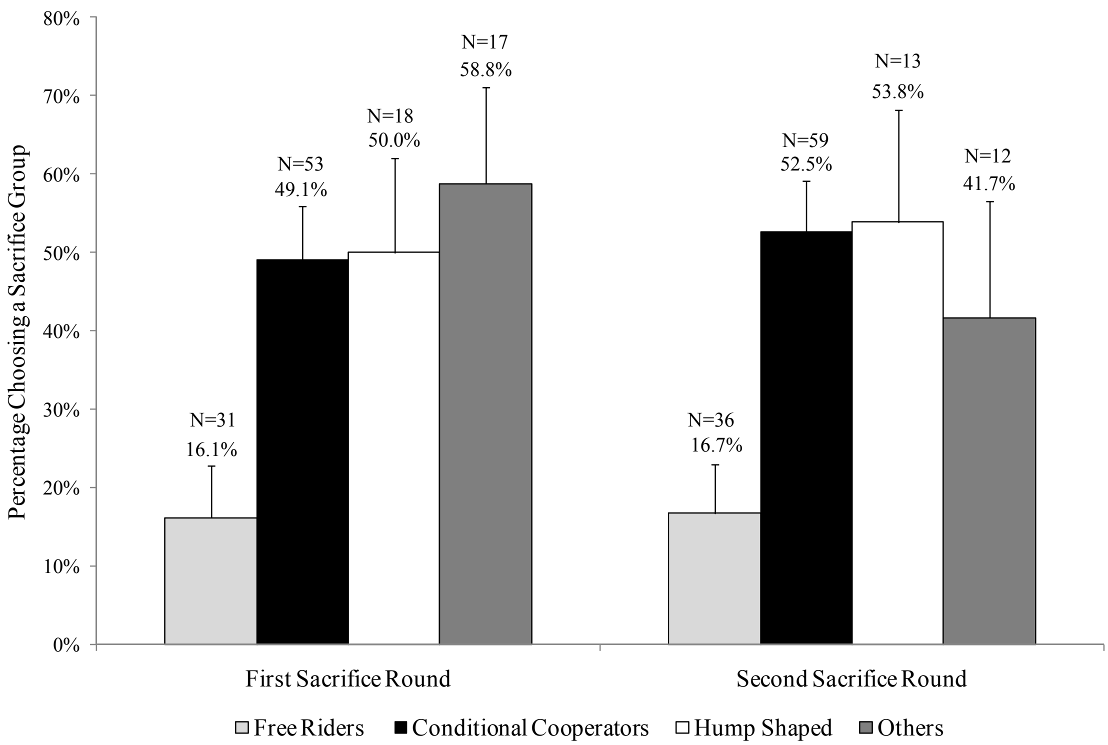
The average conditional contributions (in the normal VCM round) for each subject type illustrated in Figure 4 demonstrate how each type receives its name. We observe that (Experienced and Inexperienced pooled) 40.8% of subjects in the Normal VCM round are conditional cooperators, 25.8% are free-riders, 11.7% 'hump-shaped' contributors, and 13.3% other. A similar pooled distribution of types is seen in the Sacrifice VCM round where we observe 44.5% conditional cooperators, 26.1% free-riders, 15.1% 'hump-shaped' contributors, and 14.3% others.[14]

Typing subjects by their conditional contributions in the sacrifice round allows for a further test of the power of unproductive costs to screen free riders from those who contribute to the group (all other types). Figure 5 summarizes the fraction of each type that chose a sacrifice group in each sacrifice round. Free-riders choose sacrifice groups

[14] In their standard VCM games, Fischbacher et al. (2001) found 50%, 30%, 14%, and 6% of their subjects were conditional cooperators, free-riders, hump-shaped contributors, and other typed, respectively. Fischbacher and Gächter (2009) found 55.0%, 22.9%, 12.1% and 10.0% of their subjects were conditional cooperators, free-riders, hump-shaped contributors, and other typed, respectively.

less frequently than the other three types.[15] Free riders choose sacrifice groups only 16.1-16.7% of the time whereas the other types choose sacrifice groups 41.7-58.8% of the time. The difference between free riders and all other types is significant at the 1% level for both the first and second sacrifice rounds (Mann-Whitney Two-Tailed, $p < 0.01$ for each).[16]

Figure 5: Percentage of Each Type Choosing a Sacrifice Group



Next, we look at the make-up of sacrifice groups and non-sacrifice groups. While Figure 5 demonstrates the differences in decision-making of the types, Figure 6 shows us how the groups differ in their composition. Our theory predicts that sacrifice groups should be made up of relatively fewer free-riders and relatively more conditional cooperators. Figure 6 supports this prediction. 40.6% of the 64 subjects in Non-Sacrifice groups are free-riders while only 9.1% of the 55 subjects in Sacrifice groups are free-

[15] Note that we delineate subjects by their choice of groups, not the groups they actually played.
[16] The first sacrifice round significant difference is found for Experienced subjects ($p < 0.01$) and marginally for Inexperienced subjects ($p = 0.07$). There is also a significant difference ($p < 0.05$) in the second sacrifice round for both Experienced and Inexperienced subjects.

riders (Mann-Whitney two-tailed, $p < 0.01$).[17] Similarly, there are significantly more conditional cooperators in Sacrifice groups (54.5%) than in Non-Sacrifice groups (35.9%, p=0.04).[18]

Figure 6: Composition of Sacrifice and Non-Sacrifice Groups (First Sacrifice Round)

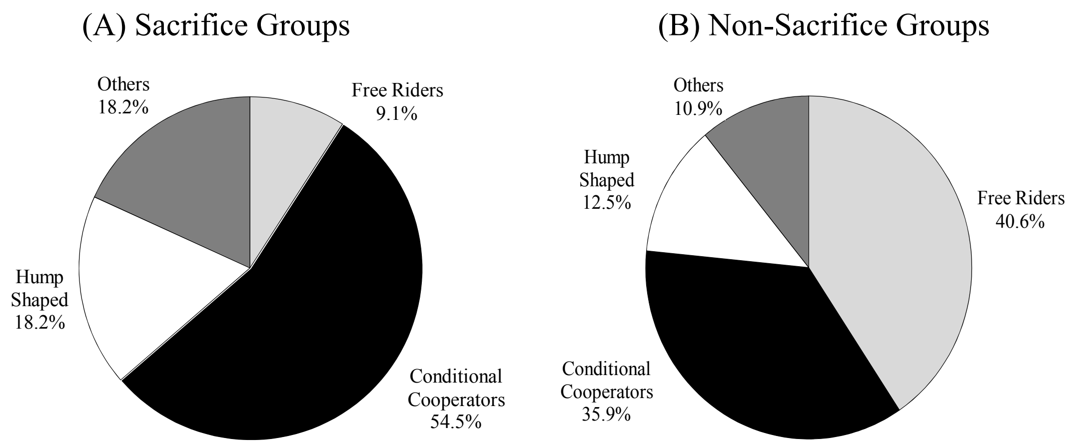


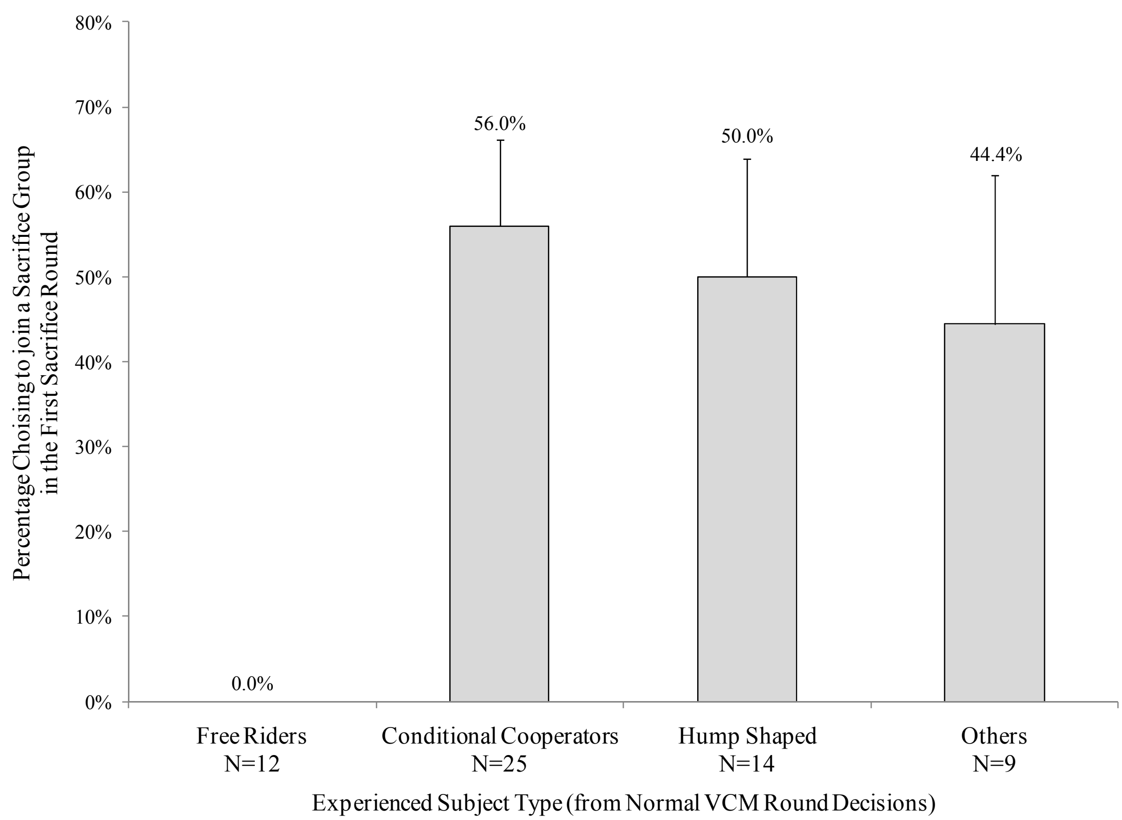
Figure 5 and 6 provide some preliminary evidence that unproductive costs act as a mechanism which screens free-riders from other "types". However, the model presented in this paper and Iannaccone (1992) identify two phenomena that could be driving these results: screening and price effects. That is, while it appears that different "types" are joining different groups, it is also possible that subjects who choose non-sacrifice groups are more likely to free ride *after* choosing the group, as the marginal cost of giving to the group is greater in these groups. In naturally occurring groups (outside of the laboratory), these two effects are indistinguishable, as high-sacrifice groups screen *via* changes in relative prices and the two are thus generally found together. In the laboratory, however, we have numerous mechanisms to distinguish between these two effects.

First, we look at Experienced subjects "typed" by their conditional contributions in the Normal (non-sacrifice) round. The benefit of concentrating on this subset is that we can see their choices in a setting where there are no price effects (differences in the private account return rate). We then analyze whether each type subsequently chooses to be part of a sacrifice group or a non-sacrifice group. We only show the results for the Experienced subjects, since Inexperienced subjects do not play the Normal VCM game

[17] The significant difference holds for both Experienced ($p < 0.01$) and Inexperienced ($p = 0.04$) groups.
[18] The significant difference holds for Experienced subjects ($p = 0.04$) but not Inexperienced subjects ($p = 0.41$).

before making their sacrifice group choice. Figure 7 reports the portion of each Experienced subject type that chose a private account return rate less than 0.95 in the first sacrifice round. It is evident that the main results of Figure 5 and 6 hold, as not a single free-rider chose to join a sacrifice group. The other three types (conditional cooperators, hump-shaped, and others) chose positive levels of sacrifice significantly more than did free-riders (Mann-Whitney Two-tailed, $p < 0.01$).

Figure 7: First Sacrifice VCM Round Choice by Normal VCM Round Type



While these results do not indicate that price effects are absent, they suggest that screening effects are present. Subjects prone to free riding make fundamentally different choices than others. Yet, these results do not confirm the presence of screening, as comparing subjects' actions across rounds may confound screening and learning effects. For example, subjects' past initial group experiences (if they were in a particularly stingy or giving group) may affect their future decisions. In the next section, we remove the endogenous group formation aspect of the design in order to eliminate the screening element completely.

4.3. Controlling for Screening: Exogenous (Random) Sorting

The results presented in Section 4.2 do not fully differentiate between price and screening effects in relation to group contributions. It is possible that *either* differences in relative prices or differences in subject "types" (or both) underlie the observation that greater contributions are given in higher sacrifice groups (Figure 1 and Figure 2).

We confront this problem by running three additional control sessions with exogenous group assignment. As in the inexperienced sessions, subjects are split into groups of 4 and play a Sacrifice VCM game followed by a Normal VCM game and then one additional Sacrifice VCM game. Unlike the previous treatments, however, subjects *do not* choose their groups. Instead, they are randomly assigned to one of three group types – High Sacrifice, Medium Sacrifice, or Low Sacrifice – differentiated by the rate of return to the private account (0.60, 0.75, or 0.95).[19]

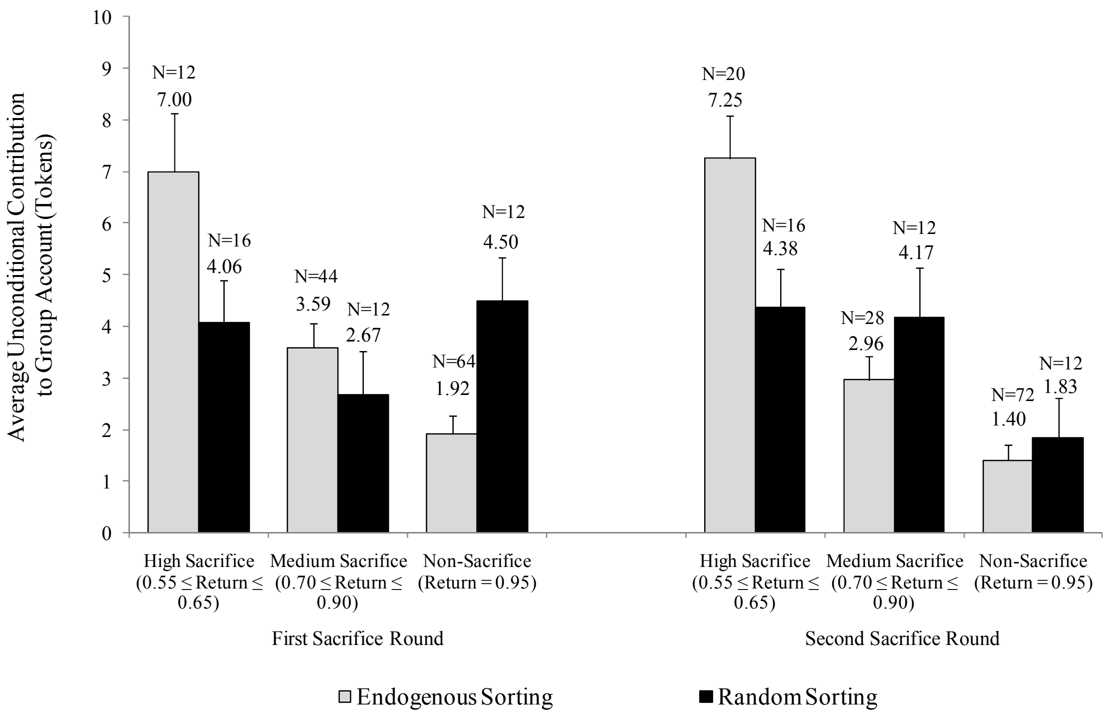
The control sessions help shed light on the role that the screening plays in the observed differences in contributions over varying sacrifice levels. If screening is indeed occurring, then we expect contributions in high-sacrifice groups to be greater in trials where groups sort endogenously, as free-riders are screened out of these groups under endogenous sorting but not under random sorting. On the other hand, we expect contributions in low-sacrifice groups to be lower in trials where groups sort endogenously, since free-riders are screened into these groups under endogenous sorting but not under random sorting.

Figure 8 suggests that the screening of free riders does explain at least some of the observed differences in group contributions. First, note that unconditional contributions are larger in high sacrifice groups under endogenous sorting than under random sorting. This difference is significant at the 1% level (Mann Whitney two-tailed, $p < 0.05$ in the first and second sacrifice rounds). Meanwhile, unconditional contributions are smaller in non-sacrifice groups, significantly in the first sacrifice round under endogenous sorting ($p < 0.01$) though not significantly in the second sacrifice round ($p = 0.20$). There is no significant difference ($p > 0.20$) for medium levels of sacrifice between endogenous and

[19] All subjects participated in the Inexperienced ordering. The results are compared in this section to those found under endogenous sorting combining the Experienced and Inexperienced orderings. All results hold when comparing the control to only the Inexperienced ordering under endogenous sorting.

exogenous sorting for either the first or second sacrifice rounds. These results suggest that unproductive costs serve to screen free riders out of high-sacrifice groups.

Figure 8: Endogenous vs. Random Comparison, Average Unconditional Contribution, Multiple Groups



4.4.Infiltrators, Payout Risk, and the Sacrifice Premium

Finally, we turn back to Hypotheses 3, 4, and 5 from the model. These hypotheses outlined conditions which must hold for an (imperfect screening) equilibrium to exist. These are, namely, that a small premium will be available (for free-riders) from joining high sacrifice groups (Hypothesis 3), there is a positive, nontrivial probability of obtaining a lower total payout by infiltrating high sacrifice groups (Hypothesis 4), and that there will exist a positive number of "infiltrators" (Hypothesis 5).

Figure 9: Potential Marginal Profit from Free Rider Infiltration

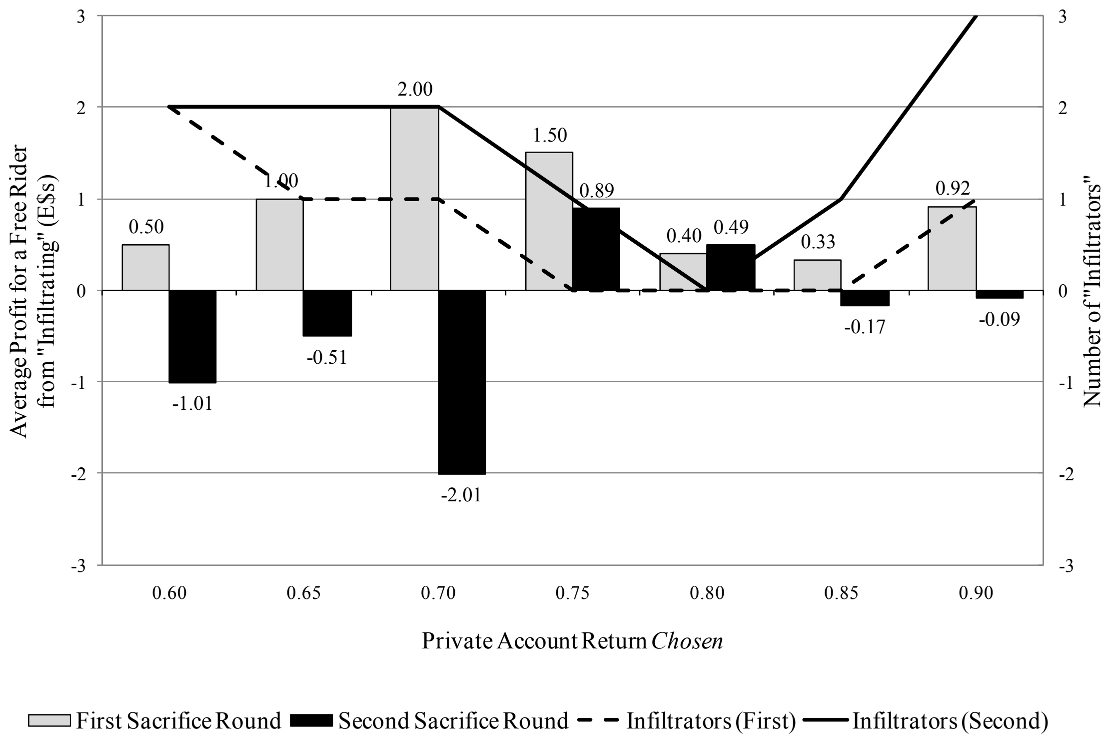


Figure 9 supports all three of these hypotheses. This figure shows i) the average marginal profit a free-rider makes by choosing each group (relative to group $1 - s = 0.95$) and ii) the number of free riders who infiltrated each group.[20] The average additional profit attainable by infiltrating was calculated by averaging the contribution of the 3 other group members for each subject who chose a given group, using this as the total group contribution (since free riders give 0). This was compared to the average contribution of the 3 other group members for subjects who chose group $1 - s = 0.95$. Note that the horizontal axis is private account return chosen, instead of private account return used. We use these data because the choice of group, not the group one ends up in, is the salient one from the infiltrator's point of view. The results are qualitatively similar if the private account return used is placed on the horizontal axis.

Figure 9 suggests that for most group choices, a small premium exists (on average) for infiltrating (Hypothesis 3), and a small number of infiltrators existed in

[20] The data in Figure 9, Figure 10, and Figure 11 use only the endogenous sorting data.

almost every group (Hypothesis 5).[21] The theory underlying these hypotheses is that if the premium is too large, everyone will want to infiltrate, whereas if the premium is too small, no one will want to join the high sacrifice groups, which have riskier returns. We find that for most groups, the premium is indeed small – 1E$ or less (or, less than 10% of the total income made in one round). Note, however, that in the second round, the average marginal profit from infiltrating certain groups is negative. This provides support for Hypothesis 4, which claims that there is a non-trivial probability that infiltrating will decrease the return made by a free-rider. Infiltrating high-sacrifice groups is *risky* – infiltrators are giving up a sure bet of 9.5 tokens in the $1 - s = 0.95$ group for a bet that the group payout will be at least 4 tokens higher in the $1 - s = 0.55$ group (a similar logic works for medium sacrifice groups).

The riskiness of the higher-sacrifice groups is supported further in Figure 10 and Figure 11. Figure 10 reveals that the marginal profit from infiltrating can be quite positive or quite negative.[22] In other words, infiltrating is a risky proposition – the rewards may be significant, but so may the losses – while the average gain is small. In fact, Figure 11 suggests that the average gain is positive only around 50% of the time. This figure shows the *ex post* probability that a free-rider benefits from infiltrating (relative to choosing the non-sacrifice group). The probabilities hover around 50%, with the probability of obtaining a positive marginal gain from joining the highest sacrifice group ($1 - s - 0.55$) at 50.3%. Although we do not explicitly test or model risk aversion, these data indicate that risk aversion provides a source of heterogeneity beyond one's propensity to give to the group (or "type"). We do not wish to push this point too far, as we do not control for different levels of risk aversion. We only note that the presence of such infiltrating individuals is essential for the equilibrium to hold, that the rewards to free-riding in high sacrifice groups are more appealing to less risk averse individuals, and that their presence in the experiment provides evidence that unproductive costs can serve as a useful mechanism to screen out most, but *not* all, free riders.

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[21] The number of infiltrators in Figure 9 is the total across all 8 sessions using endogenous sorting.

[22] The numbers in Figure 10 are calculated by comparing the best (worst) case scenario at $1 - s = 0.95$ with the worst (best) scenario at each group to derive the minimum (maximum) marginal profit.

Figure 10: Minimum and Maximum Marginal Profit from Free Rider Infiltration

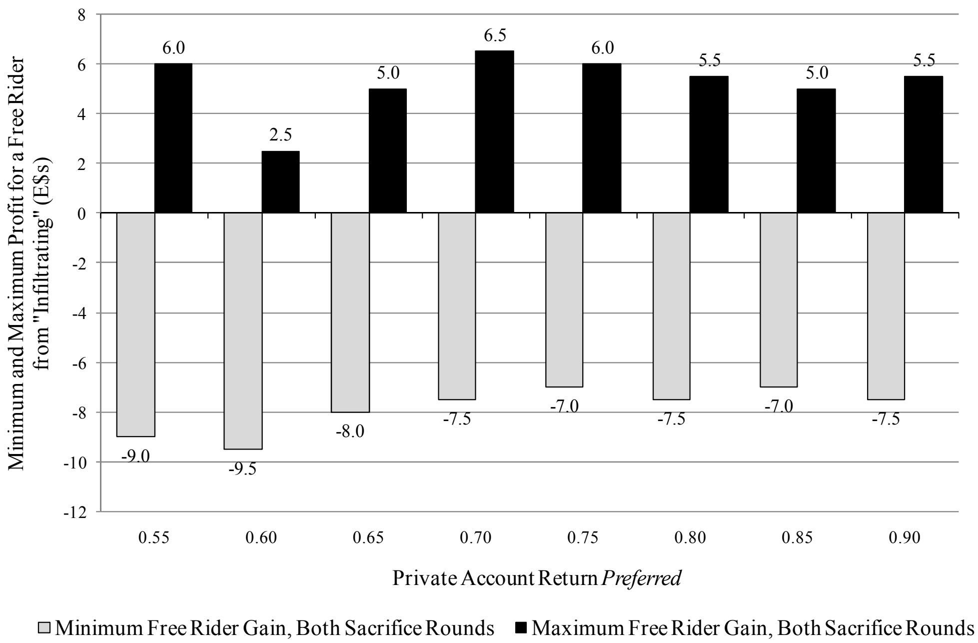
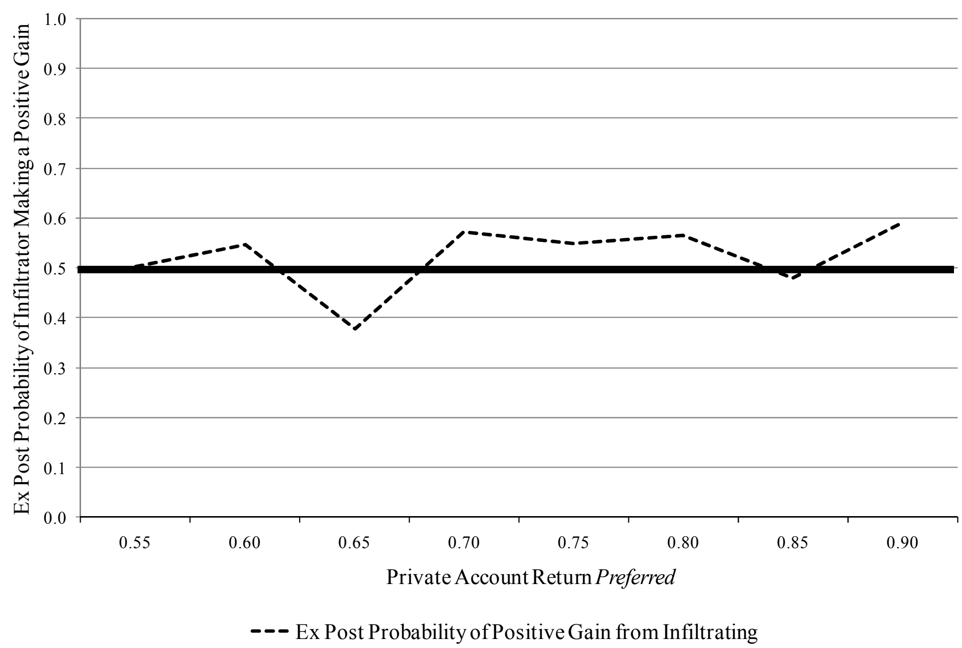


Figure 7: Ex Post Probability of Infiltrator Making a Positive Gain, at Different Levels of Private Return



5. Conclusion

While the experimental literature has revealed a great deal about the impact of exogenously imposed rules on group outcomes, particularly with relation to cooperation, much remains to be learned about how and why groups form endogenously. We demonstrate the value of rules for a group that emerge within a meaningful social context. This experiment shows that cooperation can be fostered when individuals are given the opportunity to endogenously choose the rule structure – in this case, the amount of unproductive costs undertaken – of the groups they join. Our results indicate that rules which increase the cost of actions group members take outside of the group serve to screen out free-riders and encourage more cooperative in-group behavior.

The salient features of sacrifice requirements in the VCM game are their ability to harness the productive capacity of groups and at the same time offer a simple, straight forward means for groups to emerge without direction from an outside force or authority. Sacrifice, as an accepted social norm or institution, allows individuals with shared objectives and similar preferences to engage in risky, interdependent public production and come out ahead.

Our results offer strong laboratory evidence for the efficacy of sacrifice requirements as a means of both incentivizing agents to make greater contributions to public goods and to sort agents by type through a self-selection mechanism. The sacrifice norm is a means by which members can come closer to Pareto optimality by screening out those who do not share their preferred means of social production and do so without recourse to exogenous authority or coercion. Beyond simply screening out free-riders, sacrifice serves to attract conditional cooperators – agents who see the merits of group production but who might otherwise be dissuaded by the prospect of rational defecting behavior by other agents.

The experimental structure allows groups composed of agents with similar preferences and utility maximizing strategies to form without exogenous direction. While Iannaccone's original theory of sacrifice and stigma was conceived with direct relevance for religious groups, the mechanism functioned in an anonymous laboratory setting absent any group identity or religious context. Further, the mechanism served not just to overcome free-riding, but as a means for subjects to self-sort by type and endogenously form cooperative groups with minimal interference or manipulation.

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Appendix A: Experiment Instructions

Thank you for participating in today's experiment. You have earned a $5 show-up bonus for participating. If you read and follow the instructions below carefully, you have the potential to earn significantly more. In the experiment you will earn Experimental Dollars (E$s) which will be converted into cash (US Dollars) at the end of the experiment. **For every 2 E$s you have at the end of the experiment you will be paid 1 US Dollar in cash.** During the experiment, you and the other 15 people participating will be placed into groups of 4. You will not be told the names of those in your group and they will not be told your name. All participants have identical instructions.

The decision situation

Each member of your group will have to allocate 10 tokens. You can put these 10 tokens in a **private account** or you can put them fully or partially into a **group account.** Each token you do not put into the **group account** will automatically be transferred into your **private account.** You will receive E$s based upon the number of tokens in your **private account** and the total number of tokens in the **group account.** We explain below how you earn money in each account.

Your income from the private account

For each token you put in your **private account** you will earn a number of E$s. For example, if the return to the **private account** is 1 E$ for every token, then if you put 10 tokens in your **private account** (which implies that you do not put anything into the **group account**) you will earn exactly 10 E$. If you put 6 tokens into the **private account**, you will receive an income of 6 E$s from the **private account**. For another example, if the return to the **private account** is 0.5 E$s for every token, then if you put 10 tokens in your **private account** (which implies that you do not put anything into the **group account**) you will earn exactly 5 E$. If you put 6 tokens into the **private account**, you will receive an income of 3 E$s from the **private account**. Nobody except yourself earns E$s from your **private account**. You will be told what the return to the **private account** is before you make your decision.

Your income from the group account

From the token amount you put into the **group account**, each group member (including you) will get the same number of E$s. Of course, you will also get E$s from the tokens the other group members put into the **group account**. For each group member the income from the **group account** will be determined as follows:

Income from the **group account** = sum of tokens put into the **group account** x 0.4

For example, if the sum of all contributions to the **group account** is 30 tokens, then you and all the other group members will get a payoff of 30 x 0.4= 12 E$s from the **group account**. If the four group members together put 5 tokens into the **group account**, you and all others will get 5 x 0.4 = 2 E$s from the group account.

Your total income

Your total income is the summation of your income from your **private account** and your income from the **group account**.

Income from your **private account** (=10 – contribution to the **group account**) + Income from the **group account** (= 0.4 x Sum of contributions to the **group account**) = total income.

Quiz to ensure understanding of how you earn money from each account.

You will receive $0.25 (US Dollars) for each complete correct answer to the following four questions. The purpose is to make you familiar with the calculation of incomes that come from different decisions about the allocation of 10 tokens.

For each of the following questions, suppose that the return to the **private account** is 1E$s per token:

1) Each group member has 10 tokens at his or her disposal. Assume that none of the four group members (including you) contributes anything to the **group account**. What will

your total income be? ______ What is the total income of each of the other group members? ______

2) Each group member has 10 tokens at his or her disposal. Assume that you invest 10 tokens into the **group account** and each of the other group members also invests 10 tokens into the **group account**. What will your total income be? ______ What is the total income of each of the other group members? ___

3) Each group member has 10 tokens at his or her disposal. Assume that the other three group members together contribute a total of 15 tokens to the **group account**.

What is your total income if you – in addition to the 15 tokens – contribute 0 tokens to the **group account**? ______
What is your total income if you – in addition to the 15 tokens – contribute 5 tokens to the **group account**? ______
What is your total income if you – in addition to the 15 tokens – contribute 10 tokens to the **group account**? ______

4) Each group member has 10 tokens at his or her disposal. Assume that you invest 4 tokens to the **group account**.

What is your total income if the other group members - in addition to your 4 tokens - together contribute a total of 4 tokens to the **group account**?_____
What is your total income if the other group members - in addition to your 4 tokens - together contribute a total of 6 tokens to the **group account**?_____
What is your total income if the other group members - in addition to your 4 tokens - together contribute a total of 11 tokens to the **group account**?_____

Each person has two types of decisions to make. One of these two decisions will determine how many tokens you place in each account. See the attached decision sheet that you will later be filling out.

Decision 1

Indicate on the box provided for Decision 1 how many of your 10 tokens you wish to contribute to the **group account** (this will indicate that you wish to place 10 minus this many tokens in to your **private account**.) This decision is made without knowing the decisions of your other three group members (in other words, an "unconditional contribution.")

Decision 2

For Decision 2, you will fill out a "contribution table". In the contribution table you will indicate for each possible average contribution of the other group members (rounded to the nearest integer) how many tokens you want to contribute to the **group account**. You can condition your contribution on the contribution of the other group members. This will be immediately clear if you take a look at the following table.

Average Number of Tokens the Other Members of Your Group Placed in the Group Account	How Many Tokens You Will Place in the Group Account	Average Number of Tokens the Other Members of Your Group Placed in the Group Account	How Many Tokens You Will Place in the Group Account
0		**6**	
1		**7**	
2		**8**	
3		**9**	
4		**10**	
5			

The numbers next to the input boxes are the possible (rounded) average contributions of the other group members to the group account. You simply have to insert into each input box how many tokens you will contribute to the group account – conditional on the indicated average contribution. You have to make an entry into each box. For example, you will have to indicate how much you contribute to the **group account** if the others contribute an average of 0 tokens to the group account, how much you contribute if the others contribute an average of 1, 2, or 3 tokens, etc. In each input box you can write any number from 0 to 10.

After each member of your group has made both decisions, a die roll will randomly select one group member. The Decision 2 (from the contribution table) of this randomly selected group member will be used to determine their contribution to the **group account** (and their **private account**). The Decision 1 (the "unconditional contribution") of the other three group members will determine their contribution to the **group account** (and their **private account**.) When you make your Decision 1 and 2, you of course do not know whether the die roll will select you. You will therefore have to think carefully about both types of decisions because both can become relevant for you.

> EXAMPLE 1: Assume that you have been selected by the random mechanism. This implies that your relevant decision will be your contribution table (your Decision 2). For the other three group members their unconditional contribution (Decision 1) is the relevant decision. Assume they have made unconditional contributions to the **group account** of 0, 1, and 2 tokens. The average contribution of these three group members, therefore, is 1 token. If you have indicated in your contribution table that you will contribute 1 token to the **group**

account if the others contribute 1 token on average, then the total contribution to the group account is given by 0 + 1 + 2 + 1 = 4 tokens. All group members, therefore, earn .4 x 4=1.6 E$s from the group account plus their respective income from the private account. If you have instead indicated in your contribution table that you will contribute 9 tokens if the others contribute one token on average, then the total contribution of the group to the group account is given by 0 + 1 + 2 + 9 = 12. All group members therefore earn .4 x 12 =4.8 E$s from the group account plus their respective income from the private account.

EXAMPLE 2: Assume that you have not been selected by the random mechanism which implies that for you and two other group members Decision 1 (the unconditional contribution) is taken as the payoff-relevant decision. Assume your unconditional contribution to the **group account** is 8 tokens and those of the other two group members is 9 and 10 tokens. The average unconditional contribution of you and the two other group members, therefore, is 9 tokens. If the group member who has been selected by the random mechanism indicates in her contribution table that she will contribute 1 token to the **group account** if the other three group members contribute on average 9 tokens, then the total contribution of the group to the group account is given by 8 + 9 + 10 + 1 == 28 tokens. All group members will therefore earn .4 x 28 = 11.2 E$s from the group account plus their respective income from the private account. If instead the randomly selected group member indicates in her contribution table that she contributes 10 if the others contribute on average 9 tokens, then the total contribution of that group to the group account is 8 + 9 + 10 + 10 = 37 tokens. All group members will therefore earn .4 x 37 = 14.8 E$s from the group account plus their respective income from the private account.

The random selection of the participant whose Decision 2 (from the contribution table) will be used in each group proceeds as follows. Each group member is assigned a number between 1 and 4. A participant will be randomly selected to throw a six-sided die until a number between 1 and 4 is thrown. The number that shows up will be entered into the computer. If the thrown number is the same as that assigned to you, then for you, your Decision 2 (from the contribution table) will be relevant and for the other group members Decision 1 (the unconditional contribution) will be the payoff-relevant decision. Otherwise, your Decision 1 is the relevant decision. The die roll will occur after everyone has turned in his or her decisions.

Quiz: You will receive $0.25 (US Dollars) for each complete correct answer to the following two questions.

Suppose the other members of your group place 3, 5, and 7 tokens into the **group account**, and that you have been randomly selected to have your Decision 2 (from the contribution table) used.

Question 1) Which box in the Decision 2 contribution table would contain the number of tokens you would place into the **group account**?

The box next to number _________

Question 2) How many of the other three members of your group will have their

Unconditional Contribution (Decision 1) used? ______
Contribution Table (Decision 2) used? ______

Decision 1:
Group account [ ]

Indicate, in the box above, for Decision 1 (the unconditional contribution) how many of your 10 tokens you wish to contribute to the **group account** (indicating you wish to place 10 minus this number of tokens into your **private account**.) This decision is made without knowing the decisions of your group members.

Decision 2:
On the Decision 2 table, please fill in each box with the number of tokens you want to contribute to the **group account** for each possible average number of tokens that each of the other members of your group could place into the **group account**.

Average Number of Tokens the Other Members of Your Group Placed in the Group Account	How Many Tokens You Will Place in the Group Account	Average Number of Tokens the Other Members of Your Group Placed in the Group Account	How Many Tokens You Will Place in the Group Account
0		**6**	
1		**7**	
2		**8**	
3		**9**	
4		**10**	
5			

You have been randomly matched with a group of four people for these decisions.

The **private account** pays 1E$ for every token you place in your **private account**.

The **group account** pays you 0.4E$s for every token placed in the **group account** by you or the other group members you are randomly assigned to this round.

You will play this game only once.

You will now make a decision that can affect the return to the **private account** in your group. Circle below how many E$s per token you would like the **private account** to return for the group you are placed in. You will be placed in a group with others who chose a similar amount to you. This will be done as follows:

After everyone has circled a level of return, the monitor will collect these decisions and place them in numerical order from highest to lowest (in case multiple people chose the same number, the order will be determined randomly amongst those people by rolling a die.) The first four people in the list will be in a group together, the next four people in the list will be in a group together, and so on, with the four people at the end of the list in a group as well. Each member of a group will be told what levels of return the other people in their group chose. The actual return to the **private account** in each group will be the average level chosen by the four people in the group (rounded to the nearest .05 E$s). You will be told this amount. The return to the **group account** in all groups will be 0.40 E$s for each token placed in the **group account**.

For Example: If the choices of the sixteen people in the experiment were:
[.55, .60, .60, .65, .65, .70, .70, .75, .75, .80, .80, .85, .85, .90, .90, and .95]

The four highest choices would be a group [.95, .90, .90, and .85] with a return to the **private account** for each member of that group of 0.90 E$s for every token an individual placed in their own **private account** (and a return of 0.40 E$s for each token placed in the **group account**.)

The four lowest choices would be a group [.65, .60, .60, and .55] with a return to the **private account** for each member of that group of 0.60 E$s for every dollar an individual placed in their own **private account** (and a return of 0.40 E$s for each token placed in the **group account**.)

The second four highest choices would be a group [.85, .80, .80, and .75] with a return to the **private account** for each member of that group of 0.80 E$s for every token an individual placed in their own **private account** (and a return of 0.40 E$s for each token placed in the **group account**.)

The second four lowest choices would be a group [.75, .70, .70, and .65] with a return to the **private account** for each member of that group of 0.70 E$s for every dollar an individual placed in their own **private account** (and a return of 0.40 E$s for each token placed in the **group account**.)

Quiz: You will be paid $0.25 for each complete correct answer of the following three questions:
If you are in a group where the chosen levels are [.55, .70, .70, and .85] (an average of 0.70):
1) What is the return to the **group account** (per token) for each member of your group?____
2) What is the return to the **private account** (per token) for each member of your group?____
3) What would you receive from your **private account** if you placed:
1 token in the **private account**____ 10 tokens in the **private account**_____

You will now be matched with a new group in the same manner as before. Circle below how many E$s per token you would like the **private account** to return for the group you are placed in. You will be placed in a group with others who chose a similar amount to you with matching occurring in the same manner as it did before.

Circle your preferred return level below:

.55 .60 .65 .70 .75 .80 .85 .90 .95

Your group is made of four people who chose [ ] [ ] [ ] [ ]
↑ was your choice

The **private account** pays [ ] for every token you place in your **private account**

The **group account** pays you 0.4E$s for every token placed in the **group account** by you or the other group members you are randomly assigned to this round.

You will play this game with this matching only once.