Economic Inquiry

RANK-ORDER COMPETITION IN THE VOLUNTARY PROVISION OF IMPURE PUBLIC GOODS

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Publicly provided goods often create differential payoffs due to timely or spatial distances of group members. We design and test a provision mechanism which utilizes rank competition to mitigate free-riding in impure public goods. In our Rank-Order Voluntary Contribution Mechanism (Rank-Order-VCM) group members compete via observable contributions for a larger share of the public good; high contributors receive preferential access (a larger share), while low contributors receive restricted access (a lower share). In a laboratory experiment, Rank-Order-VCM elicits median contributions equal to the full endowment throughout the finitely played games with constant groups. In the control treatment, with randomly assigned ranks, the contributions are significantly lower and decline over time. We thus provide evidence of rank competition, in situations where discriminatory access to public goods is possible, being efficiency enhancing. (*JEL* C91, H41)

I. INTRODUCTION

While most public goods today are still funded through tax revenues, tax financing is not always viable or efficient for governments, for both economic and political reasons, and impossible for private organizations. The latter therefore often have to employ voluntary contribution mechanisms (VCMs) that persistently trigger contributions below the social optimum level. Furthermore, many publicly provided goods are impure in terms of consumption as one's own consumption diminishes (though does not necessarily fully eliminate) the benefit for others, often through congestion.[1] While people may have the same rights to access these public goods, spatial or timely distances make access easier for some people than for others. For instance, the location of local public infrastructure determines to some extent the benefit one derives from its use. If exclusion of free-riders is impossible, undesired, or too costly, the allocation decision gives some people, in particular those who live in the neighborhood, preferred access to the local public good. In the current paper we focus on situations where preferential access to a publicly provided good is feasible and acceptable. For such situations, we propose a new mechanism that counteracts free-riding incentives by introducing a rank-order competition resulting in higher ranked contributors receiving preferential access.

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1. Publicly funded sports facilities, like community swimming pools, are an example of a congestible public good. They often offer time slots, at a price, to swim schools, sports teams, and other individuals or organizations. The remaining slots are open to recreational swimmers. However, if recreational swimmers are willing to stick to the one or two non-bookable swim lanes, they can use the swimming-pool at any time.

ABBREVIATIONS

MPCR: Marginal Per Capita Return
VCMs: Voluntary Contribution Mechanisms

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We contribute to the growing experimental literature that investigates how incentives or competition impacts cooperation in public goods games (e.g., Cabrera et al. 2013; Croson et al. 2015; Dickinson and Isaac 1999; Falkinger et al. 2000; Gunnthorsdottir et al. 2010). In contrast to the previous studies where incentives impact the game structure, the introduction of rank-order competition in our setup does not affect the uniqueness of the free-riding equilibrium. This kind of competition only eliminates the dominance of free-riding as the best-response correspondence suggests a higher contribution than other group member(s) for a large range of contribution profiles.

Rank-order competition in the context of public goods is related to contests such as Tullock lotteries, rank-order tournaments, or all-pay auctions that provide participants of VCMs with an opportunity to win a private prize which is higher than their contribution to the public good, in an attempt to mitigate free-riding behavior (see Section II for details).[2,3] One issue with mechanisms which use contests to fund public goods is that the cost of the prize must be covered by contributions, making them expensive and not always feasible. The prize awarded to the contest winner(s) can constitute a considerable fraction of the total contributions of all participants, leaving the contribution pool further away from the socially optimal provision. This is of particular concern when the number of possible contributors is not sufficiently large, as can be the case with local public goods.[4] An important advantage of our provision mechanism is that it takes away the fixed-prize component that has been used in almost all contests as a mean to mitigate free-riding, thus eliminating the efficiency loss.

Another advantage of our mechanism is that it does not prescribe fully excluding anyone from accessing the public good and only requires preferential or discriminatory access, which is often less costly and more likely to be acceptable. One important instance where we envision the mechanism to potentially be applied is crowdfunding of projects with a "public good flavor." Cason and Zubrickas (2017) argue that the recent large growth in crowdfunding revenue worldwide could have been driven by contributions coming from socially minded people and from the campaigner's network (see Kuppuswamy and Bayus 2018) and may slow down as this population is exhausted. As such, it will become increasingly more important to attract contributions from a broader range of donors, especially for community, charity, or art and creative projects, which can be done through implementing simple and effective mechanisms. We believe our rank-order mechanism is an example of such mechanism that could lead to a significant improvement in outcomes.[5] One can imagine organizing cultural events, such as stage productions or music events, where a higher donor receives a preferential access in terms of larger number of tickets, earlier access to tickets, or preferred seating (though we note that there is a fine line whether some of these attributes mean a larger consumption of the public good or access to a superior consumption good). Funding social entrepreneurship projects related to community development, such as the above-mentioned sports facilities that give a preferential access to high donors, is another every-day life situation where the rank-order mechanism has considerable practical potential.

In what follows, we present the *Rank-Order Voluntary Contribution Mechanism* (hereafter Rank-Order-VCM) that utilizes competition to mitigate free-riding by setting up a contest in the form of rank-order tournament. Under voluntary contribution the collection of public good funds is straightforward, but the incentive to free-ride always persists. If exclusion of free-riders is problematic, the social planner can devise a contest which gives high contributors preferred access to the public good. Rank-Order-VCM allows the planner to implement a relative reward system in which, through the allocation decision,

2. Warr (1983) demonstrates that when a single public good is provided at positive levels by private individuals, small redistributions of income among contributors will leave the total provision of public goods unchanged; which is known as Warr's neutrality finding. However, in models with impure public goods, such as public good funded by contests, neutrality does not hold (Cornes and Sandler 1994; Morgan 2000).

3. For example, in the UK 28% of the funds collected through the national lottery goes to charity and public good projects, while 12% goes back to the state. Lotteries are considered a joint public-private good (impure public good) as purchasing lottery tickets leads to a chance to win a private prize as well as contribute to a public good (Morgan 2000).

4. For a review of local public goods (identified by geographical space), and club goods (local public goods not identified by geographical space; mostly by size and crowding costs), see Scotchmer (2002).

5. For example, Kickstarter—a global crowdfunding platform focusing on invention and creativity—has in recent years seen project creators offer rewards related to preferential access or product exclusives to those willing to contribute more to their project. (Kickstarter.com)

free-riding incentives are counteracted by making the enjoyment of an (impure) public good more restrictive for low contributors. While all individuals may have the right to access the public good, timely or spatial distances can make access easier for some and more restrictive for others.[6]

In Rank-Order-VCM individuals compete with their observable contributions towards a public project for a larger share of the payoff that the project generates. The design of the mechanism ensures that people who contribute more (and thus earn a larger share of the payoff) are less likely to feel taken advantage of as it has often been reported by subjects in VCM experiments.[7] To test whether presence of rank-order competition overcomes the free-rider problem we compare it to *Random Rank Voluntary Contribution Mechanism* (hereafter Control treatment)—an institution that allocates the shares from the public project randomly but maintains all other features of the Rank-Order-VCM environment and thus provides a control in which competition for preferred access is not feasible. We conjecture that competition created by Rank-Order-VCM will result in increased contributions to the public good compared to the Control treatment. We base our conjecture on best-response correspondences that suggest increasing one's own contribution relative to the other group members for most strategy profiles in Rank-Order-VCM whereas in the Control treatment the unique best-response implies zero contribution.

Next we present a literature review, the mechanism, experimental setup, and our results, followed by a short discussion. Subject instructions are provided in Appendix A.

6. Another specific example is financing a cultural event (e.g., a theater play) through voluntary contributions with the person who contributed more receiving higher quality seats. In the same fashion, a person who exerts more effort, spends more time on the project or invests more money into it would earn a larger share of the profit in a team production scenario, or airlines with higher contributions towards the airport would get their preferred time slots or gates.

7. The idea of focusing on preferences for cooperation in a VCM setting has been suggested by Andreoni (1995). For studies and details on conditional cooperation in the VCM, see Keser and van Winden (2000), Fischbacher, Gächter, and Fehr (2001), Levati and Neugebauer (2004), Burlando and Guala (2005), Kurzban and Houser (2005), Chaudhuri and Paichayontvijit (2006), Chaudhuri (2011), Gunnthorsdottir, Houser, and McCabe (2007), Neugebauer et al. (2009), or Fischbacher and Gachter (2010).

II. RELATIONSHIP TO THE LITERATURE

Substantial literature, both theoretical and experimental, has identified the free-rider problem in organizational and societal settings (see Ledyard 1995 for a review). A small but growing research stream recognizes institutions that mitigate or completely eliminate this problem (Kosfeld and Riedl 2004 review the literature). Other papers test these institutions experimentally; it is this literature to which we wish to contribute.

One type of mechanism that has been proposed to alleviate free-riding involves sanctions and rewards. These sanctions and rewards, usually based on some form of rank-ordering of contributions, are either experimenter-imposed (e.g., Croson et al. 2015; Dickinson 2001; Dickinson and Isaac 1999; Falkinger et al. 2000; Groves and Ledyard 1977; Harbring and Irlenbusch 2005; Orrison, Schotter, and Weigelt 2004), or participant-imposed (e.g., Fehr and Gächter 2000; Masclet et al. 2003; Noussair and Tucker 2005). However, even though in some of these studies competition does occur, it is not the main focus and therefore the observed experimental results cannot provide a direct answer whether competition is capable of increasing voluntary contributions on its own. For example, Dickinson (2001) investigates a mechanism in which all but the most cooperative member of the group incur a fixed fine and the most cooperative member receives a bonus payment. Orrison, Schotter, and Weigelt (2004) and Harbring and Irlenbusch (2005) use a tournament incentive structure involving rewards for winners and sanctions for losers, and find that the additional incentives provide a large initial boost to cooperation, which diminishes over time. In Croson et al. (2015), the minimum contribution within a group is sanctioned, implying a game structure with multiple equilibria among which the Pareto efficient is selected by subjects in the experiment. In this paper, we go further by showing that neither the exclusion of noncontributors nor the change in equilibrium is required to trigger high contributions; a change in the best-response correspondences is sufficient to dramatically change contribution behavior. The use of a relative reward system is the main distinguishing feature between our Rank-Order VCM and other proportional and contest-based mechanisms.

In a closely related study to ours, Falkinger et al. (2000) design a mechanism in which subjects pay a tax if they contribute below the average contribution and receive a subsidy if they contribute above the average contribution. The authors find not only a significant initial effect on contributions but also increasing cooperation over time. In contrast to continuous changes in the marginal per capita return (MPCR) due to the tax/subsidy, our study focuses on discrete changes due to rank-order tournament rather than by comparing one's contribution to the average of the group. The other notable difference is that in the mechanism of Falkinger et al. the efficient level of public good provision is achieved in the Nash equilibrium; the efficient provision is a weakly dominant strategy. In contrast to the Falkinger mechanism, free-riding is the unique equilibrium in our design. So, whereas the Falkinger mechanism changes the equilibrium contributions relatively to the voluntary contribution game from free-riding to full contribution, our Rank-Order-VCM maintains free-riding as the unique Nash equilibrium.

While experimentally imposed sanctions and rewards have been successfully used to solve the free-rider issue, mostly in the form of tax systems, they all assume that the social planner can penalize noncontributors. This, however, is often not a feasible solution, either because the social planner might not have the power to impose punishment or because it could be too costly to enforce. More recently, incentive mechanisms in the form of contests (see Konrad 2009; Dechenaux, Kovenock, and Sheremeta 2015 for a review) have been found to successfully mitigate free-riding without requiring the institution conducting the contest to impose sanctions. While revenue comparisons of all-pay and first-prize (winner-pay) auctions as mechanisms to increase contributions to a public good (e.g., Carpenter, Holmes, and Matthews 2008; Goeree et al. 2005; Orzen 2008; Schram and Onderstal 2009) still require further experimental testing, most of the research has zeroed in on all-pay lotteries and all-pay auctions. Next, we elaborate on the most relevant contests used to enhance the standard VCM.

Morgan (2000) and Morgan and Sefton (2000) theoretically and experimentally show that Tullock fixed-prize lotteries (Tullock 1980) can be successfully used to increase public good provisions and substantially decrease free-riding. Without budget constraints, the model suggests that the higher the prize of the contest, the closer the contributions are to the social optimum level. Goeree et al. (2005) show that winner-pay auctions are not very efficient fund-raising mechanisms, and that all-pay auctions dominate lotteries and popular winner-pay auctions. Corrazini, Faravelli, and Stanca (2010), Faravelli and Stanca (2012), and Bos (2011) extend these results to all-pay contests with heterogeneous endowments. Lange, List, and Price (2007) compare the efficiency of contests when participants have both homogeneous and heterogeneous MPCRs, while Faravelli and Stanca (2014) look at the relation between competitive economic incentives and social preferences. The results in all these papers confirm that prize-based mechanisms lead to higher levels of contributions and to lower levels of free-riding than the standard VCM.

One issue with all current studies looking at contests as a mechanism to solve free-riding is that the contest prize is expensive and must be covered by the contributions. The reason for using a fixed prize in lotteries, rather than a prize that is a percentage of total contributions, is that the equilibrium provision in such a fractional-prize contest is equal to that obtained by the standard VCM (Morgan 2000). Thus, the majority of the above-mentioned papers provide a fixed reward to the contest winners, which still constitutes a considerable fraction of the total endowment of all participants. Once the prize is subtracted from the contributions, what is left in the pool is below the social optimum, leading to a lower efficiency compared to our mechanism. To the best of our knowledge the experimental studies on contests and public goods that have an identical number of group members (four), as well as identical average multiplier (0.5) as we do, provide a fixed-prize ranging from 25% (e.g., Orzen 2008) to 33% (e.g., Corrazini, Faravelli, and Stanca 2010; Faravelli and Stanca 2012) of the sum of the endowments.

In addition, while past experiments have shown that fixed-prize contests can increase contribution levels in comparison to a standard VCM even after subtracting the prize, they have also shown that the size of the prize does matter. If the number of participants is sufficiently large a high prize might behaviorally entice participants to contribute more, even though this decreases the probability of winning. However, when the number of possible contributors is limited, either by distance or crowding, as is often the case in the provision of local public goods, the size of the fixed prize may be of particular concern.

In comparison to previous studies, our Rank-Order-VCM mechanism takes away the fixed-prize component and instead differentiates access to the public good. As such, it decreases the cost of the contest compared to the previously studied mechanisms that involve a fixed prize and, as supported by our results, appears to be more efficient in eliminating free-riding.

According to Buchanan (1968), who defines an impure public good as "any departure from the availability of equal quantities of homogeneous-quality consumption units to all customers," as long as the supply of the good is collectively and cooperatively organized, the public goods model holds even if impurities are present. However, the introduction of competition allows us to alter the incentives to free-ride. Cornes and Sandler (1994) show that compared to a pure public good, an impure one decreases incentives to free-ride and increases provision.

Our Rank-Order-VCM not only rewards high contributors as in typical contest mechanisms but also directly decreases the free-riding incentives. Importantly, it does so by still providing access to the public good for everyone, regardless of contributions. The access is preferential to those who contribute the most while free-riders and lower contributors are sanctioned by limited access. The mechanism requires no taxation or fine, both of which might come at an administrative cost.

In a related study to ours in terms of competition effects, Gunnthorsdottir and Rapoport (2006) show that combining voluntary contribution mechanism with intergroup competition for an exogenous and commonly known prize reduces free-riding. Gunnthorsdottir and Rapoport implement two different profit sharing rules (egalitarian and proportional) under which the prize is distributed to members of the winning group and find that the proportional sharing rule does better than the egalitarian one. However, from their design it is not obvious to what degree the proportional sharing rule contributes to the reduction of free-riding as it is coupled with intergroup competition. Finally, Cabrera et al. (2013) hierarchically divide participants in two groups who simultaneously play the voluntary contribution game; one group is called the major and the other the minor league. After each period there is a regrouping; the most cooperative subject of the minor league is promoted to the major league and the worst free-rider of the major league is demoted to the minor league. Cabrera et al. find that this kind of competition leads to increased contribution levels in both leagues relative to the standard VCM.

In contrast to papers that study the impact of group formation based on the ranks of observable contributions, in our experiment we avoid using different groups and focus solely on the situation where a larger share of the public good goes to a higher contributor. Our Rank-Order-VCM (to be described in detail below) creates competition among contributors who are randomly assigned to a group and who repeatedly interact within the same group without having to change its composition.

III. EXPERIMENTAL DESIGN, PROCEDURES, AND THEORETICAL CONSIDERATIONS

A. *Rank-Order VCM*

In Rank-Order-VCM, each individual from a group of four ($n = 4$) faces the following decision problem: how much of the initial endowment ($e = 50$ cents) to contribute to a public good (c_i), respectively how much of it to keep ($e - c_i$). Each cent kept generates a payoff only for the given individual; each cent contributed towards the public good generates payoffs for all group members. The final payoff to individual i is determined by his own and the others' contributions via:

$$\pi_i \left(c_i, c_{-i}\right) = e - c_i + m_i \sum_{j=1}^{n} c_j.$$

The individual multiplier (m_i) is determined by the contribution rank of individual i (i's contribution relative to the amount contributed by the other members of the group); the higher the contribution the higher the multiplier. In the experiment, we have implemented the following parameterization; based on an average MPCR from the project of 0.5:[8]

- If i's contribution is the highest one, the multiplier (marginal return); $m_i = 0.65$.
- If i's contribution is the second highest; $m_i = 0.55$.
- If i's contribution is the third highest; $m_i = 0.45$.
- If i's contribution is the lowest; $m_i = 0.35$.[9]

In case of a tie, that is, if two or more group members allocate the same amount to the project,

8. Although we did not run the standard VCM with the marginal per capita return = 0.5, this choice of design makes our results comparable to previous studies implementing such setup (e.g., Herrmann, Thöni, and Gächter 2008).

9. Note that our general setup includes as special cases the standard symmetric VCM ($m_i = m$ $m_i = m_j$for all i) and the proportional rule ($m_i = \frac{2c_i}{\sum_{j=1}^{n} c_j}$ $m_i = \frac{c_i}{\sum_{j=1}^{n} c_j} * 2$ for all i if $\sum_{j=1}^{n} c_j > 0$, $\sum_{j=1}^{4} c_j > 0$ and 0 otherwise) studied in Gunnthorsdottir and Rapoport (2006).

the corresponding multipliers are averaged. For instance, if the highest allocation is equal to the second highest, the multiplier for the two group members is 0.6 [= (0.65 + 0.55)/2]. If all four group members contribute the full endowment ($e = 50$), the multiplier for each one of them is 0.5. Hence, group members contributing the same amount earn the same.

In Rank-Order-VCM, individuals are rewarded based on their contribution rank towards a group project. Given our parameterization, the unique Nash equilibrium is the situation where everyone free-rides, but it is not a dominant strategy equilibrium of the stage game as in the standard VCM.[10] While the Rank-Order-VCM mechanism allows for manipulating the Nash equilibrium (for example, with more polarized marginal returns, all members contributing their full endowment can also be a Nash equilibrium), the parameterization implemented in the experiment constitutes a stronger test of our conjecture that rank-order competition is capable of mitigating free-riding than a set up with positive contributions as part of the equilibrium would.

It is important to note that if we were to observe a different behavior in Rank-Order-VCM than in VCM it would not be obvious whether it is due to competition or not. In particular, Rank-Order-VCM and the standard VCM differ mainly in two additional aspects: the heterogeneity of marginal returns and the endogeneity of individual marginal per capita returns, related to the fact that subjects learn about their marginal returns only *after* their decision has been made as opposed to knowing what the MPCR *before* the decision is made as is the case in VCM. Thus Rank-Order-VCM does not only capture the voluntary cooperation possibilities of standard VCM but also the competition for a higher rank. To identify the competition effect of Rank-Order-VCM, we run an appropriate control treatment with identical payoff parameters but randomly assigned ranks.

B. Control Treatment

Our Rank-Order-VCM differs from the standard VCM in two ways, one is the element of competition, and the second is the marginal return parameter m_i which group members learn only after the contribution decisions are made. In order to isolate the effect of competition in Rank-Order-VCM, our Control treatment implements identical payoff parameters as Rank-Order-VCM by randomly assigning ranks to all members of the group. The software draws a rank for each individual from the set {1, 2, 3, 4} with replacement. Just as before, the individual marginal returns from a project are 0.65, 0.55, 0.45, or 0.35, based on this random rank. In case of a tie, the marginal returns get averaged. Group members learn their marginal returns after the simultaneous decisions are made. In the Control treatment free-riding equilibrium of the stage game is unique and in dominant strategies.

C. Theoretical Considerations

Subjects in the Rank-Order-VCM treatment participate in a contest that distinguishes the mechanism from the standard VCM. In a contest, decision makers maximize their expected payoff for a given probability of winning. In our Rank-Order-VCM the four prizes are described by the multiplier and the size of the group project. Let $p_k(c_i, c_{-i})$ denote the probability that subject i obtains multiplier m_k by contributing c_i given the contribution of the others. The decision problem for the individual can be written down as follows:

$$E\pi_i\left(c_i, c_{-i}\right) = e - c_i + \sum_{j=1}^{4} c_j \sum_{k=1}^{4} m_k p_k\left(c_i, c_{-i}\right).$$

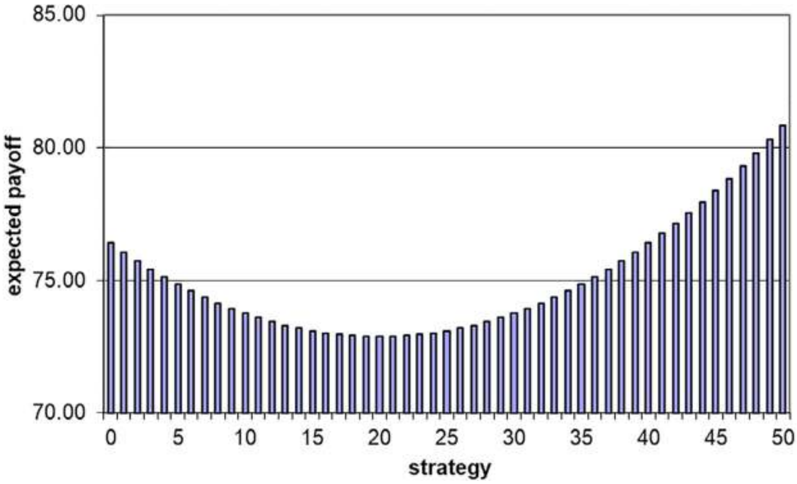
In the Control treatment, the probability of each multiplier is equal to 1/4 independently of the subject's contribution. The expected payoff in the Control treatment is the same as in the standard VCM with a multiplier of 0.5. The unique best response (assuming standard self-regarding preferences) is zero contribution.

In the Rank-Order-VCM treatment the probability of obtaining a higher multiplier increases with the subject's contribution and decreases with contributions of the other group members. Individuals must have beliefs about the contribution profile of the others in order to play a best response. There are 132,651 (= 51^3) different pure contribution profiles of the other three group members. Assuming an individual assigns equal probability to each of the profiles, Figure 1 shows the expected payoffs for each possible pure contribution strategy profile. Hence, free-riding is a local maximum but not a global maximum as in the standard VCM. If the individual actually believes that all contribution profiles of the others

10. If, for instance, the three other members of the group contribute 49 and the individual i rides free, he misses out on gaining more by contributing 50 instead. See the next section for more details.

FIGURE 1

Expected Payoff of Each Strategy Assuming Equally Likely Contribution Profiles of Others



are equally likely, a full contribution of the entire endowment maximizes the expected payoff.

To illustrate the incentives faced by an individual group member in the Rank-Order-VCM we next present an analysis of the best-response correspondence.

Best-Response Correspondence. To demonstrate the effect of rank-order competition on private incentives to contribute and to make prediction about behavior, we outline the best-response correspondence for the stage game assuming self-regarding preferences (in the case of other-regarding preferences, incentives to contribute can exist in both treatments). In line with the experimental design we consider integer contributions, groups of four and the implemented parameters.

The best-response function for an individual participating in the Control treatment requires zero contribution for any contribution profile of the others, $c_i^*(c_{-i}) = 0, \forall c_{-i}$.

The following equation describes the best-response correspondence for an individual in the Rank-Order-VCM, assuming symmetric contributions of the other group members:

$$(1) \quad c_i^{**}\left(c_{-i} | c_j = \hat{c} \forall j \neq i\right) = \begin{cases} 0 & \text{if } \hat{c} = \{0, e\} \\ \hat{c} + 1 & \text{if } \hat{c} \in \{1, \ldots, e-1\} \end{cases}.$$

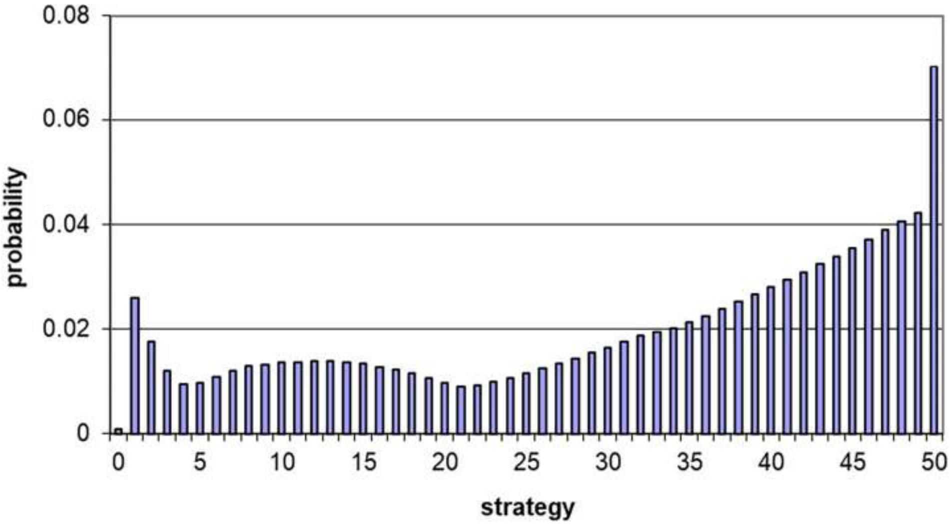
In words; if the other three members all contribute zero or full endowment, the best response prescribes a zero contribution, otherwise the best response requires having higher contributions than the other group members by one unit.

In the case of heterogeneous contributions of the other group members, the best-response correspondence is complex and not always unique.[11] Generally, best-response contributions beat one of the other member's contribution by 1 or prescribe zero or full endowment contributions. For instance, assume two other group members contribute their entire endowment. If the contribution of the third group member is below 19, then the best response exceeds the third contribution by one unit. If the third group member contributes between 19 and 49 units, the best response implies a contribution of the entire endowment. Lastly, the best response prescribes zero contribution if all three other group members contribute 50. Figure 2 shows, for each strategy, the probability of being the best response given the 132,651 pure contribution profiles of others (assuming the others choose each strategy with equal probability). Note that zero contribution is the best response only infrequently (i.e., for 104 profiles or 0.078%), in fact, less frequently than any other strategy.

11. For some strategy profiles of the others, there are multiple best-responses (6 profiles with three, and 525 profiles with two best responses accounting for permutations). For instance, if the profile of the others is (39, 17, 3), the individual has the following three best-responses; {40, 18, 4} each of which yields a payoff of 74.35.

FIGURE 2

Probability of Best Response Strategy Assuming Equally Likely Contribution Profiles of Others



For the implemented parameterization, zero contribution is a dominant strategy and therefore all group members contributing nothing is a strict Nash equilibrium in the Control treatment. In the Rank-Order-VCM treatment, zero contributions by all group members constitute a unique Nash equilibrium; there however exist strategy profiles of the other group members for which contributing zero is not a best response. Based on the best-response correspondences, the conclusion is straight forward in that contributions in the Rank-Order-VCM treatment should weakly exceed those in the Control treatment, $c_i^*(c_{-i}) \leq c_i^{**}(c_{-i})$. We draw this conclusion from the fact that the best response requires the same contribution in both treatments if the other group members contribute all or nothing, whereas the best response requires a higher (i.e., non-zero) contribution for any other profile of other group members' contributions.

D. Testable Hypothesis

Based on the equilibrium predictions, we expect no differences in behavior between Rank-Order-VCM and Control. Mutual free-riding defines the best responses. In particular, the unique Nash equilibrium implies free-riding in each stage of the repeated game for both treatments. This null hypothesis assumes (unbounded) rationality and self-regarding preferences.

Our alternative hypothesis is that the competition in Rank-Order-VCM induces an upward shift towards the efficient allocation since incentives exist that contributors may earn more than noncontributors in some (non-equilibrium) instances. Based on the discussion of the best-response correspondence, we predict a significantly higher contribution level in Rank-Order-VCM than in Control.

E. Procedures

The experiment consisted of two treatments, Rank-Order-VCM and Control, implemented in an across subjects design. All sessions were conducted in the New Zealand Experimental Economics Laboratory at the University of Canterbury. A total of 64 undergraduate subjects were recruited for the experiment.[12] Most of the subjects had not previously participated in economics experiments (and none had participated in a social dilemma experiment). Each subject only participated in a single session of the study. We ran four sessions with exactly 16 subjects in each session. On average, a session lasted 75 minutes including initial instructional period and payment

12. As we have four-subject groups, the number of independent observations is eight in each treatment, in Control and in Rank-Order-VCM. Comparing the average contributions across our two treatments, we obtain (ex-post) a power-measure of 0.8189 ($d = 1.38$, $\alpha = .05$, $n_1 = n_2 = 8$, one-tailed).

of subjects. Subjects earned on average 23.51 NZD.[13] We did not pay a show-up fee. All earnings were calculated in New Zealand cents. All sessions were computerized and run under single blind social distance protocol. The experiment was programmed and conducted with the software z-Tree (Fischbacher 2007).

The assignment of subjects into groups was done according to the following process. Upon entering the laboratory subjects drew a number from an envelope. The number indicated their computer terminal for the experiment. The terminals were randomly matched into anonymous groups of four by the server. The composition of each group remained the same throughout the experiment. All this was known to the subjects and so was the fact that all members of the group faced the same decision problem.

Each subject was provided a hard copy of neutrally framed instructions that were identical across subjects. The experimenter read the instructions aloud with subjects following the text in their own hard copy. After finishing reading the instructions and answering the questions, we administered a computerized test to check for understanding of the decision making environment. The subjects were asked to individually select four numbers (with two numbers being equal) that would represent four contributions. After choosing the four numbers the test software asked them to calculate the multipliers and profits for all group members. It did not allow them to proceed until they answered all questions correctly.

The decision-making part of the experiment followed. Each session consisted of 2x15 rounds to check for a restart effect. After restart the subjects remained in the same group as before (partners design). In every round of the play the subjects were endowed with 50 NZ cents and had to decide how much of this endowment to allocate to a project and how much to keep for themselves.

The individual round payoffs were computed as the money the subjects kept plus the sum allocated to the project by all four members of the group where the latter was multiplied by their own personal multiplier. In Rank-Order-VCM the personal multiplier was determined depending on the amount the subject contributed towards the project and on the rank order of this amount relative to the contributions of the other members of the group. In the Control treatment the multiplier was randomly determined by the computer. Each round, the software would draw a number 1, 2, 3, or 4 (with replacement to allow for ties) for each subject. The subject's individual multiplier was determined according to the rank of his random number. In particular, if the subject's number was the highest in the group, the multiplier was 0.65; 0.55 if it was the second highest; 0.45 if it was the third; and finally, 0.35 if the number was the lowest.

After each round the subjects received feedback information on the amount they and their group allocated to the project. They received information on the individual allocation ordered from highest to lowest but were not be able to trace the amount to the person who allocated it. They also received information about their personal multiplier, the resulting payoff from the project, the amount of money kept, and their round payoff. This information was recorded in a table on the subjects' screen and was available for all past rounds. At restart, the information for the first 15 rounds was cleared.

At the end of the experiment subjects were asked to fill out a questionnaire on demographics and strategies used when making the decisions. Finally, they were privately paid their earnings for the session.

IV. EXPERIMENTAL RESULTS

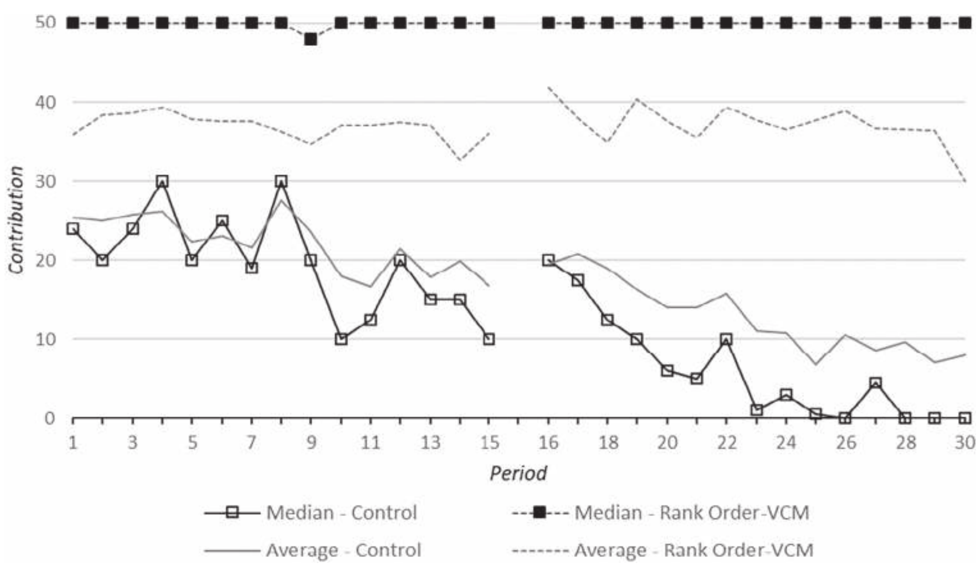
Figure 3 presents the comparison of average and median contributions in the 2×15 periods of the Rank-Order-VCM and Control treatments. While the average contribution in Rank-Order-VCM starts at 35.9 and oscillates between 30.1 and 41.8, the average contribution in Control starts at 25.4 and steadily declines throughout the whole experiment to reach its minimum of 6.8 in period 25. In the last period, the average contribution is equal to 7.9. The median contribution shows even a sharper contrast: In Rank-Order-VCM, the median contribution is equal to the entire endowment in all periods but 9, while in Control the median contribution starts at 24 and drops down to 0 by the end of the experiment.

A. *Treatment Effect*

The exact two-tailed Wilcoxon test for independent samples reveals that the group contributions in Rank-Order-VCM and Control are significantly different at 5% level for both the first 15 periods (p value = .038) and for the second 15 periods (p value = .005). Each

13. The adult minimum wage in New Zealand at the time of the experiment was 10.25 NZD per hour.

FIGURE 3
Median and Average Contributions in Rank-Order-VCM and Control



treatment involved eight independent groups. The average contribution per group member was 38.5 (13.8) in Rank-Order-VCM and 16.4 (11.5) in Control (standard deviation in parentheses). This difference is also statistically significant (p value = .005). The sample of individual first contributions which involves 32 observations per treatment suggests that the differences in contributions are significant right from period 1; the p value of the two-tailed Wilcoxon test is 0.037. Hence, we can conclude that Rank-Order-VCM leads to significantly higher contributions than Control.

Figure 4 depicts the distribution of contributions for both Control and Rank-Order-VCM. More than a third of all contributions (33.54%) in Control are zero contributions, which is both the unique best response and a Nash equilibrium strategy, whereas 15.63% of contributions are maximal ones. In comparison, only 6.04% of Rank-Order-VCM contributions are at the zero mark, and 62.50% of all contributions are maximal ones. As predicted by Figure 2, contributions in Rank-Order-VCM are heavily right skewed towards maximal contributions.

Figure B1 in Appendix B, depicting the distribution of contributions in period one only, shows that there is a difference in distributions from the very first period but also clearly indicates that this difference grows over time. This difference in contribution over time is depicted in Figure 5. It confirms that in the presence of competition contributions are larger from the very first period, and that this difference almost triples towards the latter rounds.

B. *Heterogeneity Analysis*

Figure 6 depicts contribution by rank within a group, from highest to lowest, averaged for all eight groups in each treatment. Over time, contributions for each of the four ranks in Control, averaged between groups, are significantly lower compared to those of Rank-Order-VCM; 32.52 vs. 46.85 (p value <.001) for the highest rank, 21.30 vs. 42.24 (p value <.001) for the second highest rank, 11.53 vs. 34.70 (p value <.001) for the third highest rank, and 4.38 vs. 24.40 (p value <.001) for the fourth highest rank, using a Wilcoxon rank-sum test.

When looking at contributions in period 1, all ranks in Rank-Order-VCM also start significantly higher than in Control. As we only have eight observations for each rank per treatment in a period, we combine the first three periods and run a Wilcoxon rank-sum test comparing the first three periods for each rank between the two treatments. The average of the first three initial contributions is 41.17 vs. 48.54 (p value = .078) for the highest rank, 30.75 vs. 45.21 (p value < .001)

FIGURE 4
Contribution Distributions in Control and Rank-Order-VCM

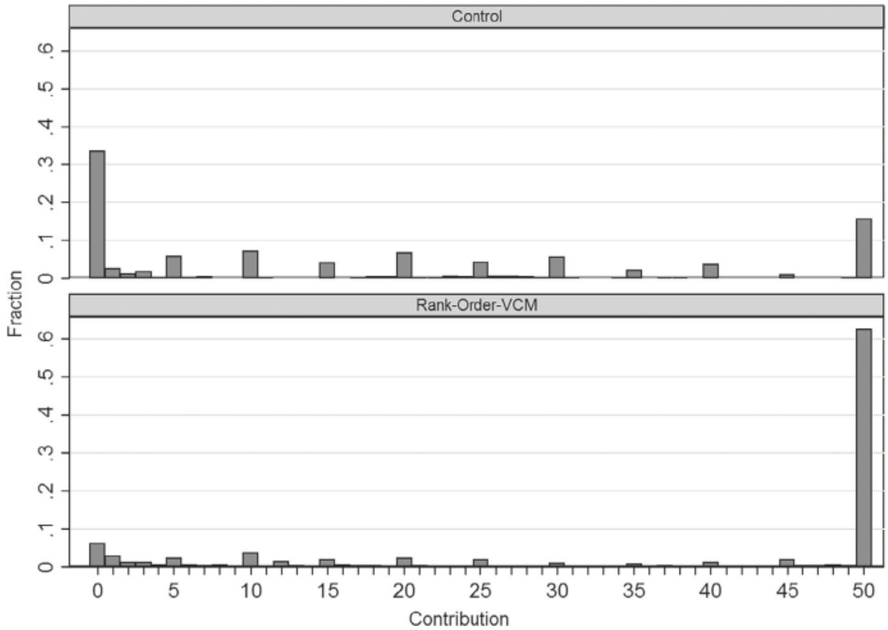
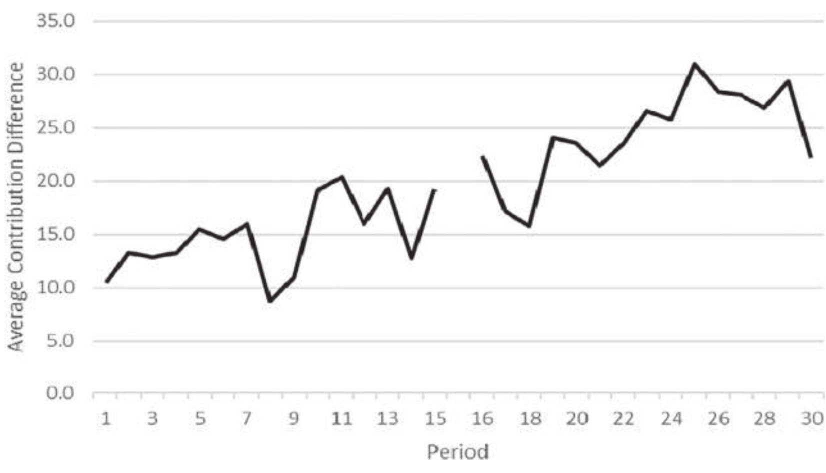


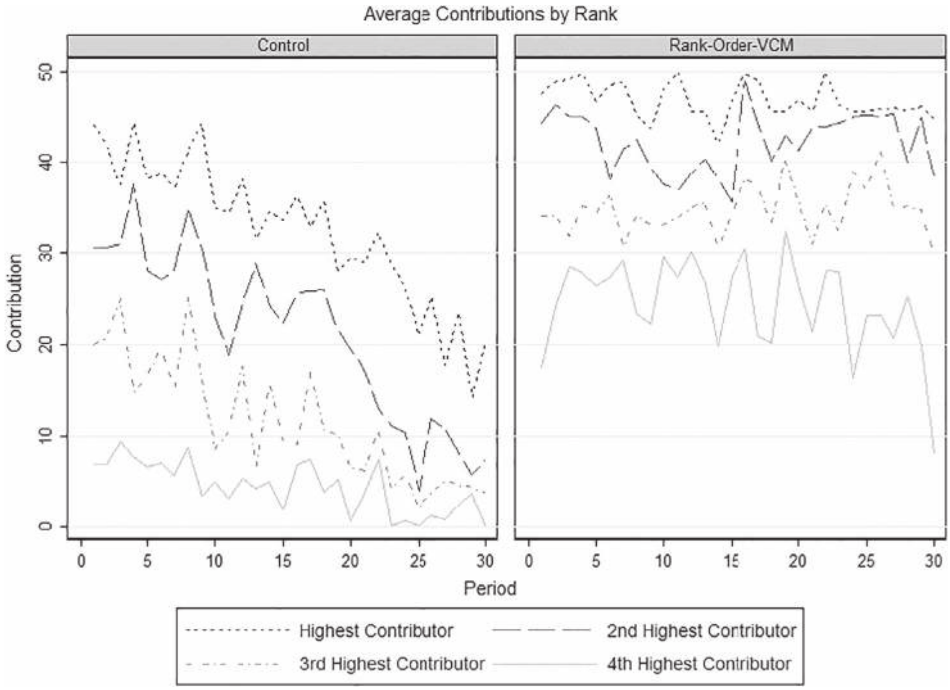
FIGURE 5
Average Contribution Difference between Rank-Order-VCM and Control



for the second highest rank, 21.96 vs. 33.29 (p value = .049) for the third highest rank, and 7.71 vs. 23.38 (p value = .004) for the fourth highest rank. While initial contributions in Control do start lower than in Rank-Order-VCM, it is clear that the differences further increase over time. Additionally, contributions in Control, for all ranks, decrease over time, whereas in Rank-Order-VCM they largely remain stable with a slight decrease by the lowest rank.

Figures 7 and 8 depict the nonaggregated contribution by rank for each of the 16 groups, thus allowing us to analyze between-group heterogeneity. While contributions of all groups

FIGURE 6
Average Contributions by Rank in Rank-Order-VCM and Control



in Control decrease over time, Figure 7 clearly shows heterogeneity between them; groups four and five have the highest contributor contribute mostly at the maximal level, whereas in groups one, two, seven, and eight the median contribution over time is at or below 50% of the endowment. Regarding the lowest contributor, in seven out of eight groups the median contribution over time is below the 10% level.

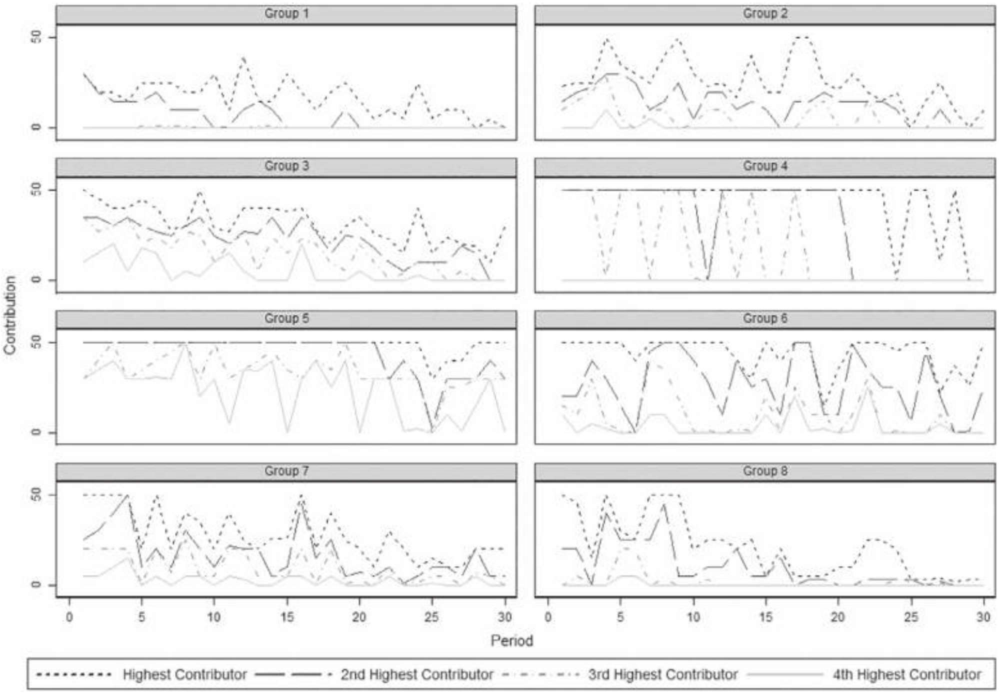
The presence of between group heterogeneity in Rank-Order-VCM can also be observed, but less so than in Control. Figure 8 depicts groups one, four, six, and eight having almost maximal contributions for at least three of the four subjects, and only group seven has the median contribution of the highest contributor below the maximal one (all groups except two and seven have both the highest and second highest contributor's median contribution at the maximal level).

C. Dynamics

Our results from Control are in line with the stylized facts on the symmetric VCM reported by Ledyard (1995): The initial contributions are almost exactly half of the endowment and their decline is significant as shown by the random effects regression of the average group contribution on the time trend. The details are presented in Table 1, column (1). The regression involves a dummy variable for the restart of the game interacted on the time trend. The decline is significant in both the original and in the restart game. The difference in contributions between the original and the restart game is evident: Each group in the Control treatment contributes lower amounts in the restart game than in the original game (p value = .008).

For Rank-Order-VCM, the average contribution increases from 37.3 to 39.6 between the original and the restart game. However, this difference is not significant as three groups increase and three groups decrease their contributions while two groups always contribute their full endowment. No significant time trend can be detected by the random effects dummy regression in the original or in the restart game for Rank-Order-VCM. The regression results are recorded in Table 1, column (2). Finally, based on the group data we observe that average contributions decline significantly more in Control than in Rank-Order-VCM (column [3]).

FIGURE 7
Contributions by Rank in Control for Each Group



Andreoni and Croson (2008) provide evidence that following a surprise restart in the symmetric VCM contributions jump back almost to their initial level after having declined in the original game. In our experiment, the restart was announced at the beginning of the experiment and so the subjects anticipated the restart game. In the absence of surprise, we do not find a significant restart effect (*p* values are .208 and .600 for Control and Rank-Order-VCM, respectively, when comparing contribution changes between periods 15 and 16 to changes between periods 14 and 15).

Starting from the second period, we calculated the ex-post best-response for each subject based on the other's contributions in the previous period. The random effects regression in Table 2 shows that, Rank-Order-VCM, subjects' contribution decisions are significantly attracted towards the ex-post best-response, that is, the best-response to the other group members' contributions in period *t*-1 has a significant effect on the contribution in period *t*.[14]

14. This behavior is in line with learning direction theory as proposed by Selten (2004). Goerg, Neugebauer, and Sadrieh (2016) provide a recent literature review.

In Control, the best-response predicts a contribution of zero in all cases (see Table B1 in Appendix B for a regression including both Rank-Order-VCM and Control), therefore conducting a similar analysis for Control treatment only is not feasible. However, the declining contribution reported in Table 1 column (1) shows an adjustment towards the best response with repetition for Control.

In summary, we observe no repetition effect and no contribution decline in Rank-Order-VCM. In contrast, there is a significant contribution decline in Control. In addition, we find no restart effect in either of the two treatments and observe a positive correlation of contributions to the ex-post best-response.

V. DISCUSSION

Our paper introduces a rank-order mechanism that counters the incentives to free-ride through competition in the VCM framework. Rank-Order-VCM assumes that one can give preferred access to the local public good to certain group members and thus generate heterogeneous

FIGURE 8
Contributions by Rank in Rank-Order-VCM for Each Group

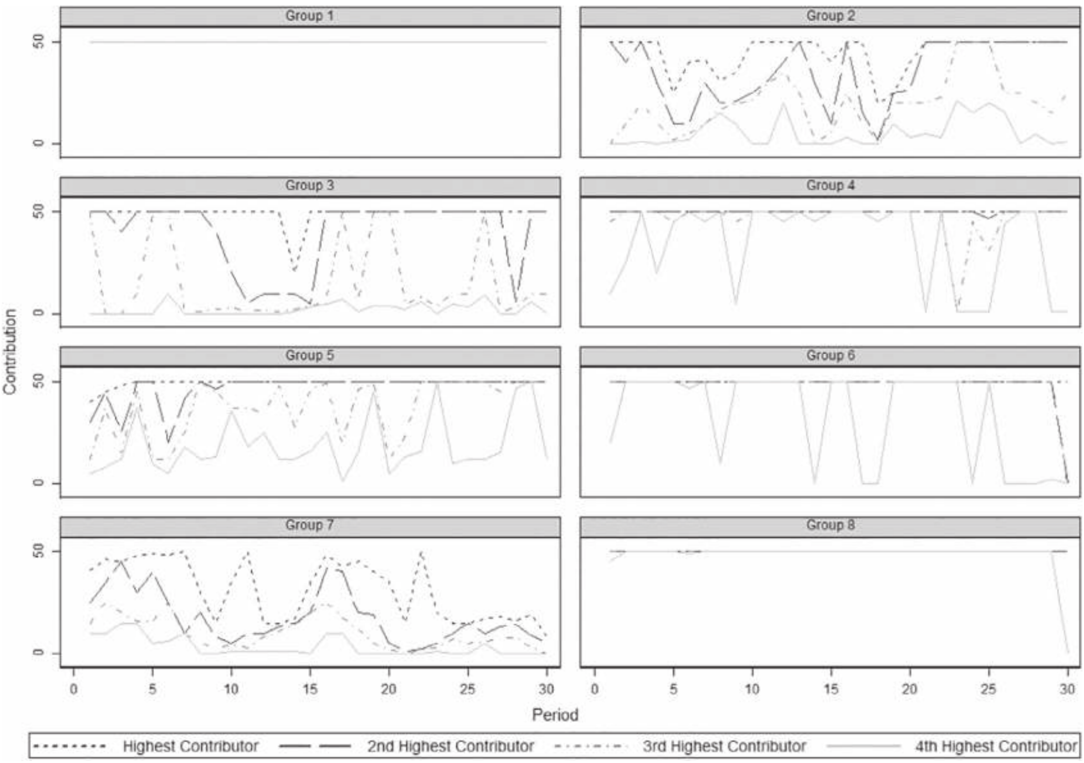


TABLE 1
Random-Effects Regression: Average Contribution per Group on Time Trend

(Column ID)	(1) Control	(2) Rank-Order-VCM	(3) Both Treatments
Number of observations	240	240	480
Number of independent observations	8	8	16
Independent variables			
Intercept	27.847*	39.999*	37.708*
	(4.415)	(5.195)	(4.619)
	[.000]	[.000]	[.000]
Dummy Restart	1.467	4.759	
	(2.372)	(2.468)	
	[.536]	[.054]	
Period	−.708*	−.334	.049
	(.217)	(.221)	(.069)
	[.001]	[.131]	[.478]
Dummy Restart × (period − 15)	−.310	.279	
	(.275)	(.286)	
	[.259]	[.330]	
Dummy Control			−8.929
			(6.532)
			[.172]
Dummy Control-VCM × (period)			−.847*
			(.098)
			[.000]

Note: Clustered at group-level; estimated coefficient (standard errors in parenthesis); [*p* values in brackets].
*Significant at 5%.

payoffs. That is, a person who receives better access to the (publicly funded) good derives a higher utility from it than a person who receives restricted access. To model such situation, we propose Rank-Order-VCM in which an individual who contributes more to a public good gains more from it than an individual who contributes less. This is accomplished by ranking the observed contributions and assigning a higher personal marginal return from the public good to a higher contributor. Rank-Order-VCM thus adds a contest aspect into the picture but keeps contributions voluntary. Furthermore, it does not require the social planner to award a fixed prize, which could change the equilibrium predictions.

In the experiment we test the hypothesis that rank-order competition, created by such assignment of marginal returns, overcomes the incentives to free-ride. This hypothesis is motivated by the analysis of the best-response correspondences.

The Control treatment features a dominant strategy of contributing zero. In Rank-Order-VCM the best response is not always unique as there exist strategy profiles of the other group members for which contributing zero is not a best response. Although our implemented Rank-Order-VCM maintains a unique Nash equilibrium of zero contributions, it elicits higher contribution levels than our Control treatment with random ranks and also sustains a median contribution of 100% of the endowment throughout the entire experiment, starting from period 1 and including the last period. Our results thus emphasize the power of rank-order competition also in collective action scenarios involving a tension between the self-interest and the interest of the group. Where applicable, this solution leads to contributions closer to the social optimum even in nonequilibrium instances as Rank-Order-VCM strengthens the private incentive to contribute.[15] This incentive can be strengthened further by parameterizing the mechanism in a way that all group members contributing their entire endowment becomes a Nash equilibrium. Naturally, the incentive to contribute is stronger for individuals with other-regarding preferences.

15. Consider the following example as an illustration. If other group members in Control contribute 50, the payoff from contributing 50 is 100 whereas the payoff from free-riding is 125, that is, 25% higher. In contrast, in Rank-Order-VCM the payoff from contributing 50 is 100 whereas the payoff from free-riding is 102.5, that is, only 2.5% higher.

While previous studies have also shown that contests can lead to decreased free-riding, in a majority of them high-contributors get rewarded with fixed prizes. In our view that approach has two downsides: First, it is a costly solution, as any prize must be subtracted from the collected contributions. Second, as the size of the prize has been found to influence behavior, it is not always a priori guaranteed whether the contest will have a positive net effect. This is of particular concern for local public goods, which are limited by geographical space, as well as congestible goods such as a publicly funded swimming pool.

Our laboratory version of Rank-Order-VCM avoids these issues. At the same time, implementing the mechanism in the field might introduce new challenges, depending on the type of good for which contributions are being raised. One such undesirable outcome would be a perception of rich having better access to the public good which might be seen as unfair and thus have consequences for the viability of the mechanism within the same community. (For similar reasons sports clubs often do not auction off season tickets but allocate them in a lottery.) A related issue might arise with limited capacity events, such as stage productions, where higher contributors receive greater access. If people paid a higher price to obtain that access and were denied because someone paid even more than them, they might not participate in future fundraising. It is therefore important to recognize our experiment as a test-bed of Rank-Order-VCM with promising results (see Servátka 2018). Regarding the practical applicability of the mechanism, there are multiple avenues for future research related to the group size effects or aggregate uncertainty that should be explored as the next step. Ideally, these further tests would be conducted in the field and will thus allow to identify context-dependent behavioral limitations of the mechanism and allow to fine-tune relevant parameters to optimize its performance in a given setting.

We note that Rank-Order-VCM can be made applicable also to pure public goods by introducing a subsidy/tax scheme similar to Falkinger et al. (2000) and where the subsidy/tax depends on the rank of the person's contribution within the group (rather than how far it is from the average as in the original setup by Falkinger et al.). The subsidy/tax, which if implemented in practice often comes with an administrative cost instead of restricting access, is based on the sum of all

TABLE 2
Random-Effects Regression: Contribution on Ex-Post Best-Response in Rank-Order-VCM

(Column ID)	(1)	(2)	(3)
Number of observations	928	928	928
Independent observations	8	8	8
Period	−0.255	−0.021	
	(−1.01)	(−0.14)	
	[0.311]	[0.885]	
Dummy Restart	4.519		0.871
	(1.45)		(0.46)
	[0.148]		[0.649]
Ex-post Best-Response	0.115*	0.116*	0.124*
	(2.30)	(2.26)	(2.42)
	[0.022]	[0.024]	[0.015]
Constant	33.00*	36.10*	34.35*
	(4.75)	(6.01)	(5.03)
	[0.000]	[0.000]	[0.000]

Note: Clustered at individual and group level; estimated coefficient (standard errors in parenthesis); [*p* values in brackets].
*Significant at 5%.

contributions and is applied on the top of the MPCR that is constant (say, 0.5) for all people in the group. If G is the sum of all contributions, the person with the highest rank then receives a subsidy of 0.15G; the person with the second highest contribution receives a subsidy of 0.05G; whereas the persons with the third and the fourth highest contributions are taxed 0.5G and 0.15G respectively (i.e., receive a negative subsidy). In case of a tie, the tax/subsidy is averaged as in the current design. As with any changes in how the decision problem is framed, splitting the personal multiplier into the uniform MPCR and a subsidy/tax might affect the behavior and so further testing of such framing is warranted. Nevertheless, it demonstrates that the rank-order competition idea could be applied more generally and not only to impure public goods.

Finally, our obtained experimental results are in line with the literature on social competition which finds that providing information on the relative performance affects behavior of individuals and entire markets, even when direct tournament incentives are not present (e.g., Fatas, Morales, and Jaramillo-Gutierrez 2015; Fischbacher and Gächter 2010; Schoenberg and Haruvy 2012). While in our setup the subjects do not receive a direct payoff feedback of the other group members, they do receive (anonymous) information about the individual contributions, ordered from highest to lowest, which allows them to calculate their relative performance. In our view, these additional nonmonetary incentives, which Rank-Order-VCM crowds in, might explain why it may convincingly outperform the standard VCM. Like Nobel laureates or Olympic medalists, who are not only richly awarded but also acknowledged as outstanding individuals in their discipline, the group members of Rank-Order-VCM receive rank-acknowledgement and are rank-dependently awarded. The discreetness of these effects may, however, question the existence of pure strategy equilibria when incorporating other-regarding concerns in the form of continuous trade-offs (e.g., Bolton and Ockenfels 2000; Fehr and Schmidt 1999; and the review of Cooper and Kagel 2016). While this is an interesting phenomenon in its own right, in the current paper we focus on the overall performance of rank-order tournaments in a VCM setting and leave the separation of monetary from nonmonetary incentives for future research.

APPENDIX A

A.1: RANK-ORDER-VCM TREATMENT INSTRUCTIONS

The purpose of the experiment is to study how people make decisions. From now until the end of the experiment, unauthorized communication of any kind between participants is prohibited. If you want to ask any question, please raise your hand first. Please turn off your cell-phone and do not use the computer for any other purpose than your participation in the experiment requires. If you break these rules, we will have to exclude you from the experiment and from all payments.

In the experiment you will earn money according to your decisions and the decisions taken by the other participants. At the end of the experiment you will be privately paid the sum of your payoffs during the experiment.

With whom do you interact?

1. At the beginning of the experiment, all participants are randomly assigned to groups of four. The composition of each group remains the same throughout the experiment, but the identity of the participants in the group will not be revealed to you at any time.

2. The experiment consists of thirty rounds. After the first fifteen rounds, there will be a restart of another fifteen rounds.

What do you have to do?

3. In every round you are endowed with 50 Cents. You have to decide how to use this endowment; what amount you allocate to a Project and how much you keep for yourself. The other three participants in your group face the same decision problem.

4. The money you allocate to the Project generates payoff to you and to every other participant in your group. The money you keep generates payoff only to you.

What will you earn?

5. In every round, your payoff will be computed as follows.

Your round payoff = the money you keep for yourself

+ the sum allocated to the Project by the four participants in your group × your multiplier

6. Your multiplier is determined by the amount you allocate to the Project and the amount allocated by the other participants in your group. Given the allocation of the others in your group, the higher your allocation to the Project, the higher are your chances for a larger multiplier in that round. In particular:

- If your allocation is the highest in the group, your multiplier is 0.65.
- If your allocation is the second highest, your multiplier is 0.55.
- If your allocation is the third highest, your multiplier is 0.45.
- If your allocation is the lowest, your multiplier is 0.35.

7. In case of a tie, that is, if two or more participants allocate the same amount to the Project, the corresponding multipliers are averaged. For instance, if the second highest allocation is equal to the third highest, the multiplier for the two participants is 0.5 [$= (0.55 + 0.45)/2$]. Hence, participants who allocate the same amount to the Project get the same payoff.

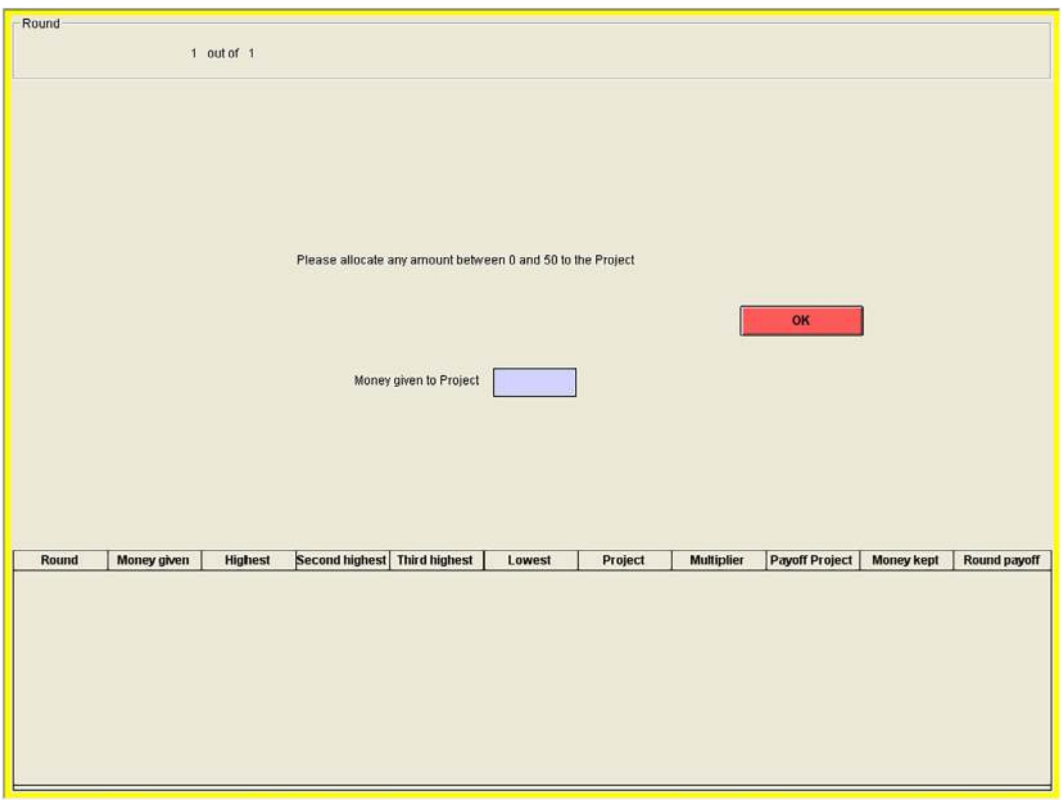
How do you make your decisions?

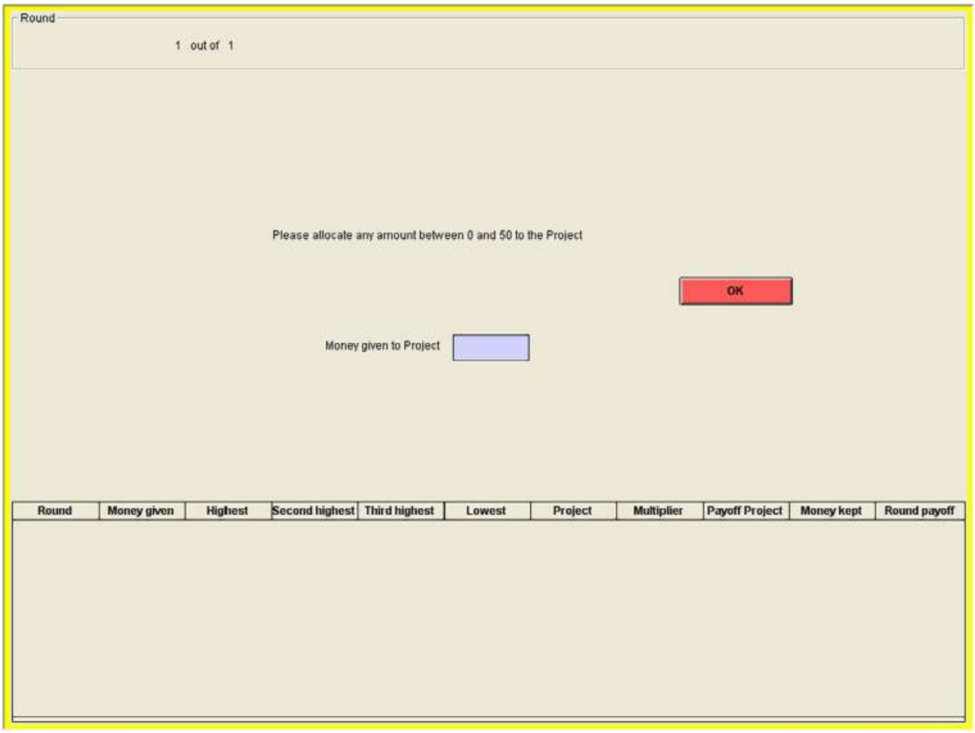
8. In each round, you make your decision on the computer by entering an amount into the input field on the screen (you can select the input field with the mouse). Next you press the OK button (with the mouse) to confirm your decision. Note: After you have confirmed your decision you can not revise it anymore.

What information will you receive?

9. After each round you receive feedback information on the amount you and your group allocated to the Project. You receive information on the individual allocation ordered from highest to lowest, but you will not be able to trace the amount to the person who allocated it. You also receive information about your multiplier, the resulting payoff from the Project, the Money kept, and your round payoff.

10. This information is recorded in a table on your screen and will be available to you for all past rounds. At restart, the information for the first 15 rounds is cleared.





A.2: CONTROL TREATMENT INSTRUCTIONS

The purpose of the experiment is to study how people make decisions. From now until the end of the experiment, unauthorized communication of any kind between participants is prohibited. If you want to ask any question, please raise your hand first. Please turn off your cell-phone and do not use the computer for any other purpose than your participation in the experiment requires. If you break these rules, we will have to exclude you from the experiment and from all payments.

In the experiment you will earn money according to your decisions and the decisions taken by the other participants. At the end of the experiment you will be privately paid the sum of your payoffs during the experiment.

<u>With whom do you interact?</u>

1. At the beginning of the experiment, all participants are randomly assigned to groups of four. The composition of each group remains the same throughout the experiment, but the identity of the participants in the group will not be revealed to you at any time.

2. The experiment consists of thirty rounds. After the first fifteen rounds, there will be a restart of another fifteen rounds.

<u>What do you have to do?</u>

3. In every round you are endowed with 50 Cents. You have to decide how to use this endowment; what amount you allocate to a Project and how much you keep for yourself. The other three participants in your group face the same decision problem.

4. The money you allocate to the Project generates payoff to you and to every other participant in your group. The money you keep generates payoff only to you.

<u>What will you earn?</u>

5. In every round, your payoff will be computed as follows.

Your round payoff = the money you keep for yourself + the sum allocated to the Project <u>by the four participants in your group</u> × your multiplier

6. In each round your multiplier is randomly determined by the computer; the computer draws a number 1, 2, 3, or 4 for each participant. The number is drawn with replacement; therefore it is possible for the computer to draw the same number for more than one person in your group. Your multiplier is determined according to the rank of your random number. In particular:

- If your random number is the highest in the group, your multiplier is 0.65.
- If your random number is the second highest, your multiplier is 0.55.
- If your random number is the third highest, your multiplier is 0.45.
- If your random number is the lowest, your multiplier is 0.35.

7. In case of a draw, that is, if two or more participants' random number is the same, the corresponding multipliers are averaged. For instance, if the second highest random number is equal to the third highest, the multiplier for the two participants is 0.5 [(= 0.55 + 0.45)/2]. You are informed

about your multiplier only at the end of the period. Hence, you make your decision about your allocation without knowing the exact value of your multiplier.

How do you make your decisions?

8. In each round, you make your decision on the computer by entering an amount into the input field on the screen (you can select the input field with the mouse). Next you press the OK button (with the mouse) to confirm your decision. Note: After you have confirmed your decision you cannot revise it anymore.

What information will you receive?

9. After each round you receive feedback information on the amount you and your group allocated to the Project. You receive information on the individual allocation ordered from highest to lowest, but you will not be able to trace the amount to the person who allocated it. You also receive information about your multiplier, the resulting payoff from the Project, the Money kept, and your round payoff.

10. This information is recorded in a table on your screen and will be available to you for all past rounds. At restart, the information for the first 15 rounds is cleared.

APPENDIX B

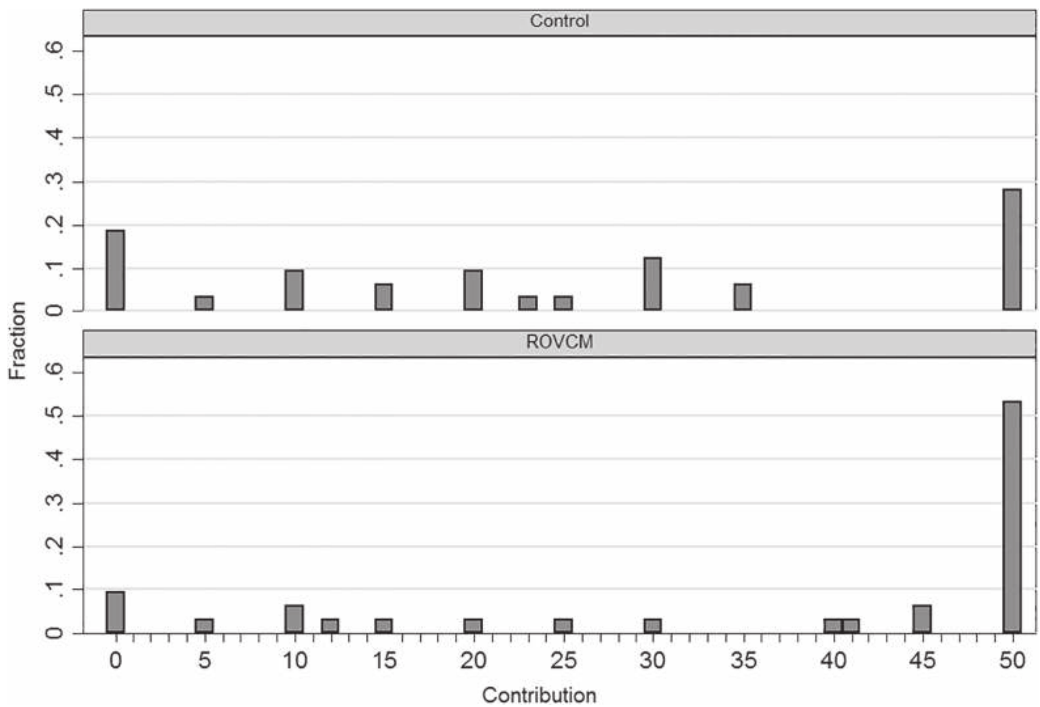


TABLE B1
Random-Effects Dummy Regression: Contribution on Ex-Post Best-Response

	Rank-Order-VCM Only	Rank-Order-VCM Only	Both Treatments	Both Treatments
Number of observations	928	928	1856	1856
Independent observations	8	8	16	16
Rank-Order-VCM treatment			19.104*	18.885*
			(3.15)	(3.08)
			[0.002]	[0.002]
Period	−0.255		−0.551*	
	(−1.01)		(−3.47)	
	[0.311]		[0.001]	
Dummy Restart	4.519	0.871	3.769*	−4.169*
	(1.45)	(0.46)	(2.329)	(−2.40)
	[0.148]	[0.649]	[0.022]	[0.017]
Ex-post Best-Response	0.115*	0.124*	0.073	0.092
	(2.30)	(2.42)	(1.30)	(1.70)
	[0.022]	[0.015]	[0.195]	[0.090]
Constant	33.00*	34.35*	20.25*	23.48*
	(4.75)	(5.03)	(4.83)	(5.11)
	[0.000]	[0.000]	[0.000]	[0.000]

Note: Clustered at individual and group level; estimated coefficient (standard errors in parenthesis); [*p* values in brackets].
*Significant at 5%.

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