Experimental Economics (2024) 27:215–243
https://doi.org/10.1007/s10683-022-09766-7

ORIGINAL PAPER

Competition among public good providers for donor rewards

Natalie Struwe[1] · Esther Blanco[1,2] · James M. Walker[2,3]

Received: 19 October 2021 / Revised: 6 May 2022 / Accepted: 23 June 2022 /
Published online: 9 September 2022

Abstract

We present experimental evidence for decision settings where public good providers compete for *endogenous* rewards which are donations (transfers) offered by outside donors. Donors receive benefits from public good provision but cannot provide the good themselves. The performance of three competition mechanisms is examined in relation to the level of public good provision and transfers offered by donors. In addition to a contest where transfers received by public good providers are proportional to effort, we study two contests with exclusion from transfers, namely a winner-takes-all and a loser-gets-nothing. We compare behavior in these three decision settings to the default setting of no-contest (no-transfers). Results for this novel decision environment with endogenous transfers show that donors offer transfers (contest prizes) at similar levels across contests and contributions to the public good are not significantly different in the three contests settings, but are consistently and significantly higher in all contests compared to the setting with no-transfers. Initially, the winner-takes-all setting leads to a significantly higher increase in public good contributions compared to the other two contests; but this difference diminishes across decision rounds.

Keywords Public good · Institution · Externality · Contests · Laboratory experiment

JEL Classification D70 · H41 · C92

✉ James M. Walker
walkerj@indiana.edu

[1] Department of Public Finance, University of Innsbruck, Universitaetsstrasse 15, 6020 Innsbruck, Austria

[2] The Ostrom Workshop, Indiana University, Bloomington, USA

[3] Department of Economics, Indiana University, Wylie Hall 105, Bloomington, IN 47405, USA

1 Introduction

In a wide array of charitable donation situations, donors care about a public good that they cannot directly provide. Consider for example programs designed to increase biodiversity in rainforests, or to facilitate education in order to reduce poverty in lower income countries. In such situations, there is a group of individuals (*insiders*) that can undertake effort (herein contributions) to provide a public good that benefits themselves and a broader group of individuals (*outsiders*). Outsiders cannot directly provide the public good, for example due to technical, institutional, or geographical restrictions, but can make donations in the form of rewards transferred to the insiders to financially support them in their efforts. Numerous forms of institutions supporting charitable giving, such as local, national, or international charitable organizations, allow outsiders to make donations to insiders who provide an array of goods and services, including environmental conservation, education, or healthier living conditions. Prominent examples are Payments for Ecosystem Services (PES) or conditional cash transfer programs for poverty alleviation. Charitable organizations typically face more requests for support than financial resources available. Thus, a critical institutional design question is how best to allocate limited donations among the different public good providers. For example, previous literature has proposed tournaments as a mechanism to distribute foreign aid to alleviate poverty (see, for example, Epstein & Gang, 2009; Svensson, 2003). Similarly, conservation auctions are used to distribute pre-defined PES contracts among ecosystem providers (see Ferraro, 2008). Field trials have shown that discriminative-prize auctions have the potential to increase program outcomes (Khalumba et al., 2014; Ulber et al., 2011). Motivated by this literature and importance of such programs, in this laboratory study we address allocation mechanisms based on competition between recipients of donations in a dynamic setting where donors and public good providers interact over multiple decision rounds.

A novelty of the experimental evidence presented herein is that in the contest settings under consideration public good providers compete for the *endogenous* funding from outsiders. The primary question being examined is whether the degree and form of exclusion in the contest mechanisms significantly affects the level of public good provision by insiders and the level of donations (herein transfers) from outsiders. This allows us to assess the impact on public good provision of policies that exclude lower performing individuals relative to policies that are fully inclusive. By focusing explicitly on contests, this study differs from the previous experimental studies investigating endogenous transfers by outsiders to insiders of public goods (see Blanco et al., 2018, BHW henceforth; Blanco et al., 2021, BSW henceforth). One of the results from this previous literature is that transfers from outsiders do not increase public good provision if transfers are allocated equally (BHW), while it significantly increases public goods provision if transfers are distributed proportional to effort (BSW). Other institutional characteristics such as conditionality of payments or additionality requirements are not found to be critical. By considering endogenous prizes (transfers to insiders through donations from outsiders), this study contributes to the literature on competition among providers of public goods, investigating competition in settings where prizes are not fixed and stable over time, but rather are based on the repeated prosocial or reciprocal decisions by outsiders to the efforts of insiders.

Specifically, we consider a *W*inner takes *A*ll contest (*WA*) where the insider with the highest contributions in a group receives all transfers made by the group of outsiders and a *L*oser gets *N*othing *(LN*) contest where the insider with the lowest contribution in a group receives no transfers and transfers are proportionally shared among the remaining three insiders. *WA* and *LN* are compared to a contest without exclusion, where transfers are distributed proportionally based on insiders' relative contributions, *Prop,* and a setting with no transfers, *No-T*. All treatments start with an initial phase where insiders provide the public good with benefits to themselves and outsiders, who are inactive. This means groups create a history in providing the public good in the absence of transfers from outsiders and consequently allows us to assess the impact that the contests have relative to each group's pre-contest cooperativeness. In all contests, after the initial phase, the decision setting then becomes a two-stage game where in stage one outsiders make independent transfer decisions. In stage two insiders observe the sum of transfers offered by the outsiders to the group of insiders and make independent contribution decisions. Transfers are then distributed to insiders based on the specific rules of the contests. Note that *WA* and *LN* can be viewed relative to each other as two extreme approaches in applying exclusion based on relative contributions. *WA* is a contest with extreme exclusion (all insiders excluded except one) while *LN* is a contest with the mildest exclusion (one insider excluded). Both *WA* and *LN* contests have characteristics of all-pay auctions. The experimental economics discipline has a long history of studying auctions as allocation mechanisms (see Kagel & Levin, 2011, for a general overview, and Dechenaux et al., 2014 for all-pay auctions in particular). To the best of our knowledge, this is the first experimental study to examine behavior in auction-type contests in decision settings in which there is endogenous interaction between donors and public good providers.

There is consensus in the theoretical and experimental literature that contests increase effort, both in individual task settings (see Dechenaux et al., 2014; and Sheremeta, 2018 for overviews), and in public good provision settings (Corazzini et al., 2010; Lange et al., 2007; Morgan, 2000; Morgan & Sefton, 2000; Orzen, 2008). Considering first the literature on contests involving individual tasks, the results addressing the performance of single versus multiple-prizes are mixed, suggesting that the relative performance of winner or loser contests are context dependent. For example, Moldovanu and Sela (2001) provide theoretical evidence for contests with multiple prizes in which agents have private information about their effort ability affecting costs. The authors show that for linear or concave effort cost functions, single prizes maximize expected efforts, however when costs are convex multiple prizes might be optimal. Cason et al. (2018) compare both theoretically and experimentally a single winner-take-all prize lottery and a deterministic contest in which prizes are shared proportional to effort. The single prize contest leads to higher effort (desirable to contest designers), while the proportional share rule generates more equitable payoffs to the contest participants. Similarly, Sheremeta (2011) show that a single prize lottery outperforms a multiple-prize lottery in terms of aggregate effort. In contrast to these studies, Dutcher et al. (2015) use rank-order tournaments with deterministic prizes and find that a proportional mechanism including a top, middle and bottom prize induces the highest effort, followed by a single loser contest, and a single winner contest being the worst performing contest.[1]

Closest to our decision setting is the literature on competition for *exogenous* prices in single group public good settings, where contributions of one group member provide positive externalities to other group members.[2] In these studies, the *size* of contest prizes is exogenously pre-defined and financed either by the experimenter or by being deducted from the group's contributions to the public good. The *distribution* of prizes is subsequently based on individual contributions relative to the group's aggregate contributions to the public good, either probabilistically through lotteries or deterministically through all-pay auction settings. In these settings, the experimental evidence suggests that a single prize (winner takes all) yields higher public good provision compared to multiple prizes (including the case of loser gets nothing). For example, by extending the single-prize lottery in Morgan (2000) and Morgan and Sefton (2000) to a lottery with multiple-prizes, Lange et al. (2007) find that the winner takes all outperforms the loser gets nothing in terms of total provision of a public good. Similarly, using a field experiment on donations, Landry et al. (2006) find that average donations are larger in a single prize lottery compared to a multiple prize lottery. Finally, using all-pay auction type contests, Faravelli and Stanca (2012) study public good provision within groups, comparing single winner prizes to a case with multiple winners receiving equal prizes and excluding the lowest contributor. They find that public good contributions are the highest with a single winner prize. As compared to these settings, we are the first to study single versus multiple prize contests in a setting where donors make *endogenous* donations that determine contest prizes and benefit from public good investments.

Further, by considering the *decisions of donors* to subsidize the provision of public goods, this study contributes to the large body of literature on the behavioral drivers of charitable donations (e.g. Andreoni, 1990; Vesterlund, 2003; Frey & Meier, 2004; Bénabou & Tirole, 2006; Ariely et al., 2009; Gneezy, et al., 2014;

[1] Further experimental evidence considering contests for the allocation of an exogenously provided, divisible resource suggests that a proportional prize contests leads to higher expenditures than both a multiple and single prize contest (Shupp et al., 2013).

[2] In addition to the literature discussed in the main text, previous studies show that competition for *external* rewards *between* groups providing a public good enhances provision (Gunnthorsdottir & Rapoport, 2006; Heap et al., 2015; Nalbantian & Schotter, 2016). An exception to this finding is Chambers et al. (2018), where groups consisting of heterogeneous subjects contributed less in a winner-takes-all scenario compared to a non-competitive setting. Importantly, in all of these studies, the provision of the public good originates in a closed group (what we refer to as only insiders) with no externality to members outside the group; and the prize in the competitive environment is exogenously defined and fixed by the experimenter.

In addition, another set of related studies on within-group competition considers prices defined by the aggregate contributions to the public good and distributed to individual contributors through changes in the marginal benefit they receive from the public good based on relative contribution levels (e.g. Angelovski et al., 2019; Colasante et al., 2019). Note that while these prizes can be understood as *endogenous,* they differ from the prizes we consider as they are not rewards received in addition to the return from the public good.

Garcia et al., 2020). By allowing interactions between donors and public good providers over multiple decision periods, we address the relevance of competition in the dynamic interaction between donations and the public good efforts that donations support. Thereby, this study intersects with a broad program of economic research that deals with social preferences (e.g. Cooper & Kagel, 2015), as well as cooperation and strategic interactions between groups (e.g. Cooper & Kagel, 2005; Kagel & McGee, 2016).

In the insider–outsider setting we study, we find that all three contest settings increase contributions to the public good relative to the setting with no transfers. We find that the *WA* and the *LN* contests yield similar increases in public good provision. Moreover, the *WA* outperforms the proportional sharing contests initially, but this difference vanishes over time. Lastly, we find that donors offer contest prizes at similar levels across contests. In this sense, our results point to the value of competition in allocating transfers from donors that can be used for multiple projects. On the other hand, the results suggest that contests that fully exclude subsets of public good providers from receiving transfers may not achieve better outcomes than inclusive mechanisms distributing transfers proportional to effort, which might be politically more attractive.

The remainder of this manuscript is structured as follows. In Sect. 2 we present the decision setting and hypotheses. In Sect. 3 we describe the experimental design and procedures. Sect. 4 presents an overview of the data, average treatment results and determinants of individual behavior across treatments. We conclude by discussing the results and respective policy implications in Sect. 5.

2 Competition in insider–outsider settings

The insider–outsider decision settings consist of a group of n_I insiders and n_o outsiders. Insiders can make contributions g_i out of endowment w, with $g_i \in [0, w]$ to a Group Account $G = \sum_{i=1}^{n_I} g_i$ that constitutes a public good with an equal marginal return of a for insiders and outsiders, where $\frac{1}{(n_I+n_O)} < a < 1$, so that the cumulative value of a contribution across all recipients (insiders and outsiders) exceeds the marginal cost of a contribution. Outsiders cannot make contributions but benefit from public good provision. However, outsiders can send transfers $t_j \in [0, w]$ from an endowment w to compensate insiders for their contributions. Transfers from outsiders are added together in a Transfer Account of size $T = \sum_{j=1}^{n_o} t_j$. The Transfer Account is distributed to insiders through the different contest mechanisms based on the treatment condition. Importantly, because transfers are distributed after insiders have made their contribution decisions, transfers do not increase the resources insiders have for making contributions but enhance their payoffs in the form of rewards. Maximum efficiency in public good provision is achieved when insiders contribute their full endowments to the public good.

A broad range of research has analysed the complex and diverse motivations in social dilemma settings beyond simple self-income maximization (see Sugden, 1984; Ostrom & Walker, 2003; Camerer & Fehr, 2006; Chaudhuri, 2011; Cooper &

Kagel, 2015). One of them is the basic human motivation of cooperation (Andreoni, 1995;Henrich et al., 2001; Goeree et al., 2002; Brandts et al., 2004; Kagel & Schley, 2013).[3] Previous evidence in the donors – public good providers environment studied here (BHW and BSW) shows significant positive levels of public good provision and transfers under varied allocation mechanisms for transfers. Thus, we allow that outsiders derive some non-monetary utility from offering transfers to insiders, given by $y_j(t_j)$, with $y_j(0) = 0$, $y_j'(t_j) > 0$, and $y_j''(t_j) < 0$.[4] Eq. (1) gives outsiders' utility function in a given period:

$$U_{Oj} = w + aG - t_j + y_j(t_j) \tag{1}$$

For the *competition settings*, an insider's utility function in a given period is given by Eq. (2).

$$U_{Ii} = w - g_i + aG + z(g_i, \boldsymbol{g_{-i}})T + f_i(g_i) \tag{2}$$

As in Orzen (2008), $z(.)$ represents the allocation rule of the prize in a given contest and $\boldsymbol{g_{-i}}$ is the vector of contributions of the other members of the group. The function $z(.)$ links relative contributions of insiders to the amount of rewards to be received, designating a competitive rewarding scheme defined for each specific contest, as described in Sects. 2.1 and 2.3 We also assume that insiders may derive utility from the act of giving, given by $f_i(g_i)$, with $f_i(0) = 0$, $f_i'(g_i) > 0$ and $f_i''(g_i) < 0$.[5]

Note that if we presume self-interested profit-maximizing preferences for outsiders, that is if $y_j(t_j) = 0$ for all j, outsiders' marginal utility from sending transfers would be $\frac{\partial U_{Oj}}{\partial t_j} = -1$. Being negative, outsiders would send no transfers and consequently there would be no contests, as the transfer account remains empty and no prize is offered. Thus with $y_j(t_j) = 0$ there would be no treatment variations in outsiders' behavior ($t_j = 0$ for all j).

Further, if in addition to $y_j(t_j) = 0$, we also assume $f_i(g_i) = 0$ for all i, that is, self-interested profit-maximizing preferences for insiders, their marginal utility from contributing to the public good would be $\frac{\partial U_{Ii}}{\partial g_i} = -1 + a$. Since we have assumed that $a < 1$, $\frac{\partial U_{Ii}}{\partial g_i} < 0$ and consequently $g_i = 0$ for all i. In sum, with self-interested profit-maximizing preferences $t_j = 0$, $g_i = 0$, and earnings for all participants would be that of their initial endowment.

It is sufficient that $y_j(t_j) > 0$ to change the result above based on purely self-interested behavior by insiders and outsiders. If outsiders derive sufficient utility from sending transfers, specifically if $y_j'(t_j) > 1$, $\frac{\partial U_{Oj}}{\partial t_j} = \left(-1 + y_j'(t_j)\right) > 0$, they would

[3] Cooper and Kagel (2015) provide an excellent selective overview of both the underlying theory and experimentalevidence related to "other-regarding preferences".

[4] Analysis of outsiders' self-reported motivations for sending transfers to insiders shows that they do not strongly differ between the different contest treatments (Struwe, Bogner, & Blanco, forthcoming). Thus, $y_j(t_j)$ is also not modelled to be treatment specific.

[5] For the case of *no transfers*, the utility function of an insider is given by: $U_{Ii} = w - g_i + aG + f_i(g_i)$. Notice that given this simple modelling assumption, extreme free riding (i.e. zero contributions by all insiders) is not a sensible prediction, as long as $f_i'(g_i) > 1 - a$, implying positive contributions.

send positive transfers ($T > 0$). Insiders would now find themselves in contests for an expected prize equal to their expected share of the transfer account, where the share received varies across treatment conditions based on relative contributions. If the size of the expected prize $z(g_i, \boldsymbol{g}_{-i})T$ is sufficiently large, insiders would have an incentive to contribute to the public good. In such cases, the marginal utility for insiders from contributing is larger in all contests than in the decision setting with no transfers, as insiders receive a higher (expected) marginal utility from contributing due to transfers from outsiders. Notice that the expected prize can motivate $g_i > 0$ even for fully self-interested profit-maximizing public good providers, with the optimal value of g_i varying for the different treatment conditions, as discussed further in Sects. 2.1 and 2.3. This outcome provides a critical difference between this study and the decision settings previously considered in BHW and BSW.

Below, we will assume that $y_j(t_j) > 0$ and $f_i(g_i) > 0$. Previous evidence shows that: (i) insiders make positive contributions to the public good even when the outsiders are inactive (BHW), supporting an interpretation that insiders derive utility from providing the public good (even if outsiders cannot offer transfers), and (ii) outsiders make positive transfers when allowed, a result that can be supported by reciprocity or other social motivations such as fairness (see, for example, Kagel et al., 1996 who suggest fairness as one reasonable motivation for reciprocal actions, and Fehr & Schmidt, 2006 for an overview of the impact that fairness considerations have on cooperation).

2.1 Proportional contest

With the proportional contest mechanism, the distribution of transfers from outsiders is proportional to insiders' individual public good contributions, thus $z(g_i, \boldsymbol{g}_{-i}) = \left(\frac{g_i}{\mathrm{G}}\right)$

Adding $z(.)$ into Eq. (2) gives an insider's utility function for the proportional contest.

$$U_{Ii} = w - g_i + aG + \left(\frac{g_i}{\mathrm{G}}\right)T + f_i(g_i) \tag{3}$$

An insiders' marginal utility from contributing to the public good is given by

$$\frac{\partial U_{Ii}}{\partial g_i} = \left(\frac{G_{-i}}{\mathrm{G}^2}\right)T - 1 + a + f_i'(g_i) \tag{4}$$

where G_{-i} is the sum of contributions of other insiders (excluding i). As shown by Eq. (3), due to the additional marginal utility from contributing associated with transfers, insiders in the proportional contest have a higher incentive to contribute to the public good as compared to insiders in the no-transfers condition (where $T = 0$).

2.2 Winner-takes-all contest

In the winner-takes-all contest, the insider with the highest contribution in a group receives the entire Transfer Account (T). Thus, this contest formally resembles an all-pay auction, in which all agents have the same endowment, which is public information, and the distribution of the prize to the highest contributor is deterministic.[6] This type of game has been formally analyzed in Orzen (2008). As in that model, $z(.)$ defines here a deterministic allocation of the contest prize, where the insider with the highest contribution wins, subject to a tie-breaking rule. Thus,

$$z\left(g_i, \boldsymbol{g_{-i}}\right) = \begin{cases} 1 & \textit{if } g_i > max\left(\boldsymbol{g_{-i}}\right) \\ \frac{1}{m} & \textit{in case i ties with } m-1 \textit{ other players} \\ 0 & \textit{if } g_i < max\left(\boldsymbol{g_{-i}}\right) \end{cases} \tag{4}$$

Considering only potential earnings from winning, an insider's optimal behavior in the *WA* contest depends both on the expectation of the behavior of other insiders, and on the size of the prize. Specifically, following the proof presented in Orzen (2008), one can show, if $0 < T < (1-a) * n * w$, insiders will randomize their contributions following the cumulative distribution function $F(g)= \left(\frac{(1-a)g}{T}\right)^{\frac{1}{n-1}}$ on the interval $\left[0, \frac{T}{(1-a)}\right]$. This implies, based on payoff maximization, that the *maximum* amount an insider is willing to contribute is $\hat{g}_{iWA} = \frac{T}{(1-a)}$, independent of expectations regarding the behavior of others. Notice that there can be situations where it is profitable for the insider to contribute more than the Transfer Account, and contribute up to their endowment w, even if $T < w$. How much to contribute below this threshold $\hat{g}_{iWA}$, will depend on the expectations of others' behavior. Disregarding motives other than maximizing earnings, insiders would want to win with the lowest possible contribution. In the limit, if an insider i expects $\boldsymbol{g_{-i}} = 0$, for any positive T, the best response of i would be to contribute one unit and thereby receiving the full Transfer Account, as opposed to tying with the other insiders and receiving only 25% of T. It follows that the best response of a different insider would be to increase their contribution by one unit above that of insider i. Thus, strategically, one can assume that insiders in this contest form an expectation at the margin of "beating" the second highest contributing insider. This iterative argument holds true until $\hat{g}_{iWA}$. Contributions above this level are strictly payoff dominated by contributing zero.

[6] Notice the difference to Morgan (2000) where the single-winner prize is probabilistically distributed through a Tullock (1980) lottery contest, with the probability of winning depending on a subject's relative contribution to the public good. The all-pay auction is limiting case of such a *Tullock* lottery contest, where the probability to win for the individual who exhibits highest effort reaches certainty. See Baye et al. (1996) for a general closed form solution for the individual all-pay auction with complete information (without a public good component). The authors show that with homogeneous valuations of the prize, there exists a unique symmetric equilibrium in mixed strategies as well as a continuum in asymmetric equilibria.

Alternatively, if $T \geq (1-a) * n * w$, insiders have an incentive to contribute their full endowment (i.e. $g_i = w$). The intuition is the following: an insider expecting others in their group to contribute $w - 1$ can increase their payoff by investing $g_i = w$, making them strictly better off as compared to $g_i = 0$. At $T = (1-a) * n * w$, insiders are exactly indifferent between tying with all others with contributions of w or deviating individually to zero contributions.

2.3 Loser-gets-nothing contest

In the loser-gets-nothing contest, the single insider with the lowest contribution in a group in a given period is excluded from receiving transfers. The Transfer Account is then shared among the remaining three insiders based on an insider's contribution relative to the sum of contributions of the three remaining insiders.[7] In case there is no unique loser (i.e. if there is a tie for the lowest contribution between at least two insiders), the Transfer Account is shared proportionally among all insiders. Thus,

$$z(g_i, \boldsymbol{g_{-i}}) = \begin{cases} \left(\frac{g_i}{\mathrm{G}_w}\right) & \textit{if } g_i > \textit{min}(\boldsymbol{g_{-i}}) \\ \left(\frac{g_i}{\mathrm{G}}\right) & \textit{in case of any ties} \\ 0 & \textit{if } g_i < \textit{min}(\boldsymbol{g_{-i}}) \end{cases} \tag{6}$$

where G_w equals the sum of contributions of the top three insiders.

Observe that this contest has similarities with symmetric multiple-prize all-pay auctions with complete information (without a public good provision environment). Barut and Kovenock (1998) show that in such a contest only mixed strategy equilibria exist and that expected expenditures are highest by defining the lowest prize equal to zero, as we do.[8] Note, however, in the decision setting we investigate, once the loser is determined, the size of the individual prizes to each of the winners in the *LN* contest are not fixed but are based on each winner's contribution relative to the total contributions by all outsiders in that particular decision period. This feature makes our loser-gets-nothing contest similar to the proportional contest. Specifically, note that there are two cases when the payoff structure is identical to that of the proportional contest, namely (i) in case of ties at the lowest contribution, and (ii) in case that at least one insider in the proportional contest contributes zero to the

[7] Note the difference to the decision setting in Lange et al. (2007) who model a lottery with three probabilistically distributed prizes and exclusion at the bottom.

[8] See Faravelli (2011) for the formal solution of a multiple-prize all-pay auction in a public good setting with heterogeneous endowments and incomplete information. In such a scenario, there exists a pure-strategy equilibrium in which contributions are increasing in the endowment. See Faravelli & Stanca (2012) for experimental evidence related to Faravelli's model. Note that agents in those setting are heterogeneous in income and the prizes are pre-defined (and equal, in the case of Faravelli & Stanca, 2012). To our knowledge, no one has yet provided a general solution for a multiple prize all-pay auction in a public good environment where there is exclusion for the lowest contributor, and where prizes are being distributed proportional to effort (and endogenously defined by a group of outsiders).

public good. Increasing the number of insiders in a group, the loser-gets-nothing contest converges to the proportional contest.

As in the winner-takes-all contest, if an insider expects the other group members to contribute zero, she has an incentive to contribute one unit and thereby receiving the full Transfer Account (the same holds true for the proportional contest). However, contrary to the winner-takes-all scenario, increasing contributions further in order to be the highest contributing individual only results in an increase in the proportional share of transfers received, not T. Thus, for a given level of contributions $\boldsymbol{g}_{-i}$ and payoff maximization, the *maximum* amount an insider is willing to contribute depends directly on the expected behavior of others, and is given by $\hat{g}_{iLN} = \frac{T}{(1-a)} - g_{-k}$, where g_{-k} are the *expected* contributions of the other two members in a group receiving transfers (i.e. excluding the expected contribution of the lowest contributor). In addition to the return from the public good, contributions above $\hat{g}_i$ imply that the proportional share from transfers received (for an insider that is not the lowest contributor) is strictly lower than the individual contribution, and so the insider is better off contributing zero. Notice, for a given level of$T$, unless g_{-k} is expected to be zero, $\hat{g}_{iLN}$ is per definition strictly lower than $\hat{g}_{iWA}$.

2.4 Behavioral conjectures

As compared to *No-T*, all contests studied here increase the marginal incentives for an insider to contribute to the public good for $T > 0$. This can be attributed to the contest increasing the expected benefits of contributions by receiving all or a share of the endogenous prize from the contest, as long as the expectation of receiving transfers is larger zero (i.e. $z\left(g_i, \boldsymbol{g}_{-i}\right) > 0$). Based on these results, as well as the previous evidence suggesting that contests within closed groups yield higher public good contributions than a simple voluntary contribution mechanism (Corazzini et al., 2010; Lange et al., 2007; Morgan, 2000; Morgan & Sefton, 2000; Orzen, 2008), we expect all three contest treatments to result in higher contributions than the *No-T* treatment, as formulated in conjecture 1.

Conjecture 1 *On average, contributions will be higher in the three contests compared to the no-transfer, inactive outsiders setting.*

Turning to comparisons of the different contests, the winner-takes-all contest constitutes the strongest form of competition, excluding all but a single winner from receiving transfers in a given period in a given group. Given positive transfers by outsiders, the incentives to win the contest are highest in the winner-takes-all setting.[9] As discussed, the previous experimental literature focusing on contests

[9] Meaning, the incentive to increase the individual contribution by one additional unit in order to “win” a given contest and be the highest contributing insider, is highest in the winner-takes-all contest. This is because the marginal benefit from this additional contribution is largest in this setting – moving from an equal share of the Transfer Account (equally shared between the number of tying insiders) to the full Transfer Account; as opposed to marginally increasing the share of transfers received in both the proportional and the loser-gets-nothing contest.

in closed groups providing a public good and comparing single or multiple prizes supports the finding that winner–takes–all contests outperform contests with multiple prizes (with a loser-gets-nothing structure) in terms of public good provision (e.g. Faravelli & Stanca, 2012; Lange et al., 2007). Based on these findings, and the arguments developed in Sect. 2.2; we conjecture that the winner-take-all contest will induce the highest average contributions of insiders. Through reciprocity from outsiders, we expect this to also result in the highest average transfers.[10]

For a given $\boldsymbol{g}_{-i}$, the share of transfers an insider can receive is larger in the loser-gets-nothing contests than in the proportional contest, i.e. $\left(\frac{g_i}{G_w}\right) > \left(\frac{g_i}{G}\right)$. Thus, one might conjecture the incentives to contribute to be larger for insiders in the loser-gets-nothing contest. Note however, as discussed in Sect. 2.3, this holds true only as long as there are no (*expected*) ties in loser-gets-nothing and no (*expected*) zero contributions of any insider in a given round in the proportional contest. Based on the considerations above, we formulate conjecture 2 on the relative comparison of the three contests under consideration.

Conjecture 2 *On average, contributions and transfers will be higher in the winner-takes-all contest than in the proportional and the loser-gets-nothing contests.*

3 Experimental design and procedures

Table 1 provides an overview of the four treatment conditions (*WA, LN, Prop and No-T)* implemented and the respective attributes of the decision settings. The data from *Prop* were initially reported in BSW. All remaining data presented herein is previously unpublished. We conducted a total of 20 experimental sessions during March 2018 and January 2020 at the EconLab of the University of Innsbruck, Austria, consisting of 24 participants per session. The experiments were programmed using zTree (Fischbacher, 2007) and subjects were recruited using the HROOT system (Bock et al., 2014). Our sample consists of 53.7% females and participants are on average 22.4 years old (sd = 0.14).

An experimental group is composed of two randomly assigned types of subjects, $n_I = 4$ insiders and $n_O = 4$ outsiders, for a total group size of 8. An experimental session consists of multiple decision-making periods and includes two parts, 5 periods of Part 1 and 10 periods of Part 2. Part 1 is equivalent in all treatments. Subjects learned the decision-making details of Part 2 only after the completion of Part 1. Subjects participated in only one of the treatment conditions in a between-subjects design. Groups and participants' roles remained fixed for the duration of the experiment. Instructions were read aloud by the experimentalist (see the Supplementary Materials for instructions, which were common knowledge among insiders and

[10] See Sugden (1984) for a formal discussion of reciprocity and Croson (2007) for experimental evidence in repeated linear VCM public good settings.

Table 1 Overview of implemented treatment conditions

Treatment	Contest	Nr. of observations
WA	winner-takes-all contest	13 groups 104 subjects
LN	loser-gets-nothing contest	12 groups 96 subjects
Prop	proportional contest	21 groups* 168 subjects
No-T	no contest	14 groups 112 subjects
Total		60 groups 480 subjects

*The data collection took place in two waves, one in 2018, with 12–14 groups per treatment, and one in 2020 that started with the proportional treatment, reaching the full set of planned observations (about 20 groups in each treatment). Due to the outbreak of Covid-19 in the spring of 2020 and ongoing restrictions with running laboratory experiments, we could not complete the observations for the other treatments. Section 1 in the Supplementary Matierals presents a robustness analysis on treatment effects considering only the 2018 observations for *Prop*. The main text includes all observations, for transparency[11]

outsiders) and subjects were required to answer a series of control questions on the screen before making decisions.

In Part 1, in all treatment conditions, outsiders are inactive and insiders make contributions g_i from an endowment of $w = 100$ ECUs (Experimental Currency Units), with $g_i \in [0, 100]$ to the Group Account G that constitutes a public good with an equal marginal per capita return of $a = 0.4$ for insiders and outsiders. Outsiders have an equivalent endowment of $w = 100$ ECUs, but cannot make allocation decisions, they simply receive the benefits of the public good provision by insiders, which is common information. Outsiders were, however, asked to provide an estimate of the average individual contribution of insiders to the Group Account in the given period. It can be argued that in most (or many) field settings with insider–outsider interactions there is a history where insiders provide a public good with benefits extending to a broader population. Including Part 1 in the experimental design is important as we are interested in providing such a history, where insiders have not been compensated for their contribution efforts. Further, Part 1 provides evidence of variation across groups within a treatment and serves as a statistical control when examining variation in behavior due to treatment effects.

The decision-making setting in Part 2 depends on the specific treatment condition. The role of outsiders, and the specific allocation of transfers varies depending on the

[11] See section 1 in the Electronic Supplementary Material for robustness on treatment effects considering only the first wave of data collection (i.e. taking into account only the first 12 groups in the *Prop* treatment). All results are robust.

specific treatment condition. In the *No-T* decision setting, Part 2 is equivalent to Part 1. In the treatments with transfers, Part 2 becomes a two-stage game. In stage 1, each outsider makes a transfer decision $t_j \in [0, 100]$ to be sent to the insiders in the form of the Transfer Account. In stage 2, insiders are informed of the size of the Transfer Account and make their Group Account contribution decisions, as in Part 1. Similar to the estimate that outsiders provided on insiders' expected behavior, insiders were asked to provide an estimate on their expectations about outsiders' average transfer offers.[12] At the end of each period in Part 2, the sum of contributions is communicated to all subjects in a group. Both insiders and outsiders are also informed of the collective contributions of insiders and the collective transfers of outsiders, as well as their individual earnings. Importantly, in none of the contest treatments is the group informed about individual insiders' contributions and which insider in a group won or lost the respective contest, such that there is no reputation building across decision rounds.

In the *Prop* treatment, at the end of each period, each insider is privately informed of the amount of transfers they receive, as well as the share of transfers it represents. In the *WA* treatment, at the end of each period, insiders receive feedback on whether or not they are the highest contributor in the group and thus whether or not they receive the Transfer Account. Importantly, if there is a tie for the highest contributor, the group is informed of the tie and the Transfers Account is shared equally among the winners who are informed of their share of transfers in that case. In the *LN* treatment, in the case of a unique lowest contributor, at the end of a period, the lowest contributor learns (s)he was the insider with the lowest contribution in the group and thus receives no transfers. The remaining group members are privately informed of their share of the Transfer Account. If there is a tie for the lowest contribution (i.e. no unique lowest contributor), the group is informed of this and the Transfer Account is shared proportionally among all four insiders in a group.

4 Results

The presentation of results is organized around four sub-sections. In Sect. 4.1, we provide a descriptive overview of the data. Sect. 4.2 reports the results from a regression analysis designed to test for differences in average treatment effects for period 6 group decisions and for group decisions in all periods of Part 2. Sect. 4.3 focuses on heterogeneous responses of insiders to the transfer mechanisms, and Sect. 4.4. addresses heterogeneous responses of outsiders to the behavior of insiders.

[12] Insiders' and outsiders' estimates were not considered a central focus of the experimental design. They were not incentivized in order to have subjects focus on contribution and transfer decisions. The precise wording for the question posed to insiders was: "On average, how many ECUs do you think each Type B participant will allocate to the transfer account (between 0 and 100)?" and the precise wording for the question posed to outsiders was: "On average, how many ECUs do you think each Type A participant will allocate to the group account (between 0 and 100)?" where, in the manuscript, we refer to Type B as outsiders and Type A as insiders. See Fig. B9 in the Electronic Supplementary Material for the distribution of insiders' and outsiders' expectations in Part 2 for each treatment.

4.1 Description of data

Figure 1 presents average group contributions (sumG, solid lines) and average group transfers (sumT, dashed lines) for all treatments. In addition, Figures B1–B4 Section 2 of the Electronic Supplementary Material show average contributions and transfers for each group in each treatment separately.

In Period 1 insiders contribute on average 35–43% of their endowment, with the differences not being statistically significant between treatments, nor is the difference significant pooling across all periods of Part 1 (p-value > 0.1 for all relevant t-test comparisons based on average group contributions).[13] Moving to Part 2, in all treatments, contributions decay after an initial increase from period 5 to period 6, but stay significantly above zero (all p-values < 0.05 from t-tests comparisons, unit of analysis is a group in a given period) throughout all periods. Throughout Part 2, contributions in *WA, LN* and *Prop* remain at a higher level than *No-T.* The evolution of group transfers is similar in all contest treatments. Considering all periods of Part 2, average group transfers equaled 15.4% of outsiders' group endowment in *Prop*; 17.5% in *WA* and 20.4% in *LN*.

4.2 Aggregate treatment effects

To formally analyze the impact of the introduction of the different contests on group contributions and group transfers, we use a "difference-in-differences" estimation approach, explicitly accounting for Part 1 group decisions. We define net contributions for each *group* and each period of Part 2, as contributions relative to the group's average contributions during Part 1, **net contributions** = sumG – $avgG_{1\text{-}5}$. Similarly, acknowledging that outsiders' willingness to offer transfers likely depends on the Part 1 behavior of insiders in a given group, we also create a net transfers variable, **net transfers** = sumT – $avgG_{1\text{-}5}$.[14] This approach allows

[13] We also observe that average contributions in periods 2–5 decay at different rates between some of the treatments: two sample t-tests for average group contributions reveal that the difference between *No-T* and *Prop* is significant in both period 4 and period 5 at $p < 0.05$ (unit of observation is a group in a given period), as is the difference between *No-T* and *LN* at $p < 0.05$ in period 04. Given that experimental conditions are equivalent in Part 1 in all treatments and prior to Part 2 subjects are not informed of the treatment differences in Part 2, these differences are attributed to group-specific dynamics.

[14] Not controlling for differences in contributions across groups in Part 1, Period 6 differences in average group contributions are significant only for the comparison of *WA* with *No-T* and with *Prop* (p-values < 0.05 from t-test, unit of analysis is a group in period 06) and weakly significant for the comparison of *LN* with *No-T* (p-value = 0.08). Period 6 comparisons of *LN* with *Prop* and with *WA* are both insignificant (p-values > 0.1). Similarly, the differences in average Part 2 contributions are significant for the comparison of *WA* with *No-T*, and with *Prop* (all p-values < 0.05 from t-tests, unit of analysis is a group's average contribution pooled for Part 2), and weakly significant for the comparison of LN with No-T (p-value = 0.07). Average Part 2 comparisons of *LN* with *Prop* and with *WA* are again not significant (p-values > 0.1). Average group transfers are not significantly different for either period 6 or the average of Part 2 (p-value > 0.1 for all relevant t-test comparisons).

See Fig. B5 in the Electronic Supplementary Material for robustness tests on average treatment effects, using average group contributions (and transfers) as the dependent variable (instead of net contributions and net transfers), using average Part 1 contributions of each group as a control variable. Results are qualitatively stable, except for the comparison in average contributions between WA and Prop—where both Period 6 and Part 2 contributions are significantly higher in *WA*.

for controlling for Part 1 differences in contributions between groups across treatments.

Figure 2 presents the coefficient plots for average treatment effects for differences in net-contributions and net-transfers, separately for period 6 and for the average of Part 2. The reference treatment for net contributions is *No-T*, and for net transfers it is *Prop*.[15] Period 6 analysis is based on regressions with clustered standard errors at the group level. The analyses for Part 2 (periods 6–15) is based on panel-regression analysis using multilevel mixed effects regressions with random effects on the group and session level and robust standard errors that are clustered at the session level. Explanatory variables are dummy variables indicating the treatment, and the period for the regressions for periods 6–15.

Focusing first on period 6, compared to *No-T* all contest treatments generate significantly higher net contributions, with an average treatment effect of 10.7% for *Prop*, 25.9% for *WA* and 19.3% for *LN*. Pairwise comparisons of net contributions between treatments based on post-estimation Wald tests are significant only for the comparison of *Prop* and *WA* (p-value = 0.012). We do not find a significant difference for net contributions between *Prop* and *LN* (p-value = 0.086) nor for *WA* and *LN* in period 6 (p-value = 0.3). Considering net transfers, the two treatments that allow for exclusion do not generate significantly different net transfers as compared to *Prop* for period 6 (effect size for *WA* vs *Prop* is −6.8%, p-value = 0.27 and effect size for *LN* vs *Prop* is, 5.9%, p-value = 0.41), and the comparison between net transfers for *WA* and *LN* is weakly significant (p-value = 0.11).

Turning to all periods of Part 2 (periods 6–15), Fig. 2 shows that, as observed for Period 6, all contest treatments exhibit significantly higher levels of net contributions compared to *No-T*. The average treatment effect for Part 2 compared to *No*-T is a 17.1% increase in net contributions in *Prop*, 20.7% in *WA* and 22.6% in *LN*. Thus, contrary to conjecture 2, the *LN* treatment results in the highest net contributions. However, all pairwise comparisons of net contributions between treatments based on post-estimation Wald tests are insignificant. Net transfers are not significantly different for the comparison of *WA* and *LN* with *Prop* (effect sizes are −3.1 and 4.6%, and p-values are 0.36 and 0.1, respectively), though the difference in WA as compared to *LN* is significant (p = 0.033). These effect sizes of net transfers are small. Further, *average* absolute transfers offered by outsiders (i.e. not explicitly accounting for Part 1 contributions of insiders) are not significantly different in the three contests, see Fig. B5 in the Electronic Supplementary Material.

In addition, we find a negative and significant effect of time (periods) on net contributions and net transfers. Figures B6 and B7 in the Electronic Supplementary

[15] For the analyses that includes multiple decision periods, multilevel mixed-effects regressions are used to model the hierarchical structure of our data, thus accounting for existing intra-class correlations (ICC) of groups within a session, and individuals within a group, respectively. These can be interpreted as the fraction of total variability associated to the session (or group) level. Residual ICCs range between 22 and 68% for all regression models under consideration. Further, for all panel-data regression analysis, we specify robust standard errors that are clustered at the highest level in multilevel mixed-effects models (that is on the session level for analysis of average treatment effects, and on the group level for analysis of individual behaviour).

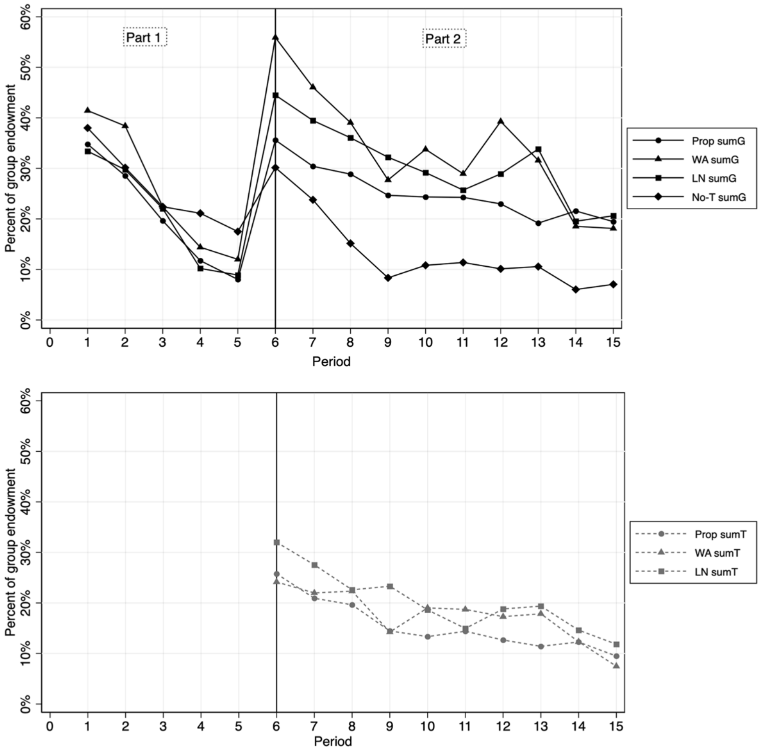


Fig. 1 Average group contributions (top figure) and group transfers (bottom figure) across periods

Material plot the difference in net contributions and net transfers between treatments for each period of Part 2, providing insights into the time-stability of the treatment effects. We observe that for the comparisons of the contests to *No-T* most period-wise comparisons are significant, with the sole exception being periods 14 and 15 in the comparison *WA* vs. *No-T*. We further find that the pairwise comparisons for net contributions between the contests are not significant (except for the period 6 comparison of *WA* and *Prop*). Finally, net transfers are not significantly different for any of the period-wise comparisons.

Results 1 and 2 summarize the findings on average treatment effects.

Result 1 *In support of Conjecture 1, all contest treatments generate significantly higher net contributions relative to No-T.*

Result 2 *While WA initially generates higher net contributions than Prop, this difference vanishes in later decision periods, inconsistent with Conjecture 2.*

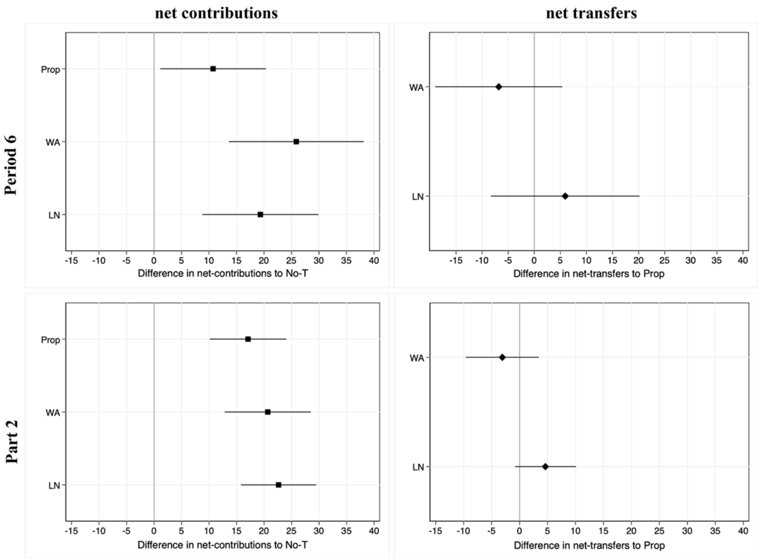


Fig. 2 Period 6 treatment effects for average group net contributions and average net transfers, period 6 only**.** Point estimates and 95% confidence intervals based on treatment differences from OLS regressions, with clustered standard errors at the group level. Part 2: Treatment effects for average group net contributions and average net transfers, decision periods 6–15. Point estimates and 95% confidence intervals based on cluster-robust standard errors on the session level for treatment differences from multilevel mixed-effects regressions with random effects at the group and session level

4.3 Determinants of insiders' behavior under competition for transfers

Similar to other social dilemma studies, we observe substantial heterogeneity in individuals' behavior within and across treatments. For example, Fig. B8a in the Electronic Supplementary Material shows the histograms of individual contribution decisions for all treatments, with the distribution of insiders' decisions being significantly different for all treatment comparisons (all p-values < 0.0001 from respective Kolmogorov–Smirnov tests, unit of observation is an individual insider in a given period, for periods 6–15). As can be seen from Fig. B8a, considering all decision periods of Part 2, strong free-riding (defined as zero contributions of a given insider in a given period) accounts for 49.8% of all observations in *No-T*. This is reduced to 30.4% in *WA*, 25% in *Prop*, and 21% in *LN* (all p-values < 0.0001 from t-test comparisons, unit of analysis is an individual insider in a given period, for periods 6–15). Further, the difference between *WA* and *Prop* is also significant (p-value = 0.038), as is the difference between *WA* and *LN* (p-value < 0.0001).[16]

[16] We further identify 10.7% of insiders as full free riders (meaning zero contributions in *all* decision periods in Part 2) in *No-T*. This number is reduced to 3.6% in *Prop*, 3.8% in *WA* and 4.2% in *LN*. The differences, however, are not significant (all p-values > 0.05 from all t-test comparisons, unit of analysis is an individual insider's contributions pooled for Part 2).

We now turn to examining determinants of individual decision making that help explain the observed differences in insiders' behavior across treatments. The repeated insider–outsider setting we study is a complex decision environment in that it includes the potential for reciprocity within the groups of insiders and outsiders, as well as between insider–outsider groups. As compared to previous public good studies with contests in closed groups and exogenously provided prizes, the dynamic between those providing the contest prizes and those competing in the contest is a novel aspect of our study. The analysis below examines changes in contributions by insiders from the perspective of a) the effect of unmet or exceeded expectations of transfers, and b) the effect of winning or losing in the respective contest.

The rationale behind this additional analysis is the following. First, since contest prizes are subject to outsider's endogenous and dynamic decisions over time, it is reasonable to assume that insiders could be disappointed by transfers that do not meet expectations which could lead to insiders' decreasing their contributions. Second, being excluded from transfers in a given period could provide a basis for losers to be less motivated in making future contributions.

Broadly, in all treatments, average transfers offered by outsiders fall short of insiders' average expectations (see Table B1 column 4, in the Electronic Supplementary Material). But this average effect hides individual heterogeneity. Based on the difference between individual expectations and transfers offered, we construct two continuous variables: unmet-expectation$_t$, measuring the extent to which transfers are lower than insiders' expectations in a period and exceeded-expectation$_t$, measuring the extent to which transfers offered are higher than insiders' expectations in a period.

Table 2 presents the results from multilevel mixed-effects regressions with random effects on the group and subject level and cluster-robust standard errors at the group level, where the dependent variable is insiders' *individual* contribution to the public good in each period t of Part 2 (periods 6–15). Explanatory variables in column I (for *Prop*), column II (for *WA*) and column IV (for *LN*) include (i) the previous periods' average contribution of other insiders in a group (other insiders$_{t-1}$), (ii) unmet-expectation$_t$, (iii) exceeded-expectation$_t$, (iv) the individual insider's average contribution during Part 1 (avg$_{1-5}$), (v) the previous periods' share of transfers received (share transfers$_{t-1}$), and (vi) the period. Instead of share transfers$_{t-1}$ received, Column III for *WA* includes whether the insider was the winner of the contest in the previous round (winner$_{t-1}$) and the number of winners in the previous period (#winners$_{t-1}$), in case there were ties. Similarly, column V for *LN* includes whether the insider was the (sole) loser of the previous contest (loser$_{t-1}$).[17] Table B2 in the

[17] For *LN*, if there was a tie for the lowest contribution in a group in a given round, no insider was classified as having lost the contest and all insiders received a proportional share from the Transfer Account. In *WA*, if there was a tie for the highest contributions, the tying insiders were classified as having won the contest and received an equal share from the Transfer Account. Overall, in the *WA* treatment there were 38 ties for the winner within 130 group observations, and in the *LN* treatment there were 27 ties for the loser out of 120 group observations.

See Table B2 in the Electronic Supplementary Material for the results of this regression when considering instead average transfers offered as explanatory variable, as opposed to (un)met expectations. All results are robust, except for the coefficient on *other insiders$_{t-1}$* in Prop, which is significant in Table B2 (Electronic Supplementary Material, Section 2).

Table 2 Determinants of insiders' contribution behavior in contests, Periods 6–15, from multilevel mixed-effects regressions with random effects on the subject and group level. Cluster-robust standard errors at the group level in parentheses. *** $p < 0.005$, ** $p < 0.05$, * $p < 0.1$

	(I)	(II)	(III)	(IV)	(V)
Dep. Variable: individual contribution in period t, in % of endowment	*Prop*	*WA*	*WA*	*LN*	*LN*
other insiders$_{t-1}$	0.333*** (0.0642)	-0.00382 (0.0578)	-0.0273 (0.0584)	0.103 (0.0662)	0.0995 (0.0658)
unmet-expectation$_t$	0.0967 (0.113)	0.0458 (0.116)	0.0391 (0.117)	-0.0774 (0.0699)	-0.0747 (0.0732)
exceeded-expectation$_t$	0.377* (0.193)	0.912** (0.331)	0.895** (0.334)	0.449* (0.240)	0.462* (0.246)
avg$_{1-5}$	0.422*** (0.133)	0.461*** (0.108)	0.451*** (0.0959)	0.531*** (0.101)	0.540*** (0.101)
share transfers$_{t-1}$	18.75*** (4.625)	10.83* (6.309)	–	15.58** (5.980)	–
winner$_{t-1}$	–	–	8.753* (5.151)	–	–
#winners$_{t-1}$	–	–	0.460 (2.759)	–	–
loser$_{t-1}$	–	–	–	–	-6.928*** (2.121)
Period	-1.332*** (0.443)	-2.971*** (0.661)	-2.973*** (0.645)	-1.926*** (0.497)	-1.955*** (0.502)
Constant	15.49*** (5.374)	47.06*** (10.21)	47.35*** (10.50)	31.77*** (6.944)	37.18*** (7.413)
Observations	*840*	*520*	*520*	*480*	*480*
Number of groups	*21*	*13*	*13*	*12*	*12*
Number of subjects	*84*	*52*	*52*	*48*	*48*

Given the well-established gender competition effect in the literature (see Niederle & Vesterlund, 2011 for a review), we also included the explanatory variable female into the regression models. We do not find any significant difference in behavior in male vs females in our contest settings

Electronic Supplementary Material includes additional analyses for the effect of average transfers offered by outsiders.

As shown in Table 2, individual insiders' behavior in the contests is significantly correlated with their previous cooperativeness in Part 1 ($avg_{1\text{-}5}$) and the individual share of transfers received from the Transfer Account (share $transfers_{t\text{-}1}$) in a given period in Part 2. As shown in Table B2, we also find contributions to be significantly correlated with the average amount of transfers the outsiders offer. Further, on average, transfers exceeding expectations (exceeded-$expectation_t$) has a positive effect on contributions in all three contest treatments, which is weakly significant for *Prop* and *LN* and strongly significant at $p<0.005$ for *WA*. However, we do not find evidence that transfers below expectations (unmet-$expectation_t$) have a significant effect on individual contributions in any of the contest treatments. These latter two results suggest an asymmetry in how insiders reciprocate transfers made by outsiders.

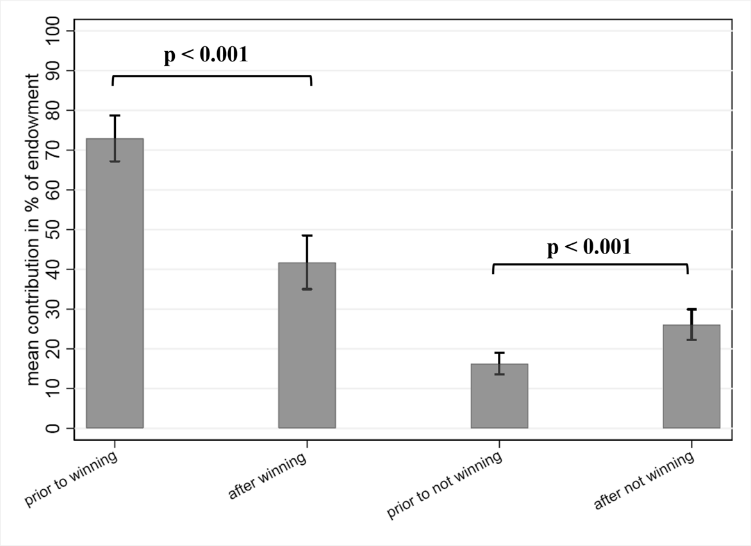
Result 3 *Insiders' contributions in all contests are found to be positively impacted by the share of transfers received in the previous decision period. Further, despite the trend for contributions to decline across periods, there is evidence of a positive reciprocal response by insiders when transfers offered by outsiders exceed expectations*.

As shown in Fig. 3, in addition to the between-subject differences in the contest treatments (Table 2), we also explore the within-subject change in behavior after winning (or losing) in the two contests with exclusion. Panel-a shows mean contributions of insiders before and after winning or not winning in *WA*. Panel- b shows mean contributions of insiders before and after not losing or losing in *LN*.[18] As shown, after not winning in *WA* or being the sole loser in *LN* we find evidence on average that insiders increase contributions in the next round, consistent with insiders remaining motivated to increase their chance of winning (not losing) in the next round. Further, winning in *WA* or not losing in *LN* reduces contributions in next round. This latter result is consistent with a motivation of trying to still win but with a lower contribution in next round. This effect is stronger in *WA*. These results are also supported by regression analysis considering the within-subject change in contributions for winners and

[18] In support of this observation, Fig. B10 in the Electronic Supplementary Material shows the distribution of the change in contributions from t-1 to t for winners in t-1. While many insiders do not change their contributions in period t as compared to the period in which they won, there is considerable variation in responses. Note that 56% of insiders winning in *WA* have won by contributing 100% of their endowment. Thus, not changing contributions in future periods means again contributing the full endowment. In this sense, the reaction of winners from t-1 to t is somewhat bounded to the right of the figure. There is also variation in the response of losers in *LN* (see again Fig. B10 in the Electronic Supplementary Material).

See also Figs. B12 and B13 in the Electronic Supplementary Material for the evolution of insiders' ranks in each treatment over time. These figures show that (i) often times, insiders ranked last in *LN* (first in *WA*), continue to keep the last rank (first rank) for some time, while this observation is less systematic for winners in *WA* (as suggested also by the only weakly significant coefficient in Table 2), and (ii) in the majority of groups we find variation with respect to ranks between insiders, meaning they change over time.

a ***WA***



b ***LN***

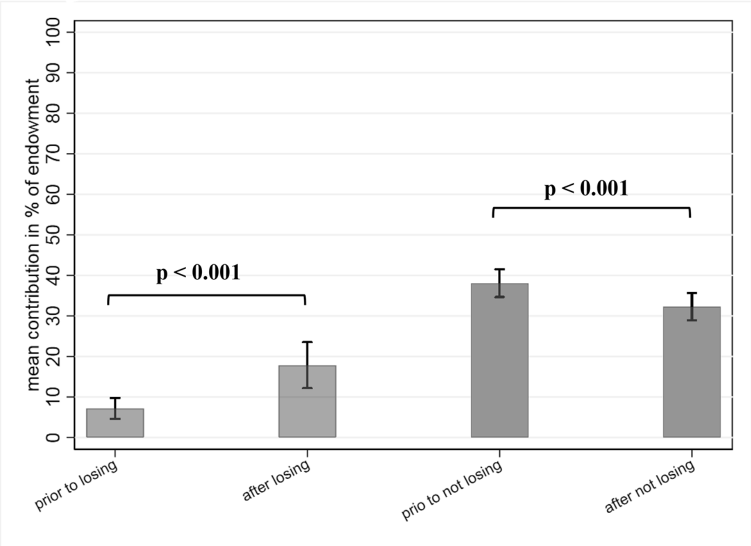


Fig. 3 **a)** contributions and 95% confidence intervals indicated by error bars of insiders in *WA* before (not) winning in t-1, as well as in period t after (not) winning, thus excluding period 6. *P*-values based on paired t-tests, unit of analysis is an individual insider in a given period, for periods 7–15. **b)** Mean contributions and 95% confidence intervals of insiders in *LN* prior to (not) losing in t-1, as well as after to (not) losing in t-1, thus excluding period 6. *P*-values based on paired t-tests, unit of analysis is an individual insider in a given period, for periods 7–15

losers, controlling for group and time dynamics (see Table B3 in the Electronic Supplementary Material). Nevertheless, Fig. 3 also shows that contributions of previous winners remain at a higher level than those of previous non-winners (in *WA*) and contributions of previous losers remain lower than those of previous non-losers (in *LN*).

Result 4 *In both contests with exclusion from transfers, we observe that (i) after winning, insiders significantly decrease their contributions, and (ii) after losing, insiders significantly increase their contributions. Yet, on average, winners tend to continue to be winners and losers tend to continue to be losers.*

There is no exclusion from transfers in *Prop,* but, as discussed in Sects. 2.4 and 2.5 the *Prop* and *LN* contests are theoretically similar to each other. Thus, we also analyze to what extent we find evidence that the response of insiders in *Prop* is similar to the response of insiders we observe in *LN*. This analysis for *Prop* requires ranking insiders based on contributions in a given group and a given period, as this determines the share of transfers received (see Fig. B11 in the Electronic Supplementary Material). Interpreting the lowest rank as losing in *Prop*, we compare the change in contributions of insiders prior and after to (not) having the lowest rank. The results are qualitatively similar to what we observe in *LN*, reinforcing the similarity of these two contests. This is interesting, because in *Prop*, insiders only receive feedback on their individual share of the transfers received and are thus not explicitly informed whether they had the lowest rank in a given group in a given contest round.

4.4 Determinants of outsiders' behavior

We next analyze the difference in outsider responses to insiders' behavior across contests. Fig. B8b in the Electronic Supplementary Material shows the histograms of individual transfer decisions for all contest treatments. The distribution of outsiders' decisions is significantly different for the comparisons of *LN* and *Prop* (p-value = 0.002 from Kolmogorov–Smirnov test, unit of analysis is an individual outsider in a given period, for periods 6–15) as well as *LN* and *WA* (p-value = 0.004 from KS test), while the distribution of outsiders' transfers in *Prop* is not significantly different to that of *WA* (p-value = 0.374 from KS test). Analogous to the analysis of strong free-riding behavior of insiders, we define strong-free riding of outsiders as zero transfers of a given outsider in a given period, considering all decision periods of Part 2. This accounts for 36.7% of all observations in *Prop,* 40.8% in *WA* (where the difference to *Prop* is not significant, p-value = 0.13 from t-test comparison, unit of analysis is an individual outsider in a given period, for periods 6–15) and 29.8% in *LN* (with the difference being significant for both comparisons to *Prop* and *WA*, p-values 0.01 and 0.0003 respectively).[19]

[19] We further identify 5.95% of outsiders as full free riders (meaning zero transfers in *all* decision periods in Part 2) in *Prop*, 4.1% in *WA* and 2.1% in *LN*. The differences are not significant (all p-values > 0.1 from all t tests comparisons, unit of analysis is an individual outsider's transfers pooled for Part 2).

Table 3 Determinants of outsiders' behavior in contests, Periods 6–15, from multilevel mixed-effects regressions with random effects on the subject and group level. *** $p<0.005$, ** $p<0.05$, * $p<0.1$

	(I)	(II)	(III)
Dep. Variable: individual transfers in period t, in % of endowment	Prop	WA	LN
other outsiders$_{t-1}$	0.194***	0.0842	0.171**
	(0.0591)	(0.0767)	(0.0801)
unmet-expectation_outsiders$_{t-1}$	0.337***	0.0146	0.145**
	(0.0826)	(0.0540)	(0.0726)
exceeded-expectation_outsiders$_{t-1}$	0.125*	0.0627*	-0.0623
	(0.0753)	(0.0365)	(0.0705)
Period	-0.729**	-1.293***	-1.343***
	(0.266)	(0.436)	(0.430)
Constant	15.59***	28.58***	29.84***
	(3.685)	(5.629)	(7.309)
Observations	*840*	*520*	*480*
Number of groups	*21*	*13*	*12*
Number of subjects	*84*	*52*	*48*

Cluster-robust standard errors on the group level in parentheses

Table 3 presents the results from a multilevel mixed-effects regression with random effects on the group and individual level, where the dependent variable is outsiders' *individual* transfer decision to the Transfer Account in each period t of Part 2 (periods 6–15). Explanatory variables in column I (for *Prop*), column II (for *WA*) and column III (for *LN*) include: (i) average transfers of other outsiders in a group in the previous periods (other outsiders$_{t-1}$), (ii) the extent to which contributions by insiders are lower than outsider's expectations in a period (unmet-expectation-outsiders$_{t-1}$), (iii) the extent to which contributions are higher than outsiders' expectations in a period (exceeded-expectation-outsiders$_{t-1}$), and (iv) the period. Table B4 in the Electronic Supplementary Material includes additional analyses examining the effect of average contributions of insiders in the previous period, in place of the variables measuring expectations.[20]

As shown in Table 3, outsiders' behavior seems qualitatively similar in the two contests that include proportional sharing of transfers, *Prop* and *LN*. In both contests, the higher the other outsiders' transfers, the higher the transfers of an individual outsider in the next period. Importantly, previous unmet expectations of contributions to the public good by insiders significantly increases the transfers in the next period. This

[20] Table B4 shows that the previous periods' behavior of the group of insiders significantly increases transfers in the *Prop* and *WA* contest, but not in the *LN* contest.

result is interesting in that it suggests an attempt by (at least some) outsiders to motivate insiders to contribute more by increasing transfers. We do not find this relationship for the *WA* contest. Also as shown in Table 3, we find a weaker link between changes in transfers when contributions exceed expectations, marginally significant in *Prop* and *WA* and insignificant in *LN*.

Result 5 *Despite the trend for transfers to decline across periods, there is evidence consistent with positive reciprocity for outsiders' transfer decisions, both within the group of outsiders and across groups of insiders and outsiders. This evidence is more robust in Prop than in WA and LN.*

As a final remark, we observe that the *WA* contest results in the lowest net transfers by the group of outsiders. And, as mentioned above, the net contributions in *WA* by insiders for Part 2 are not significantly different relative to the other treatments. Together, these results might indicate greater disparities between insiders and outsiders with respect to earnings in *WA*.[21] To address this point, in each treatment we consider the difference in total earnings (measured in ECUs, summing across all periods 1–15) between insiders and outsiders. We observe that in all treatments, across all decision rounds, outsiders have on average higher total earnings than insiders. As expected, this difference is highest in the *No-T* treatment with outsiders receiving on average 262.6 ECUs more than insiders (p-value from t-test < 0.001, unit of analysis is an individual insider or outsider pooled for all periods 1–15). For the contest treatments, the difference is highest in *WA* with 116.8 ECUs (p-value < 0.01), followed by the *Prop* contest with 45.3 ECUs (p-value from t-test $= 0.18$), and 6.9 ECUs in *LN* (p-value $= 0.91$). Notably though, these results for the different contests are driven by Part 1. Considering only total earnings of Part 2 (summing across periods 6–15), insiders actually earn slightly more on average than outsiders, with the difference being significant in *Prop* (57.5 ECUs difference, p-value < 0.05) and in *LN* (97.4 ECUs difference, p-value < 0.05) but not so in *WA* (11.9 ECUs difference, p-value $= 0.74$). This result is illustrative of the redistributive nature of transfers from outsiders to insiders, keeping in mind that all three contests increase the provision of the public good as compared to *No-T*.

5 Discussion and conclusion

This study examines the behavioral response to three contest mechanisms used for distributing donated transfers from outsiders to insiders who contribute to a public good benefiting both groups. The mechanisms differ in the degree of competition among insiders within a group for transfers. In addition to a contest where transfers are allocated to individual insiders in proportion to their contributions relative to other insiders in their group (*Prop*), we study two contests which allow for exclusion from receiving transfers, namely a winner-takes-all (*WA*) and a loser-gets-nothing

[21] We thank an anonymous referee for suggesting analysis about the welfare implications of the different contests.

(*LN*). We compare behavior in these three decision settings to the default setting of no-transfers (*No-T*).

We report three main results. First, we find that all contest mechanisms generate an increase in public good provision relative to *No-T*. Second, as compared to *Prop* and *LN,* the *WA* contest generates greater increases in public good provision in the first period in which transfers are allowed. Third, across repeated periods of the decision settings, the observed differences vanish and the two contests with exclusion result in similar levels of public good provision relative to that of the proportional contest.

Thus, competition is found to be a useful mechanism to increase program outcomes in terms of public good provision, while contests with exclusion are not found to bring additional significant and stable increases in public good provision as compared to inclusive proportional prizes. From a policy perspective, our results can be considered as evidence in support of charitable giving programs that rely on inclusive programs such as proportional payments. This policy implication is reinforced by previous experimental results showing that inclusive proportional payments have a similar impact than individually targeted payments and do better than equal payments (BSW). Inclusive proportional payments have additional advantages in that they are simpler to implement in field settings, simpler to communicate, simpler to enforce, and may be perceived as outcome-based fairer (Wells et al., 2020). Importantly, based on the results in this study and in BSW, the evidence points to the conclusion that inclusive proportional payments are able to sufficiently motivate donors, which is also critical to overall program success (Wunder et al., 2018, 2020).

The results related to the effects of implementing the different contests in our insider–outsider decision setting were not expected. In particular, evidence from prior experimental studies suggests that exclusion in single winner prizes generates greater public good contributions, both for *Tullock*-style lottery contests and all-pay auctions (e.g. Faravelli & Stanca, 2012; Lange et al., 2007). We conclude that the differences in our insider–outsider decision environment, as compared to other studies, is the source of these differences in behavior. In particular, previous studies entail exogenous prizes to a single-group of individuals providing the public good. Our decision settings, however, include group-to-group interactions between outsiders and insiders, where outsiders provide endogenously determined transfers (prizes) to insiders who compete for transfers through their contributions.

Considering the determinants of individual behavior in the contests, we interpret our results as evidence for positive across-group reciprocity from insiders to the behavior of outsiders and vice versa.[22] From the perspective of outsiders, this evidence is found to be more robust in *Prop* than in *WA* and *LN*. This latter result raises the question of why outsiders' response to insiders' behavior might differ between the three contest treatments. In a related study that focused on self-reported motivations of outsiders there is evidence of three primary motivations: cooperation, egoism and

[22] Importantly, we found no evidence of insiders being demotivated from losing to the extent of not participating in the contests via contributions. This result is in line with that of previous studies on rank order contests without exclusion (Dutcher et al., 2015) and on competition between groups (Chambers et al., 2018).

insider–outsider-reciprocity (Struwe et al.,, forthcoming). While the insider–outsider reciprocity motivation negatively affects transfers in *WA,* it has no effect in *Prop* or *LN*. Further, outsiders report to be overall less satisfied with the behavior of insiders in *WA* and *LN* as compared to *Prop*, leading to a significant negative effect on transfers in the case of the *WA* contest. These results suggest the need for further research on fairness considerations in the insider–outsider group-to-group interaction, in particular, as related to the mechanisms used to allocate transfers to insiders.[23]

Broadly, our results contribute to the study of effective institutional design and implementation in a broad range of programs where donors provide transfer payments or donations. The research contributes to understanding the effectiveness of alternative funding mechanisms, in particular contests. For example, in conservation programs based on payments for ecosystem services, there is a recurring discussion on how to efficiently allocate scarce funds via compensation payments among landowners qualifying to participate. Our results support the conclusion that excluding low-performers from donor payments may not be more effective than inclusive proportional payments, where low-performers receive a positive but smaller amount than others who put in more effort. This conclusion supports the need for further research on testing the effectiveness of competition in increasing public good provision (or more broadly on pro-social behavior) under varied decision environments, specifically situations that rely on the distribution of endogenously funded contest prizes. This view is in line with the approach to research discussed in Cooper and Kagel (2009), where the authors provide an insightful discussion of context and learning across game types (decision settings), linking experimental research in economics and psychology.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s10683-022-09766-7.

Acknowledgements We are grateful to Ines Ladurner, Paul Dinter, Dominik Schmidt, and Sebastian Kupek for their exceptional assistance in running the experimental sessions, the Faculty of Economics and Statistics at the University of Innsbruck for the support to have student assistants, and participants of the 6th Workshop on Experimental Economics for the Environment, the 3rd AERNA Workshop on Game Theory and the Environment and the 2021 North-American Economic Science Association Meetings for their comments, and Florian Morath for feed-back. Financial support was provided by the Austrian Science Fund (Grant Number P 25973-G11 and P 32859-G).

Declarations

None.

References

Andreoni, J. (1990). impure altruism and donations to public goods : A theory of warm-glow giving. *The Economic Journal, 100*(401), 464–477.

Andreoni, J. (1995). Cooperation in public-goods experiments : Kindness or confusion? *The American Economic Review, 85*(4), 891–904.

[23] See Kagel and McGee (2014) for further discussion of the study of personality traits and cooperation in social dilemma settings.

Angelovski, A., Neugebauer, T., & Servátka, M. (2019). Rank-order competition in the voluntary provision of impure public goods. *Economic Inquiry, 57*(4), 2163–2183. https://doi.org/10.1111/ecin.12797

Ariely, B. D., Bracha, A., & Meier, S. (2009). Doing good or doing well ? Image motivation and monetary incentives in behaving prosocially author. *American Economic Review, 99*(1), 544–555.

Barut, Y., & Kovenock, D. (1998). The symmetric multiple prize all-pay auction with complete information. *European Journal of Political Economy, 14*(4), 627–644. https://doi.org/10.1016/S0176-2680(98)00029-9

Baye, M. R., Kovenock, D., & de Vries, C. G. (1996). The all-pay auction with complete information. *Economic Theory, 8*(2), 291–305. https://doi.org/10.4324/9781351327688

Bénabou, R., & Tirole, J. (2006). Incentives and prosocial behavior. *American Economic Review, 96*(5), 1652–1678. https://doi.org/10.1257/aer.96.5.1652

Blanco, E., Haller, T., & Walker, J. M. (2018). Provision of environmental public goods: Unconditional and conditional donations from outsiders. *Journal of Environmental Economics and Management, 92*, 815–831. https://doi.org/10.1016/j.jeem.2017.10.002

Blanco, E., Struwe, N., & Walker, J. M. (2021). Experimental evidence on sharing rules and additionality in transfer payments. *Journal of Economic Behavior and Organization, 188*, 1221–1247. https://doi.org/10.1016/j.jebo.2021.06.012

Bock, O., Baetge, I., & Nicklisch, A. (2014). Hroot: Hamburg registration and organization online tool. *European Economic Review, 71*, 117–120. https://doi.org/10.1016/j.euroecorev.2014.07.003

Brandts, J., Saijo, T., & Schram, A. (2004). How universal is behavior? A four country comparison of spite and cooperation in voluntary contribution mechanisms. *Public Choice, 119*(3–4), 381–424. https://doi.org/10.1023/b:puch.0000033329.53595.1b

Camerer, C. F., & Fehr, E. (2006). When does "economic man" dominate social behavior? *Science, 311*(5757), 47–52. https://doi.org/10.1126/science.1110600

Cason, T. N., Masters, W. A., & Sheremeta, R. M. (2018). Winner-take-all and proportional-prize contests: Theory and experimental results. *Journal of Economic Behavior and Organization, 175*, 314–327. https://doi.org/10.1016/j.jebo.2018.01.023

Chambers, P. E., Dutcher, G. E., & Isaac, M. R. (2018). Improving environmental quality through aid: An experimental analysis of aid structures with heterogeneous agents. *Ecological Economics, 146*, 435–446. https://doi.org/10.1016/j.ecolecon.2017.11.017

Chaudhuri, A. (2011). Sustaining cooperation in laboratory public goods experiments: A selective survey of the literature. *Experimental Economics, 14*(1), 47–83. https://doi.org/10.1007/s10683-010-9257-1

Colasante, A., García-Gallego, A., Georgantzis, N., Morone, A., & Temerario, T. (2019). Intragroup competition in public good games: The role of relative performance incentives and risk attitudes. *Journal of Public Economic Theory, 21*(5), 847–865. https://doi.org/10.1111/jpet.12369

Cooper, D. J., & Kagel, J. H. (2005). Are two heads better than one? Team versus individual play in signaling games. *American Economic Review, 95*(3), 477–509.

Cooper, D. J., & Kagel, J. H. (2009). The role of context and team play in cross-game learning. *Journal of the European Economic Association, 7*(5), 1101–1139.

Cooper, D. J., & Kagel, J. H. (2015). Other-regarding preferences. In J. H. Kagel & A. E. Roth (Eds.), *The handbook of experimental economics* (Vol. 2, pp. 217–289). Princeton University Press.

Corazzini, L., Faravelli, M., & Stanca, L. (2010). A prize to give for: An experiment on public good funding mechanisms. *Economic Journal, 120*(547), 944–967. https://doi.org/10.1111/j.1468-0297.2009.02314.x

Croson, R. T. A. (2007). Theories of commitment, altruism and reciprocity: Evidence from linear public goods games. *Economic Inquiry, 45*(2), 199–216. https://doi.org/10.1111/j.1465-7295.2006.00006.x

Dechenaux, E., Kovenock, D., & Sheremeta, R. M. (2014). A survey of experimental research on contests, all-pay auctions and tournaments. *Experimental Economics, 18*(4), 609–669. https://doi.org/10.1007/s10683-014-9421-0

Dutcher, E. G., Balafoutas, L., Lindner, F., Ryvkin, D., & Sutter, M. (2015). Strive to be first or avoid being last: An experiment on relative performance incentives. *Games and Economic Behavior, 94*, 39–56. https://doi.org/10.1016/j.geb.2015.08.008

Epstein, G. S., & Gang, I. N. (2009). Good governance and good aid allocation. *Journal of Development Economics, 89*(1), 12–18. https://doi.org/10.1016/j.jdeveco.2008.06.010

Faravelli, M. (2011). The important thing is not (always) winning but taking part: Funding public goods with contests. *Journal of Public Economic Theory, 13*(1), 1–22.

Faravelli, M., & Stanca, L. (2012). Single versus multiple-prize all-pay auctions to finance public goods: An experimental analysis. *Journal of Economic Behavior and Organization, 81*(2), 677–688. https://doi.org/10.1016/j.jebo.2011.10.007

Fehr, E., & Schmidt, K. M. (2006). The economics of fairness, reciprocity and altruism–experimental evidence and new theories. In S. Kolm & J. M. Ythier (Eds), *Handbook of the economics of giving, altruism and reciprocity* (vol. 1, pp. 615–691)

Ferraro, P. J. (2008). Asymmetric information and contract design for payments for environmental services. *Ecological Economics, 65*(4), 810–821. https://doi.org/10.1016/j.ecolecon.2007.07.029

Fischbacher, U. (2007). Z-Tree: Zurich toolbox for ready-made economic experiments. *Experimental Economics, 10*(2), 171–178. https://doi.org/10.1007/s10683-006-9159-4

Frey, B. S., & Meier, S. (2004). Social comparisons and pro-social behavior: Testing conditional cooperation in a field experiment. *American Economic Review, 94*(5), 1717–1722. https://doi.org/10.1257/0002828043052187

Garcia, T., Massoni, S., & Villeval, M. C. (2020). Ambiguity and excuse-driven behavior in charitable giving. *European Economic Review, 124*, 103412. https://doi.org/10.1016/j.euroecorev.2020.103412

Gneezy, U., Keenan, E. A., & Gneezy, A. (2014). Avoiding overhead aversion in charity. *Science, 346*(6209), 632–635. https://doi.org/10.1126/science.1253932

Goeree, J. K., Holt, C. A., & Laury, S. K. (2002). Private costs and public benefits: Unraveling the effects of altruism and noisy behavior. *Journal of Public Economics, 83*(2), 255–276. https://doi.org/10.1016/S0047-2727(00)00160-2

Gunnthorsdottir, A., & Rapoport, A. (2006). Embedding social dilemmas in intergroup competition reduces free-riding. *Organizational Behavior and Human Decision Processes, 101*(2), 184–199. https://doi.org/10.1016/j.obhdp.2005.08.005

Heap, S. P., Ramalingam, A., Ramalingam, S., & Stoddard, B. V. (2015). “Doggedness” or “disengagement”? An experiment on the effect of inequality in endowment on behaviour in team competitions. *Journal of Economic Behavior and Organization, 120*, 1–14. https://doi.org/10.1016/j.jebo.2015.10.002

Henrich, J., Boyd, R., Bowles, S., Camerer, C., Fehr, E., Gintis, H., & McElreath, R. (2001). In search of Homo economicus: Behavioral experiments in 15 small-scale societies. *American Economic Review, 91*(2), 73–84. https://doi.org/10.1257/aer.91.2.73

Kagel, J. H., Kim, C., & Moser, D. (1996). Fairness in ultimatum games with asymmetric information and asymmetric payoffs. *Games and Economic Behavior, 13*(1), 100–110.

Kagel, J. H., & Levin, D. (2011). Auctions: A survey of experimental research, 1995–2010. *Handbook of Experimental Economics, 2*, 563–637.

Kagel, J. H., & McGee, P. (2014). Personality and cooperation in finitely repeated prisoner’s dilemma games. *Economics Letters, 124*(2), 274–277.

Kagel, J. H., & McGee, P. (2016). Team versus individual play in finitely repeated prisoner dilemma games. *American Economic Journal: Microeconomics, 8*(2), 253–276.

Kagel, J. H., & Schley, D. R. (2013). How economic rewards affect cooperation reconsidered. *Economics Letters, 121*(1), 124–127.

Khalumba, M., Wünscher, T., Wunder, S., Büdenbender, M., & Holm-Müller, K. (2014). Combining auctions and performance-based payments in a forest enrichment field trial in Western Kenya. *Conservation Biology, 28*(3), 861–866. https://doi.org/10.1111/cobi.12278

Landry, C. E., Lange, A., List, J. A., Price, M. K., & Rupp, N. G. (2006). Toward an understanding of the economics of charity: Evidence from a field experiment. *Quarterly Journal of Economics, 121*(2), 747–782.

Lange, A., List, J. A., & Price, M. K. (2007). Using lotteries to finance public goods: Theory and experimental evidence. *International Economic Review, 48*(3), 901–927. https://doi.org/10.1111/j.1468-2354.2007.00449.x

Moldovanu, B., & Sela, A. (2001). The optimal allocation of prizes in contests. *The American Economic Review, 91*(3), 542–558. https://doi.org/10.1016/j.econlet.2021.109850

Morgan, J. (2000). Financing public goods by means of lotteries. *The Review of Economic Studies, 67*(4), 761–784. https://doi.org/10.1111/1467-937x.00153

Morgan, J., & Sefton, M. (2000). Funding public goods with lotteries: Experimental evidence. *The Review of Economic Studies, 67*(4), 785–810. https://doi.org/10.1111/1467-937x.00154

Nalbantian, B. H. R., & Schotter, A. (2016). Productivity under group incentives : An experimental study. *The American Economic Review, 87*(3), 314–341.

Niederle, M., & Vesterlund, L. (2011). Gender and competition. *Annual Review of Economics, 3*, 601–630. https://doi.org/10.1146/annurev-economics-111809-125122

Orzen, H. (2008). Fundraising through competition: Evidence from the lab. *CeDEx Discussion Paper Series.*, *(No. 2008-*).

Ostrom, E., & Walker, J. M. (2003). *Trust and reciprocity: Interdisciplinary lessons from experimental research*. Russell Sage Foundation.

Sheremeta, R. M. (2011). Contest design: An experimental investigation. *Economic Inquiry, 49*(2), 573–590. https://doi.org/10.1111/j.1465-7295.2009.00274.x

Sheremeta, R. M. (2018). Behavior in group contests: A review of experimental research. *Journal of Economic Surveys, 32*(3), 683–704. https://doi.org/10.1111/joes.12208

Shupp, R., Sheremeta, R. M., Schmidt, D., & Walker, J. (2013). Resource allocation contests: Experimental evidence. *Journal of Economic Psychology, 39*, 257–267. https://doi.org/10.1016/j.joep.2013.09.001

Struwe, N., Bogner, K., & Blanco, E. (forthcoming). Why do ousiders make donations to public good providers? In *Behavioral Economics and the Environment.* Routledge.

Sugden, R. (1984). Reciprocity : The Supply of Public Goods Through Voluntary Contributions. *Royal Economic Journal, 94*(376), 772–787.

Svensson, J. (2003). Why conditional aid does not work and what can be done about it? *Journal of Development Economics, 70*(2), 381–402. https://doi.org/10.1016/S0304-3878(02)00102-5

Tullock, G. (1980). Efficient rent seeking. In J. M. Buchanan, R. D. Tollison, & G. Tullock (Eds.), *Toward a theory of the rent-seeking society* (pp. 97–112). Texas A&M University Press.

Ulber, L., Klimek, S., Steinmann, H. H., Isselstein, J., & Groth, M. (2011). Implementing and evaluating the effectiveness of a payment scheme for environmental services from agricultural land. *Environmental Conservation, 38*(4), 464–472. https://doi.org/10.1017/S0376892911000385

Vesterlund, L. (2003). The informational value of sequential fundraising. *Journal of Public Economics, 87*(3–4), 627–657. https://doi.org/10.1016/S0047-2727(01)00187-6

Wells, G., Ryan, C., Fisher, J., & Corbera, E. (2020). In defence of simplified PES designs. *Nature Sustainability, 3*, 426–427.

Wunder, S., Brouwer, R., Engel, S., Ezzine-de-Blas, D., Muradian, R., Pascual, U., & Pinto, R. (2020). Reply to: In defence of simplified PES designs. *Nature Sustainability, 3*(6), 428–429.

Wunder, S., Brouwer, R., Engel, S., Ezzine-De-Blas, D., Muradian, R., Pascual, U., & Pinto, R. (2018). From principles to practice in paying for nature's services. *Nature Sustainability, 1*(3), 145–150. https://doi.org/10.1038/s41893-018-0036-x