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DELEGATION AND COORDINATION WITH MULTIPLE THRESHOLD PUBLIC GOODS: EXPERIMENTAL EVIDENCE

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Abstract

When multiple charities, social programs and community projects simultaneously vie for funding, donors risk miscoordinating their contributions leading to an inefficient distribution of funding across projects. Community chests and other intermediary organizations facilitate coordination among donors and reduce such risks. We explore such considerations by extending the threshold public goods framework to allow donors to contribute to an intermediary rather than directly to the public goods. We experimentally study the effects of the intermediary on contributions and successful public good funding. Results show that delegation increases overall contributions and public good success, but only when the intermediary is formally committed to direct funding received from donors to socially beneficial goods. Without such a restriction, the presence of an intermediary is detrimental, resulting in lower contributions, a higher probability of miscoordination, and lower payoffs.

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1. Introduction

In threshold public good games, players choose how much (money, time or effort) to contribute towards a public good that will provide benefits to all players only if the total contributions exceed a minimum level. Such an environment may represent the strategic decisions behind the efforts of individuals to support crowdfunding projects, social movements, and charitable organizations. In these situations, individuals choose how much to contribute to a common cause, while recognizing that their contribution may have a meaningful impact only if the cause also receives enough support from others to be viable. For example, philanthropists who wish to support the construction of a new community arts center recognize that their contribution will only have its intended effect if total contributions from all donors are high enough for the project to move forward. Except in the case of very large donors who can unilaterally ensure the success of a project, donors prefer to contribute to projects that receive enough funding from others to be viable, but not so much funding from others that the marginal impact of their own contribution is low.

Within these strategic environments, donors risk contributing to a good that does not receive enough contributions from others. If players expect that others will contribute too little, then their own best response is to contribute nothing. Only when players expect that others will contribute enough to a public good to ensure that it is viable do they too want to contribute. Further complicating the donor decision is the fact that, in many settings, multiple projects or opportunities simultaneously vie for donor funding. Donors must not only choose how much to contribute, but also choose to which projects or charities to contribute. In these settings, donors not only face the risk that others contribute too little; they are exposed to the additional risk that they contribute to different things. Corazzini et al. (2015) (henceforth CCV) extend the threshold public good environment to allow for multiple public goods simultaneously vying for funding, and show how increasing the number of public goods can discourage giving, decrease total contributions and increase the probability that all public goods fail.

The present paper extends the multiple threshold public good environment of CCV to allow for strategic delegation.[1] Donors may provide their contributions to an intermediary organization, which then chooses how to allocate total contributions across potential recipients. The presence of such organizations has the potential to simplify donor strategies and reduce coordination problems. No longer must one choose how to allocate contributions across alternative projects. One must simply choose *how much* to contribute, leaving the decision about *where* to contribute in the hands of the intermediary. The use of delegation strategies may avoid situations where contributions are spread inefficiently across public goods. It reduces the risk of wasting one's contribution by contributing to a different good than the other players. The presence of an intermediary could therefore encourage contributions and increase the probability that public goods successfully reaches their funding thresholds.

The presence of intermediary organizations is common in real world philanthropic environments. Within communities, multiple promising projects may simultaneously vie for donor funding, potentially overwhelming donors or introducing coordination problems among them. Recognizing these concerns, community chest organizations operate in many locations with the objective of encouraging and coordinating philanthropic efforts. A relevant example in the nonprofit sector is the popularity of the United Way as an intermediary for the charitable contributions of donors. In 2016, United Way pooled funds from more than 9 million individual donors and 60,000 corporate partners for a total of $ 4.7 billion raised. It also managed a network of 1,200 local offices in 40 different countries and coordinated the volunteer efforts of 2.9 million individuals. The funding activities and the volunteer efforts supported projects in 1,800 communities, serving more than 60 million people (UnitedWay, 2016; Economist, 2017).

Typically, individuals choose how much to contribute to their local United Way. Then the organization decides how to allocate the sum of its contributions across the many local projects and agencies asking for funding in order to maximize the social impact of the donations. By contributing through the United Way or related organizations, individuals do not need to strategize about whether their own donations are optimal given the allocation decisions of others. They simply choose how much to give and defer to the community chest organization to allocate their contributions across projects in the optimal way.

[1] The literature review discusses several recent papers that extend CCV in other directions.

In this paper, we incorporate a delegated organization into a repeated multiple threshold public good game and show experimentally that the effectiveness of such an organization depends heavily on the formal restrictions placed on its use of donor funds.

First, we consider a version of the environment in which the intermediary is under no obligation to allocate donor funds to a use that is valued by the donors. It can expropriate donations for private benefit. This need not be interpreted as illegal theft or embezzlement of funds. Rather, it captures the possibility that a delegated organization may be able to direct contributions towards increasing its staff size or salaries, or towards projects that are unrelated to the projects donors hoped to fund. However, just because an intermediary can expropriate funding doesn't mean that it will do so. Intermediaries may for instance feel obligated to use funding in accordance with donor expectations. This is especially possible in dynamic environments where intermediaries may be concerned with how their use of funds today affects future donations.

Second, we consider an alternative version of the delegation environment in which a "destination rule" restricts the intermediary organization's use of donor funds. In this case, the intermediary is formally required to pass along the entire value of the donors' delegated contributions to the public goods. Redirecting all or part of the delegated contributions for private benefit is no longer possible. Such a destination rule is consistent with nonprofit sector regulations or public commitments made by NGOs that generally improve transparency regarding the use of funds and limit the share of contributions that can be directed to overhead or administrative costs.[2]

In both environments, the presence of an intermediary may feasibly reduce the risk that donors support projects that do not receive enough support from others to be viable. In doing so, the presence of an intermediary may thereby encourage contributions and increase public good success and payoffs. In the unrestricted delegation environment, however, donors face a dimension of uncertainty and risk that is not present in the delegation environment with a destination rule. They face uncertainty about whether the intermediary will work in the public interest, and risk that their contributions will not be passed along to a public good. Regardless of whether the intermediary intends to behave outside of the public interest, donors face the possibility that it might. Such a risk is not present in either the game without delegation or the game with delegation and a destination rule.

The relative risk associated with contributing is lower in the game with delegation and a destination rule than it is in either the game without delegation or the game with unrestricted delegation. We therefore expect delegation to increase contributions and public good success when intermediaries face restrictions on their use of funds. It is less clear, however, whether delegation may increase contributions and public good success when there is no destination rule. Unrestricted delegation reduces the risk of miscoordinating contributions across different projects, while simultaneously introducing the risk of the intermediary expropriating funds. Which dimension of risk is more effective at discouraging contributions is an empirical question, which we consider experimentally.

In the laboratory experiment, we show that the presence of an intermediary increases donations and the success of public goods only in the setting with a destination rule. In the delegation treatment with destination rule, the ability to delegate donations has a significant positive impact on public good funding. With the destination rule, total contributions, the probability of successfully funding a public good and payoffs are all significantly higher than in the unrestricted delegation environment. Furthermore, compared to the game without delegation, the presence of delegation with the destination rule increases the probability of public good success and payoffs and decreases the probability that donors' contributions are directed to unsuccessful public goods.

When the intermediary does not face formal restrictions on the use of funds, donors contribute even less than in the case without an intermediary. Without a destination rule, the intermediary organization does not help increase contributions or improve public good success. In fact, unrestricted delegation has the opposite effect as delegation with a destination rule. Compared to the case without delegation, unrestricted delegation may lead to worse outcomes for groups and less success for the public goods

[2]It is also related to donors adding conditions to their contributions that require the funding to be spent in certain ways. Large donors often add restrictions to an organization's use of their funding. There is not only a moral obligation for nonprofits to honor donor's wishes, but they are also required by law to do so (Brody, 1998; Bac, 2002; Goodwin, 2005; Atkinson, 2008). Under destination rules, NGOs must be careful in choosing how to use donations as, in case they do not comply with the initial intent, donors can take legal action, resulting in substantial monetary and reputation costs for the intermediary.

they are trying to support. The observation that unrestricted delegation can decrease the success of public goods suggests that, at least in our environment, the increased uncertainty about the intermediary's behavior dominates the reduction in donor miscoordination risk, leading them to focus more on the less-risky, no-contribution option.

Together, these results suggest that an intermediary organization can help facilitate coordination among donors and successfully fund a public good. In order for this to be the case, however, donors must have reason to believe that the intermediary will use their donations effectively. Without this confidence, the presence of an intermediary does not improve public good success and can decrease contributions.

Our findings highlight the potential for community chest organizations and other intermediaries, and the benefits from such organizations restricting how they are able to use donations ahead of any funding drive. They also illustrate a channel through which regulations and oversight of charitable organizations, such as rules governing the portion of donations that may be directed to administration, may facilitate donations and lead to more successful charitable giving.

2. Literature review

There is a substantial and growing literature using laboratory experiments to consider the decisions of individuals to contribute to public goods. Within this literature, our analysis is most related to the papers that consider the allocation of contributions across multiple goods (e.g. Blackwell and McKee, 2003; Moir, 2006; Bernasconi et al., 2009) and the papers which focus on threshold public goods that must reach a minimum level of total contributions before they return a benefit (Bagnoli and Lipman, 1989; Andreoni and Gee, 2015). The threshold public good setting is considered a stylized description of donor contributions to charitable organizations and fundraising projects (Andreoni 1989, 1998). Donors freely decide whether and how much to contribute to a social project knowing that the success of the project also depends on the overall amount of resources collected within their community.

Several recent papers, beginning with CCV (first discussed in the introduction), consider environments in which donors allocate contributions across multiple public goods, each with a contribution threshold. Such a framework is a stylized representation of an environment in which multiple charities or fundraising projects simultaneously vie for donations. CCV show how increasing the number of public goods in such an environment can make coordination among donors more difficult to achieve, which discourages donations and makes it less likely that any public good succeeds. Several recent papers consider related extensions of this framework. Ansink et al. (2017) considers the impact of seed money on contributions and extends the framework to allow for giving in continuous time. Cason and Zubrickas (2018) and Liu et al. (2016) considers the impact of rebates when a public good fails to achieve its threshold on contributions in a multiple good setting.[3] These papers consider various aspects of how inefficiencies arise as multiple projects vie for funding. Our paper contributes to this literature by exploring how the presence of an intermediary may reduce donor coordination failures and increase successful funding of public goods.

Our central research question of whether the presence of an intermediary can increase player coordination and outcome efficiency is related to an extensive literature on delegation. The idea that delegation can improve coordination has been well studied in a variety of other strategic environments. Theoretical analysis of the topic focuses mainly on principle-agent settings (e.g. Aghion and Tirole, 1997; van den Steen, 2006; Hammon et al., 2010) and the theory of firm (e.g. Vickers, 1985). Empirical research on delegation has devoted attention to contexts such as corporate governance (e.g. Alfoldi et al., 2012), management (e.g Sengul et al., 2012) and labour relations (e.g. Charness and Sutter, 2012). Our focus on delegation in charitable giving represents a novel focus of research.

While the literature has shown that delegation can, in principle, help to solve coordination issues, it also highlights relevant trust-related concerns between principals and the delegated entities. Opportunistic behavior, essentially due to free-riding, leads to delegation failures and sub-optimal outcomes (e.g. Gur and Bjørnskov, 2017; Herz et al., 2016; Löschel and Rübbelke, 2014; Brown et al., 2012). In our experiments, we compare outcomes in a setting in which a delegate is unable to act outside of the interests of the others players and a setting in which delegate behavior is unrestricted (and trust-related concerns are relevant). This allows us to identify the degree to which such concerns affect donor behavior and outcomes in our environment.

[3]See also Bouma et al. (2018).

Related to our paper, a recent strand of experimental research has confirmed the positive effects generated by delegation-based mechanisms in voluntary contribution settings. In this literature, the discretionary power on financing a public good is given to intermediaries, either endogenously elected by the group members [e.g.][]Hamman2011, Bernard2013, Kocher2018 or exogenously appointed (e.g. Bolle and Vogel, 2011; Oxoby, 2013; Hauge and Rogeberg, 2015). None of these papers focus on delegation in a multiple public good or threshold public good environment.

Among this literature, our analysis is most related to the subset of papers focuses on standard public good games in which the members of a given group are called to contribute to a single public good. Oxoby (2013) report about a single public good game in which a "dictator" can mandate the contributions of the other group members or restrict their choices to a subset of feasible contributions levels, depending on the different treatments. The role of the dictator in that study is very similar to the intermediary in the present paper when it comes to allocate the funds to the different possible projects. Compared to a baseline treatment in which agents make choices from the set of all contribution alternatives, the introduction of the group's "dictator" results in more efficient outcomes. In another lab experiment, Hamman et al. (2011) analyze the effect of endogenous electoral delegation in a linear public good game. Under the baseline condition players choose how to divide their own endowments between public good provision and private consumption in each period. In one treatment, each group elects one delegate to make the decision on behalf of each player in the group. Once elected, a player serves as the delegate for three periods before another election. The authors find that delegation increases public goods contributions to levels close to the social optimum. Despite the incentive of the intermediary to free ride, electoral delegation results in (more) generous provision of public goods. In our design, the intermediary is not appointed through an endogenous election procedure, but rather is randomly selected. This experimental feature rules out the possibility that the intermediary acts pro-socially to reciprocate for electoral support. Bolle and Vogel (2011) examine the effect of using either an endogenous or an exogenous procedure to appoint the intermediary in a public good setting. They find that, relative to what is observed in a standard public good game, both delegation schemes stimulate the provision of public goods, although the effect tends to vanish over repetitions.

Taking another approach, Kocher et al. (2018) study the effect of delegation when a global public good benefits multiple groups of agents and investigate whether welfare increases when groups delegate the contribution decision to a single (delegated) player. Results show that electoral delegation substantially increases inter-group cooperation, and that re-election incentives prevent representatives from excessive exploitation of their constituents. Bernard et al. (2013) considers a similar problem devising a tragedy-of-the-commons game in which players choose how much to extract from a common pool of resources. They provide further supporting evidence on the general conclusion that delegation can lead to higher payoffs, in this case reducing the severity of tragedy of the commons.

A connected stream of literature looks at the role of leadership on voluntary provision of public goods. Leaders are defined as the first movers in choosing contributions to a public good. A leader's contribution is observed by other group members before they choose their own individual contributions. It is found that leaders, by setting a virtuous example, can positively influence followers' contributions both in public good (Levati et al., 2007; Rivas and Sutter, 2011; Jack and Recalde, 2015) and common pool settings (Buchholz and Sandler, 2017). Delegation, as we consider in our experiment, represents an alternative means of improving contributions.

3. Experimental design

Our experimental design extends the multiple threshold public good setting of CCV to include treatments in which subjects can delegate their contributions to one group member (the "intermediary") who then decides how to allocate the delegated contributions across different public goods.

We present results from three distinct treatments with multiple public goods, using a between-subject design:

- *No delegation (NoDel)* - Benchmark treatment with multiple public goods and no delegation based on the setting in CCV.
- *Delegation without restriction (Del)* - Treatment with multiple public goods and the option to delegate contribution to an intermediary but with no destination rule.

- *Delegation with destination rule (DelRule)* - Treatment with multiple public goods, the option to delegate contributions to an intermediary and a destination rule restricting her behavior.

In the Appendix, we also report results from three additional and analogous treatments in which there is only one available public good: $NoDel[1]$, $Del[1]$, $DelRule[1]$.

72 subjects participated in each treatment, for a total of 432 participants in the experiment. In each of the treatments, 18 groups of four participants were formed. These groups were kept constant throughout the experiment. Each group participated in a repeated threshold public good contribution game with 12 rounds of repetition. Subjects received feedback about the results at the end of each round. We describe the treatments in detail below.

No delegation treatment. In every period of $NoDel$, each participant is endowed with 55 tokens. Participants independently and simultaneously choose how to divide their endowment between a "private account" and twelve "collective accounts", indexed by n. For each token put into his own private account, a subject receives a return of two points. Each token put into a collective account n returns a benefit of B_n to all players. The benefit associated with a collective account depends on total contributions to that account from all players, denoted C_n, with

$$B_n(C_n) = \begin{cases} 0 & \text{when } C_n < 132 \\ C_n + b_n & \text{when } C_n \geq 132, \end{cases} \tag{1}$$

where $b_n \in \{20, 30\}$ denotes the bonus associated with that good. When total contributions to n do not achieve the threshold of 132 tokens, the contributions to that good are forfeited. When they reach or exceed the threshold, all players benefit equally. The threshold is set at 60% of the total endowment, assuring that at most one public good can be effectively funded.[4] Four of the collective accounts offer bonuses $b_n = 30$ and eight offer $b_n = 20$. Otherwise, the goods are identical.[5]

In the single public good environment with no delegation discussed in the Appendix ($NoDel[1]$) in the Appendix, the collective account has a threshold of 132 and offers a bonus of 30 in case of successful contribution.

Delegation treatments. We extend the multiple threshold public good environment to allow for delegation in two ways. Treatments Del and $DelRule$ add an initial stage to the $NoDel$ treatment in which group members can make transfers to an intermediary player. There are still four group members, each endowed with 55 tokens, and three of the group members can transfer any number of tokens between 0 and 55 to the fourth group member. In the second stage, players contribute to public goods in the same way that they did under $NoDel$ except that their updated endowments reflect the first stage transfers. The only difference between Del and $DelRule$ concerns restrictions placed on the intermediary's use of the transferred funds in the second stage. In Del, there are no restrictions in how the intermediary may allocate the transfers received between public goods and her private account. In $DelRule$, the intermediary cannot direct transfers received from other players to her own private account; she must direct transfers to a public good.

In the Appendix, $Del[1]$ and $DelRule[1]$ are analogous to the multiple public good treatments but with only a single public good to which players may contribute.

3.1. **Procedures.** Upon their arrival to the lab, subjects were randomly assigned to a computer terminal. At the beginning of the experiment, instructions were distributed and read aloud (see the online Supplementary Material for the instructions used in $DelRule$). Before the first period started, subjects were asked to answer control questions at their terminal to ascertain their understanding of the procedure and instructions. Subjects' questions about procedures and instructions were answered privately.

As explained above, in each period of Del and $DelRule$ (and later $Del[1]$ and $DelRule[1]$), subjects participated in two consecutive phases: a delegation phase and a contribution phase. At the beginning of

[4]The marginal per capita return to the collective account equals 0.5 meaning that the marginal return to a subject from successfully contributing to a collective account (namely, once the threshold is reached) is half the return from the private account.

[5]We thus modify the original setting characterized by multiple public goods and one more efficient alternative introduced by CCV in one important way. While in CCV only one collective account was made salient by increasing its bonus relative to the remaining alternatives, in the present study the four most-efficient alternatives are equally salient.

the delegation phase, the computer randomly chose one of the group members to serve as an intermediary, and subjects were privately informed about their role. Non-intermediary group members simultaneously chose how much of the initial endowment to transfer to the intermediary. The intermediary did not make any choice in the delegation phase. At the end of the delegation phase, subjects received feedback on the overall amount transferred to the intermediary, and their own updated endowment that they would have access to in the contribution phase. For the non-intermediaries, this equaled 55 minus any transfer they made in the first stage. For the intermediary, this equaled 55 plus the sum of transfers from others.

At the beginning of the contribution phase, each subject was presented with a number of bins (on the terminal screen) equal to the total number of private and collective accounts (thirteen in $NoDel$, Del, and $DelRule$; two in $NoDel[1]$, $Del[1]$, and $DelRule[1]$). In order to minimize frame effects associated with letter or number labels, the twelve collective accounts in $NoDel$, Del, and $DelRule$ were labeled using colors: white, yellow, green, red, light blue, blue, gray, violet, brown, pink, black, and orange. Also, subjects in these treatments were told that the order of (but not the label associated with) the boxes of the collective accounts on their screen was randomly determined by the computer in every period. Each of the twelve boxes of the collective accounts showed the threshold and the size of the corresponding bonus.

The twelve collective accounts were divided into two groups. Four were efficient, assigning a bonus of 30 points in case the group contributed more than the threshold, and eight were inefficient, with a respective bonus of 20 points. The four efficient public goods were randomly selected in periods 1, 5, and 9, and were kept unchanged for four consecutive periods. The random reshuffle of the efficient public goods every four periods was motivated by two important considerations. First, in particular in the reshuffling periods, delegation could be used by group members to select one collective account across the viable alternatives. Second, by keeping the efficient accounts unchanged for four periods, subjects had the possibility to develop coordination over multiple alternatives even without delegation, by simply using contributions to signal to the other group members the alternative to opt for in the next period.

At the end of every period, each subject was informed about the number of tokens allocated by the group to (each of) the collective account(s), whether the corresponding threshold was reached, and any bonus paid. Additionally, following each period, subjects learned the number of points they received from each account and in total.

The experiment took place at the Bocconi Experimental Laboratory for Social Sciences (BELSS) at Bocconi University, Milan, in June 2017. Participants were mainly undergraduate students, recruited using the SONA recruitment system (http://www.sona-systems.com/default.aspx). The experiment was computerized using the *z-Tree* software (Fischbacher, 2007). At the end of the experiment, points obtained by a subject during the experiment were converted at an exchange rate of 1 euro per 120 points and monetary earnings were paid in cash privately. On average, subjects earned 14.50 euros for sessions lasting 60 minutes, including the time for instructions and payments. Before leaving the laboratory, subjects completed a short questionnaire containing questions on their socio-demographics and their perception of the experimental task.

4. Delegation and multiplicity: Theoretical insights and testable predictions

In this section, we present a game theoretic model of threshold public goods adapted from CCV. We then discuss how this model may be extended to incorporate delegation rules, and the impact of these extensions on the predictions of the model (in the Appendix, we provide a formal analysis). This discussion leads to several testable hypotheses, which guide the experimental design and analysis.

4.1. **Model of threshold public goods without delegation.**

There are J players, indexed $j \in \{1, ..., J\}$. Each player receives an endowment y at the beginning of the game. Players simultaneously decide how much of their private endowment to contribute to each of N public goods. The contribution of player j to good n is denoted by $c_{j,n} \geq 0$. Let $C_n \equiv \sum_j c_{j,n}$ and $c_j = \sum_{n=1}^{N} c_{j,n}$ denote the aggregate contributions to good n and the total contributions made by player j, respectively. A player's total donations cannot exceed his endowment, $c_j \in [0, y]$.

Function $B_n(C_n) = B(C_n)$ determines the benefit each player receives from public good n. The benefit depends on whether total contributions reach some contribution threshold, τ, below which the public good fails to return any benefit. For each good n,

$$B_n(C_n) = \begin{cases} 0 & \text{when } C_n < \tau \\ C_n + b_n & \text{when } C_n \geq \tau. \end{cases} \tag{2}$$

When the threshold is reached, the public good returns a benefit to each player that is increasing in total contributions, plus a bonus of b_n associated with good n. Any unit of endowment not contributed to a public good gets directed to private consumption, where it returns a marginal benefit of two (implying a marginal per capita return to the public good is 1/2 that from private consumption). Therefore, player j earns total payoff:

$$u_j(c) = 2(y - \sum_{n=1}^{N} c_{j,n}) + \sum_{n=1}^{N} B(C_n) \tag{3}$$

We assume that $J = 4$, $y = 55$, $\tau = 132$ and $b_n \in \{20, 30\}$. These will be the parameters incorporated into our experiment. They assure that groups can fund at most one public good at its threshold, that players are unable and unwilling to unilaterally fund a good at its threshold, and that players prefer to contribute to a public good only if they expect that others are also contributing to the same public good.

CCV consider such a framework, showing that there exists two type of equilibria. First, there exists an equilibrium in which players contribute nothing to any of the public goods. Second, for each of the public goods, there exists equilibria in which the groups provide contributions to that good exactly equal to the threshold, while providing no contributions to any other good. There are $N + 1$ symmetric equilibria: one in which $c_{n,j} = 0$ for all n and j, and one for each good n in which each player contributes $c_{n,j} = \tau/J = 34$ and $c_{m,j} = 0$ for all $m \neq n$.

The threshold public good environment is coordination game in which players want to contribute to a public good only if they expect that others are also contributing the same good. Furthermore, the size of the contribution they want to provide depends on the contributions they expect others to provide.

As the number of goods N increases, the coordination problem among donors becomes more challenging. Even if a player expects that others will contribute, it becomes less likely that everyone's contribution will go towards the same good, and more likely that the player's own contribution will be directed to an underfunded good and, therefore, be wasted. This miscoordination problem is the focus of CCV, who show how an increase in N discourages contributions, leading to fewer contributions in total and decreasing the probability that any public good is successfully funded. They argue that adding additional goods increases the risk of miscoordinating contributions, making it more likely that players focus on the low-risk strategies that are associated with the no-contribution equilibrium.

When players interact over several periods, there are even more equilibria to consider, and the main insights from the model regarding how adding multiple goods discourages donations continue to hold.

4.2. **Allowing delegation.** To incorporate delegation into the threshold public good framework, we add an initial stage to the game. In this initial stage, one of the four players, i, is appointed to serve as the intermediary, and then the other players choose how much of their endowments to transfer to player i. Denote player j's transfer by $d_j \in [0, y]$, and let $D = \sum_{j \neq i} d_j$. In the second stage of each period, all four players simultaneously choose how to distribute their endowments across the N public goods and their private account just as they did in the game without delegation, except here their endowments are updated to reflect the first stage transfers.

We consider two versions of the delegation game. In the first, player i faces no restrictions in the allocation of her own initial endowment or the transfers received from other players. She can direct as much or as little of the funds to her private account as well as to the public good as she chooses. In the second version, player i faces no restriction on the allocation of her own initial endowment, but she does face a restriction on her use of the contributions transferred to her from the other players. The "destination rule" requires that any transfer from another player in the first stage must be passed along to a public good in the second stage; the transfers cannot be directed to the intermediary's private account.

The ability to contribute through an intermediary has the potential to greatly reduce the coordination problem among donors. If they expect the intermediary to behave in the best interests of the group, then they can simply choose how much to contribute, leaving the intermediary to decide which public good receives funding.

Delegation can eliminate the risk that players contribute to different public goods, thereby wasting their contributions. This can encourage players to contribute through the intermediary. At the same time, however, the presence of delegation adds complexity to the overall game, and in the case of delegation without a destination rule, it also adds a new dimension of risk: that the intermediary expropriates transfers for her personal gain (rather than using them for the intended social benefit). These factors may discourage any form of contribution and lead players to focus on no-contribution strategies.

In the delegation environment with a destination rule, there exists equilibria in which the other players only contribute through the intermediary, who then funds one of the public goods at its threshold. For example, there exist equilibria in which each non-intermediary player provides some transfer d_j to the intermediary, who then contributes $c_{i,n} = 132$ to one of the public goods. When players choose such strategies as part of an equilibrium, there is no need to correctly anticipate which of the other goods the other players are going to contribute to. The non-intermediaries simply choose how much to contribute, and the intermediate then chooses the public good to fund using the groups' contributions. Such equilibria continue to exist in the repeated version of the game.

In the delegation environment with unrestricted transfers, there does not exist equilibria of the non-repeated game in which other players only contribute through the intermediary. The intermediary has an incentive to expropriate contributions for her own use rather than pass along enough transfers to reach a funding threshold. Because of this, in a one shot game, any equilibrium that involves funding a public good entails players coordinating direct contributions on the same good. Some moderate amount of delegation may exist in equilibrium, but not to the extent that it simplifies the coordination problem among donors; it does not eliminate the need to anticipate where others will contribute as part of equilibrium.

In the repeated version of the delegation game with unrestricted transfers, delegation can be more helpful. This is because the presence of repeated interactions between the same set of players allow them to play conditional strategies, which can introduce the potential threat that players will stop contributing to any public good after an intermediary acts outside of the groups' interests and expropriates the transfers for her own gain. Using such strategies, one may construct equilibria in which non-intermediaries provide contributions only through the intermediary, except for in the last periods of play in which players don't need the intermediary to coordinate if they simply continue to fund the same good that was funded in the previous periods. Although delegation can help groups reduce the risk of contributing to different goods in the repeated environment, this requires more complex conditional strategies than in the presence of a delegation rule.

4.3. **Testable predictions.** The insights gained from the theoretical analysis (see Appendix C) provide several predictions that help guide the experimental analysis.

In the multiple public good environment without delegation, CCV showed that players often focused on less-risky strategies. As the risk of miscoordination increased, players were more likely to play the least risky strategy and contribute nothing to any of the public goods. In the above discussion, we considered how delegating contributions through an intermediary changes the risk of providing contributions.

Delegating contributions can reduce the risk that a donor effectively wastes his contribution by contributing to a different good than other donors. This reduction in risk is likely to increase the probability that players provide contributions (through an intermediary), which in turn increases the probability that a public good reaches its funding threshold.

At the same time, however, delegating contributions can increase the risks that the intermediary redirect money away from public good funding for her private gain. This is a possibility in the game with unrestricted delegation, but not in the environment with a destination rule. Although the theory shows that delegation can exist as part of equilibria in both environments, the strategies involved in such equilibria are much more complicated in the game with unrestricted delegation than in the game with a destination rule, as conditional strategies and dynamic incentives are required to reduce the risk that the intermediary expropriates transfers.

These insights suggest that both total contributions and the probability that a public good succeeds will be higher in the game with delegation and a destination rule than in either the game without delegation or the game with unrestricted delegation. The theory does not provide clear predictions regarding the comparison of outcomes in the game without delegation and the game with unrestricted delegation. Compared to the multiple public good framework without delegation, unrestricted delegation reduces the risks associated with contributing on one dimension, while introducing a new risk on another dimension. Whether contributions and donor coordination increase or decrease in the game with unrestricted delegation will depend on whether the risk of miscoordination or the risk of intermediary expropriation are viewed as more significant concerns for donors. This is an empirical question, which we consider in the experimental analysis below.

5. Experimental results

Throughout the body of the paper, we focus attention on the treatments with multiple public goods: *NoDel*, *Del*, and *DelRule*. We explore differences across treatments in overall contributions, coordination, the delegated amount, and delegation behavior. In the Appendix, we replicate the analysis on treatments with a single public good to disentangle the role played by multiplicity of public goods in mediating the effects of delegation, and we present some additional results on the comparison between *NoDel*[1] and *NoDel* to highlight differences between our setup and CCV.

In the statistical analysis, we use both non parametric and parametric techniques. The non parametric tests are based on independent observations at the group level. Moreover, when looking at differences across treatments over all periods, we will also discuss results from the bootstrap-based methodology developed by List et al. (2016) to test multiple null hypotheses simultaneously in experimental settings with multiple treatments. Concerning the parametric analysis, in order to account for potential dependence across periods, the estimated coefficients are based on standard errors clustered at the group level.

5.1. **Total contributions.**

Figure 1 shows the mean total contributions to the collective accounts over periods in *NoDel*, *Del* and *DelRule*.

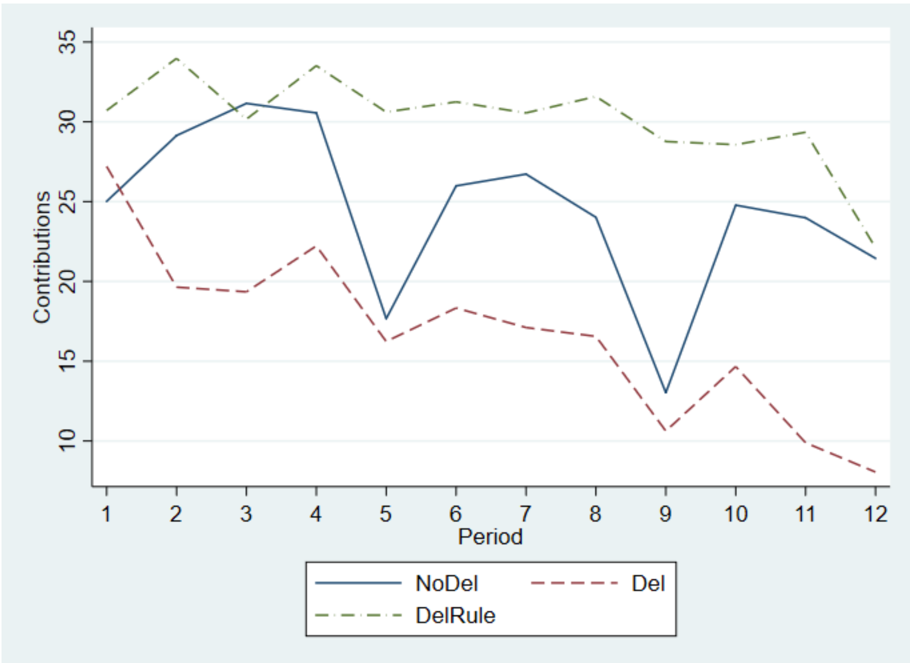

Figure 1. Total contributions with multiple collective accounts, by treatment and period.

Averaging over all periods, subjects contribute 24.46 tokens in *NoDel*, 16.66 in *Del*, and 30.01 tokens in *DelRule*. Contributions in *NoDel* are placed between those in *Del* and *DelRule* and are characterized by higher volatility across periods. Downward peaks in total contributions observed in the *NoDel* treatment occur in the reshuffling periods (1, 5, and 9) and are followed by sustained contributions in the next three periods, suggesting that moderate contributions in reshuffling periods are used as a signal to let group members coordinate higher contributions in the following three repetitions. In all treatments, contributions tend to decline over periods, with this effect being particularly pronounced in *Del*.

TABLE 1. Total contributions with multiple collective accounts: parametric analysis

Total contributions	(1)	(2)	(3)	(4) *NoDel*	(5) *Del*	(6) *DelRule*
Del	-7.800^{**}	-8.176^{**}	-8.736^{*}			
	(3.919)	(3.384)	(5.045)			
DelRule	5.639	3.392	3.563			
	(3.919)	(3.427)	(5.255)			
$Coord(t-1)$		7.523^{***}	7.867^{**}			
		(1.868)	(3.195)			
$Del * Coord(t-1)$			1.684			
			(4.608)			
$DelRule * Coord(t-1)$			-2.623			
			(4.571)			
Trend		-0.975^{***}	-1.045^{**}	-0.791^{***}	-1.007^{**}	-0.434
		(0.232)	(0.408)	(0.180)	(0.451)	(0.693)
$Del * Trend$			0.010			
			(0.576)			
$DelRule * Trend$			0.252			
			(0.574)			
$d1$				-6.281^{***}	4.577	-2.743
				(1.907)	(4.773)	(7.333)
$d5$				-10.463^{***}	-2.369	-1.105
				(1.661)	(4.158)	(6.388)
$d9$				-11.937^{***}	-3.953	-1.217
				(1.709)	(4.279)	(6.573)
$d12$				-1.146	-3.502	-6.569
				(1.930)	(4.832)	(7.422)
cons	24.457^{***}	27.368^{***}	27.657^{***}	31.295^{***}	22.631^{***}	33.451^{***}
	(2.771)	(2.843)	(3.479)	(3.331)	(3.889)	(4.442)
ll	-13055.40	-11950.55	-11950.00	-3542.40	-4279.61	-4629.27
$Wald-\chi^2$	11.86	50.62	52.25	119.17	19.91	2.49
$p > \chi^2$	0.003	0.000	0.000	0.000	0.001	0.777
Obs.	2592	2376	2376	864	864	864

Notes. This table reports coefficient estimates (standard errors in parentheses) from two-way linear random effects models accounting for both potential individual dependency over periods and dependency within group. The dependent variable is the total contributions made by the subject to the twelve collective accounts in the period. Columns (1) and (2) report results by pooling data from *NoDel*, *Del*, and *DelRule*. Columns (3), (4), and (5) consider data from each treatment, separately. $Coord(t-1)$ is a dummy that assumes value 1 if subject's group reached the threshold on one collective account in the previous period; *Trend* is a linear time trend that starts from 0; *Del* and *DelRule* are treatment dummies; $Del * Trend$, $DelRule * Trend$, $Del * Coord(t-1)$, $DelRule * Coord(t-1)$ are interaction terms. $d1$, $d5$, $d9$, and $d12$ are period dummies that assume value 1 in periods 1, 5, 9, and 12, respectively. Significance levels are denoted as follows: * $p < 0.1$, ** $p < 0.05$, and *** $p < 0.01$.

Table 1 reports results from parametric, random effects panel regressions to assess the statistical relevance of these preliminary observations.

Column (1) compares contributions in *NoDel* with those observed in *Del* and *DelRule* to assess the effects of delegation in a setting characterized by multiple collective accounts. The negative and significant ($p < 0.05$) coefficient of the treatment dummy *Del* indicates that introducing delegation with no destination rule is detrimental for cooperation, as it reduces contributions relative to the baseline treatment with no delegation, *NoDel*. Instead, delegation seems to stimulate contributions in *DelRule*, when the intermediary is subject to the destination rule. The difference in contributions between *DelRule* and *Del* is positive and highly significant ($p < 0.001$), while the difference between *DelRule* and *NoDel*, although positive, does not reach statistical significance ($p = 0.150$). These results are confirmed by non parametric tests. According to a two-side Mann–Whitney rank-sum test, mean (over all periods) total contributions in *Del* are significantly lower than those in *DelRule* ($p < 0.001$) and *NoDel* ($p < 0.05$), while no difference is detected between *DelRule* and *NoDel* ($p = 0.311$). When accounting for multiple null hypotheses testing, the difference in contributions between the two treatments with delegation, *Del* and *DelRule*, remains highly significant ($p = 0.003$), while that between *Del* and *NoDel* reaches only marginal significance ($p = 0.095$).

Result 1. Subjects make significantly larger total contributions in *DelRule* and *NoDel* than in *Del*. Contributions are higher in *DelRule* than in *NoDel*, although this difference is not statistically significant.

Column (2) shows how results change when controlling for the past ability of the group to reach the threshold and adding a time trend. The coefficient of $Coord(t-1)$ is positive and highly significant ($p < 0.001$) suggesting that total contributions increase when the group successfully reached the threshold in the previous period. Finally, the negative and highly significant coefficient of the time trend confirms the existence of a decaying pattern in contributions, as highlighted by Figure 1. Both the magnitude and significance of the differences in contributions across treatments are not substantially affected by the introduction of these two additional covariates: the differences between *DelRule* and *Del* or between *NoDel* and *Del* remain positive and significant (for the two comparisons, $p < 0.001$ and $p < 0.001$, respectively), while the difference between *DelRule* and *NoDel* is not significant ($p = 0.322$).

Column (3) replicates the analysis in column (2) by adding a number of interaction terms to control for (potential) heterogeneous effects of the linear trend and the past successful provision across treatments. As shown by the results, all the interaction terms are not significant, suggesting that, relative to the baseline, we do not detect significant differences in the effects of the covariates between *Del* and *DelRule*.[6]

Columns (4), (5), and (6) focus on each of the three treatments, separately. We are mainly interested in assessing whether the three treatments differ from each other in the decaying pattern and the effects of reshuffling the efficient collective accounts. In order to properly identify the effects of reshuffling, for each treatment, we modify the specification in column (2) by adding dummies for periods 1, 5, 9, separately. We also include a dummy for period 12 to look at potential ending game effect. Finally, we exclude $Coord(t-1)$ from the three regressions in order to identify the effect of period 1.

Concerning the effects of the time trend, we find that contributions significantly decline over repetitions in *NoDel* ($p < 0.001$) and *Del* ($p < 0.05$), while they do not exhibit any particular time pattern in *DelRule* ($p < 0.531$).

Every four periods, the four efficient public goods were randomly reshuffled. As highlighted by Figure 1, the effect of reshuffling is strong in *NoDel*, where subjects cannot use delegation to solve the coordination problem. Indeed, in this treatment, total contributions substantially fall in periods 1, 5 and 9 (for all dummies: $p < 0.001$). In *Del* and *DelRule*, reshuffling does not have any significant effect on contributions.

Result 2. Delegation attenuates the negative effects of reshuffling the more efficient alternatives on total contributions. Moreover, contributions decline more rapidly in *Del* than in *DelRule* or *NoDel*.

In a similar experimental setting characterized by multiple threshold collective accounts, CCV showed that subjects prefer to contribute to the most efficient alternatives, even when the inefficient collective account is salient and might represent a coordination device. The tendency to opt for efficient collective accounts finds further empirical support in the present paper. Table 2 reports the mean contribution to efficient and inefficient collective accounts in *NoDel*, *Del*, and *DelRule*, over periods.[7]

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[6] We also detect no difference between *Del* and *DelRule* when performing formal tests to compare the interaction terms (for the difference between $Del * Trend$ and $DelRule * Trend$: $p = 0.671$; for the difference between $Del * Trend$ and $DelRule * Trend$: $p = 0.671$; for the difference between $Del * Coord(t-1)$ and $DelRule * Coord(t-1)$: $p = 0.355$.

[7] The mean contributions to the efficient (inefficient) collective accounts in a period is given by the ratio between the total contributions to the efficient (inefficient) alternatives and the number of efficient (inefficient) collective accounts to which, in that period, the subject allocated strictly positive amounts.

TABLE 2. Contributions to efficient and inefficient alternatives with multiple collective accounts

Period	1	1 − 4	5	5 − 8	9	9 − 12	12	*All*
NoDel								
Eff. pgs	18.560	26.343	11.524	20.193	8.772	18.183	19.472	21.573
Ineff. pgs	0.516	0.188	4.319	2.701	2.806	2.264	1.972	1.718
Diff.	18.044***	26.155***	7.205***	17.492***	5.966**	15.919***	17.500***	19.855***
Del								
Eff. pgs	21.998	19.441	12.767	15.625	8.399	9.674	6.684	14.913
Ineff. pgs	0.425	0.154	2.488	0.644	0.479	0.290	0.625	0.363
Diff.	21.573***	19.287***	10.279**	14.981***	7.920***	9.384***	6.059**	14.550***
DelRule								
Eff. pgs	25.285	27.935	26.222	28.426	26.806	24.944	17.396	27.102
Ineff. pgs	1.303	1.120	0.666	0.318	1.264	1.110	1.940	0.850
Diff.	23.982***	26.815***	25.556***	28.108***	25.542***	23.834***	15.456***	26.252***
Obs. (per treat)	18	18	18	18	18	18	18	18

Notes. This table reports the mean contributions to efficient and inefficient collective accounts in *NoDel*, *Del*, *DelRule*, over periods. Moreover, the table shows significance levels from a (two-sided) Wilcoxon signed-rank test for the null hypothesis that the difference between the contribution to the efficient and inefficient options is null. Significance levels are denoted as follows: $^{*}p < 0.1$, $^{**}p < 0.05$, and $^{***}p < 0.01$.

TABLE 3. Mean proportion of successful provision with multiple collective accounts

Period	1	1 − 4	5	5 − 8	9	9 − 12	12	*All*
NoDel	0.000	0.389	0.000	0.361	0.056	0.431	0.500	0.394
Del	0.389	0.375	0.222	0.333	0.167	0.181	0.111	0.296
DelRule	0.500	0.653	0.667	0.694	0.667	0.639	0.444	0.662
NoDel − Del	−0.389***	0.014	−0.222**	0.028	−0.111	0.250**	0.389**	0.098
NoDel − DelRule	−0.500***	−0.264**	−0.667***	−0.333***	−0.611***	−0.208*	0.056	−0.268**
Del − DelRule	−0.111	−0.278**	−0.445***	−0.361***	−0.500***	−0.458***	−0.333**	−0.366***
Obs. (per treat)	18	18	18	18	18	18	18	18

Notes. This table reports mean proportions of successful provision (namely, reaching the threshold of one collective account) over periods in *NoDel*, *Del*, and *DelRule*. The table also shows significance levels from a nonparametric (two-sided) Mann–Whitney rank-sum test for the null hypothesis that the proportion in two treatments is the same. The other remarks of Table 2 apply.

According to a (two-sided) Wilcoxon signed-rank test, the mean contribution to the efficient collective accounts is, over all periods, substantially higher than that to the inefficient alternatives in all treatments ($p < 0.01$).

Result 3. With multiple collective accounts, subjects contribute substantially more to the efficient collective accounts than to the inefficient alternatives.

5.2. **Successful provision of collective accounts.** We now consider the ability of groups to coordinate contributions on the same collective account and successfully reach the required threshold. As discussed in the theoretical section, delegation may reduce the risk of donor coordination. It allows group members to centralize the choice of allocating the group's resources across collective accounts on the intermediary. Table 3 reports the mean proportions of successful provision in *NoDel*, *Del*, and *DelRule*, over periods.

Over all periods, *DelRule* is the treatment with the highest percent (66.2%) of groups contributing at or above the threshold of one of the collective accounts, followed by *NoDel* (39.4%) and *Del* (29.6%). According to a Mann-Whitney rank-sum test (two-sided), the mean proportion of periods a group reaches the threshold is significantly higner in *DelRule* than in either *NoDel* ($p = 0.014$) or *Del* ($p = 0.003$). The difference between *Del* and *NoDel* is not significant ($p = 0.653$).

Statistical significance of these results is confirmed when accounting for multiple null hypotheses testing, as the difference in proportions between *DelRule* and *Del* or *NoDel* remain highly significant (respectively, for the two comparisons: $p = 0.006$ and $p = 0.021$), while the difference between *Del* and *NoDel* is not significant ($p = 0.369$).

Thus, delegation leads to greater coordination only in *DelRule*, where the intermediary is constrained by the destination rule to contribute at least as much as she receives from the rest of the group.

Result 4. With multiple collective accounts, delegation increases the ability of the group to successfully reach the threshold of a collective account only when the intermediary's behavior is limited by the destination rule.

5.3. **Subjects' earnings.** As discussed earlier, while no difference in the total contributions is detected between *DelRule* and *NoDel*, subjects in *DelRule* are more successful in coordinating contributions on the same collective account and reaching the required threshold. In contrast, when there is no destination rule, delegation seems to be detrimental for public good success. Relative to the other two treatments, *Del* is associated with lower contributions and lower probability of reaching the threshold.

We now look at how previous results translate into differences in subjects' earnings across treatments. Figure 2 shows the mean earnings over periods in *NoDel*, *Del* and *DelRule*.

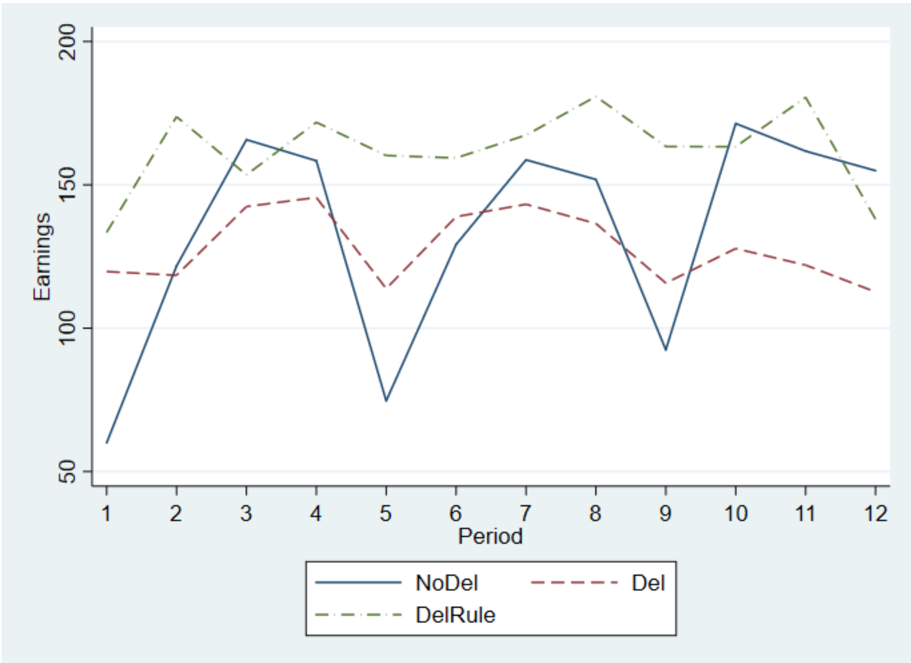

FIGURE 2. Subjects' earnings with multiple collective accounts, by treatment and period.

Averaging over all periods, subjects earn 133.40 points in *NoDel*, 128.07 points in *Del*, and 162.13 points in *DelRule*. Again, we observe a large variability in earnings in *NoDel*, with downward peaks occurring in the reshuffling periods (1, 5 and 9) when coordination is more difficult to achieve, and upward peaks reached in the subsequent three periods. Again, a plausible interpretation of this pattern is that subjects use (moderate) contributions in the reshuffling periods as a signal to achieve coordination in subsequent rounds. The highest earnings are registered in *DelRule*, where group members are more successful in coordinating and contributing above the threshold.

These initial observations are formally investigated in Table 4, which shows the mean earnings in *NoDel*, *Del* and *DelRule*.

TABLE 4. Subject's earnings with multiple collective accounts

Period	1	$1-4$	5	$5-8$	9	$9-12$	12	*All*
NoDel	59.972	126.444	74.667	128.611	92.444	145.132	154.944	133.396
NoDel − 110	-50.028^{***}	16.444	-35.333^{***}	18.611	-17.556^{***}	35.132^{**}	44.944^{**}	23.296^{*}
Del	119.750	131.556	113.806	133.104	115.750	119.549	112.667	128.069
Del − 110	9.750	21.556	3.806	23.104	5.570	9.549	2.667	18.069^{*}
DelRule	133.417	158.125	160.222	166.944	163.361	161.313	138.056	162.127
DelRule − 110	23.417^{*}	48.125^{***}	50.222^{***}	56.944^{***}	53.361^{***}	51.313^{***}	28.056	52.127^{***}
NoDel − *Del*	-59.778^{***}	-5.112	-39.139^{***}	-4.493	-23.306^{**}	25.583	42.277^{*}	5.327
NoDel − *DelRule*	-73.445^{***}	-31.681^{*}	-85.555^{***}	-38.333^{**}	-70.917^{***}	-16.181	16.888^{*}	-28.731^{**}
Del − *DelRule*	-13.667	-26.569^{*}	-46.416^{*}	-33.840^{*}	-47.611^{*}	-41.764^{**}	-25.389	-34.058^{**}
Obs. (per treat)	18	18	18	18	18	18	18	18

Notes. This table reports mean earnings over periods in *NoDel*, *Del*, and *DelRule*. For each treatment, the table reports results of a (two-sided) Wilcoxon signed-rank test for the null hypothesis that earnings are equal to 110, namely the level that is associated with the zero contribution equilibrium. Finally, the table shows results from a nonparametric (two-sided) Wilcoxon rank sum test for the null hypothesis that the mean earnings in two treatments are the same. The other remarks of Table 2 apply.

Over all periods, according to a Mann-Whitney rank-sum test (two-sided), the difference between *DelRule* and both *NoDel* and *Del* are significant ($p = 0.034$ and $p = 0.011$, respectively). Again, differences remain significant when accounting for multiple null hypotheses testing (for the difference between *DelRule* and *NoDel*, $p = 0.031$; for the difference between *DelRule* and *Del*, $p = 0.023$). The difference between *Del* and *NoDel* is non significant using either a standard Mann-Whitney rank-sum test ($p = 0.874$) or when accounting for multiple null hypotheses testing ($p = 0.650$).

We also consider how mean earnings differ from 110, the payoff associated with the no-contribution equilibrium. Only in *DelRule* do subjects earn significantly more than what they could get by entirely allocating the endowment in the private account, according to a (two-sided) Wilcoxon signed-rank test ($p < 0.001$). In the other two treatments, although the difference between earnings and 110 is positive, it is only marginally significant (in *NoDel*: $p = 0.078$; in *Del*: $p = 0.061$). In the reshuffling periods of *NoDel*, the difference is negative and highly significant (in period 1, $p < 0.001$; in period 5, $p < 0.001$; in period 9, $p = 0.006$). Thus, delegation, if sustained by the destination rule, stimulates cooperation among group members and increases their earnings.

Result 5. With multiple collective accounts, delegation is profitable and significantly increases subjects' earnings only when it is sustained by the destination rule.

5.4. **Delegated amounts and contributions.** The previous results suggest that, in *DelRule*, delegation may help groups coordinate on a public good and increase their expected payoffs.

Figure 3 shows the amounts delegated by the group members to the intermediary, as well as her total contributions to the collective accounts in *Del* and *DelRule*.

Three important observations emerge from Figure 3. First, the amounts transferred by group members to the intermediary are higher in *DelRule* than in *Del*. Over all periods, the mean delegated amounts are 85.44 tokens in *DelRule* and 47.69 tokens in *Del*, respectively. Second, while the intermediary contributes more than what is transferred by the group in *DelRule*, there is no substantial difference between delegated amounts and the intermediary's total contributions in *Del*. Over all periods, the difference between the intermediary's total contribution and the delegated amounts is 24.99 in *DelRule* and 3.27 in *Del*. Third, both the delegated amounts and the intermediary's total contributions substantially decay over repetitions in *Del*, but remain stable in the *DelRule*.

Table 5 reports descriptive statistics on the delegated amounts and the intermediary's total contributions in *Del* and *DelRule* over all periods, together with results from non parametric tests.

Over all periods, both the delegated amounts and the intermediary's total contributions are substantially higher in *DelRule* than in *Del*. According to a Mann-Whitney rank-sum test (two-sided), the differences between *Del* and *DelRule* in both variables are highly significant (for the delegated amounts:

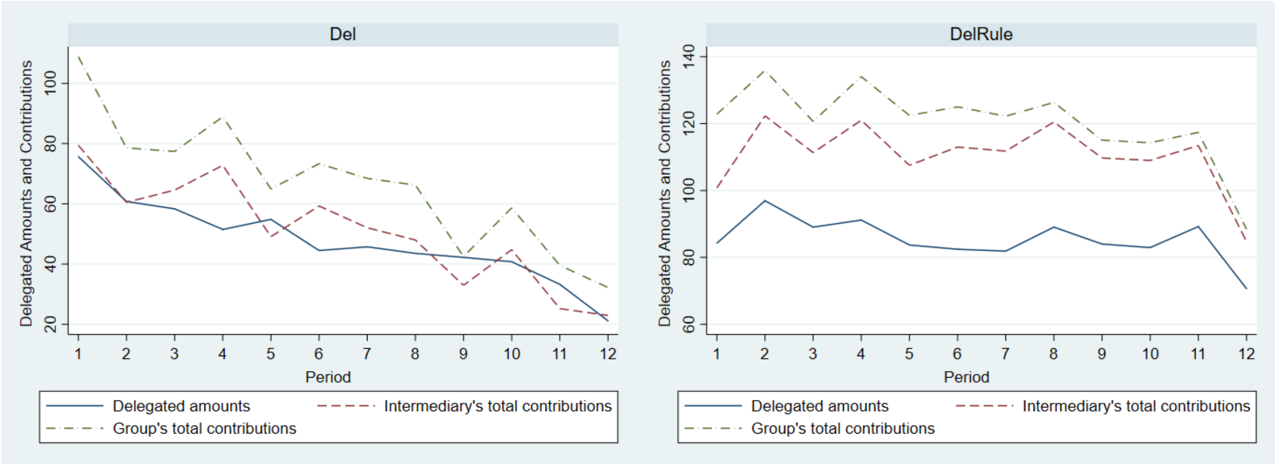

FIGURE 3. Delegated amounts and intermediary's total contributions with multiple collective accounts, by treatment and period.

TABLE 5. Delegated amounts and intermediary's total contributions with multiple collective accounts

Period	1	1 – 4	5	5 – 8	9	9 – 12	12	*All*
Int.'s cont.								
Del	79.444	69.319	49.111	52.111	32.944	31.472	22.944	50.968
DelRule	100.778	113.861	107.556	113.208	109.722	104.236	84.778	110.435
Del − DelRule	−21.334	−44.542**	−58.445***	−61.097***	−76.778***	−72.764***	−61.834***	−59.467***
Del.Am.								
Del	75.667	61.569	54.833	47.153	42.222	34.361	21.167	47.694
DelRule	84.222	90.347	83.722	84.278	84.000	81.708	70.667	85.444
Del − DelRule	−8.555	−28.778***	−28.889**	−37.125***	−41.778***	−47.347***	−49.500***	−37.750***
Int.'s cont. − Del.Am.								
Del	3.777	7.750	−5.772	4.958	−9.278	−2.934	1.777	3.274
DelRule	16.556***	23.514***	23.834***	28.930***	25.722***	22.528***	14.111***	24.991***
Obs. (per treat)	18	18	18	18	18	18	18	18

Notes. This table reports means of both the delegated amounts and intermediary's total contributions over periods in *Del* and *DelRule*. The table also shows results from a nonparametric (two-sided) Wilcoxon rank sum tests for the null hypotheses that the mean delegated amounts and the intermediary's mean contributions in the two treatments are the same. Finally, for each treatment, the table reports results of a (two-sided) Wilcoxon signed-rank test for the null hypothesis that the delegated amounts are equal to the intermediary's total contributions. The other remarks of Table 2 apply.

$p < 0.001$; for the intermediary's total contributions: $p < 0.001$). These results remain highly significant when accounting for multiple null hypotheses testing (for both the delegated amounts and the intermediary's total contributions: $p < 0.001$).

Next, we compare the intermediary's total contributions with the transfers received from the group members in the first stage. In *DelRule*, the intermediary contributes substantially more than the delegated amounts, while no remarkable differences are detected in *Del*. Indeed, over all periods, the difference between the intermediary's total contribution and the delegated amounts in *DelRule* is 24.99 tokens (around 29% of what is transferred by the group) and highly significant according to a (two-sided) Wilcoxon signed-rank test ($p < 0.001$). In *Del* the difference drops to 3.27 tokens and is not significantly different from zero ($p = 0.617$).

Result 6. With multiple collective accounts, the destination rule increases the amount transferred by the group members in the delegation phase. Moreover, in *DelRule*, the intermediary's total contributions are on average 29.25% higher than the total amount delegated by the members of the group.

The previous result does not take into account the difference in the proportion of successful groups between *DelRule* and *Del* (Result 4). In order to better understand the interplay between the intermediary's total contribution and the delegated amounts, we now focus on groups that successfully reached the threshold of a collective account. For these groups, Figure 4 shows the delegated amounts, the intermediary's contributions, the contributions made by the other three group members, and the group's aggregate contributions to the financed collective account over all periods in *DelRule* and *Del*.

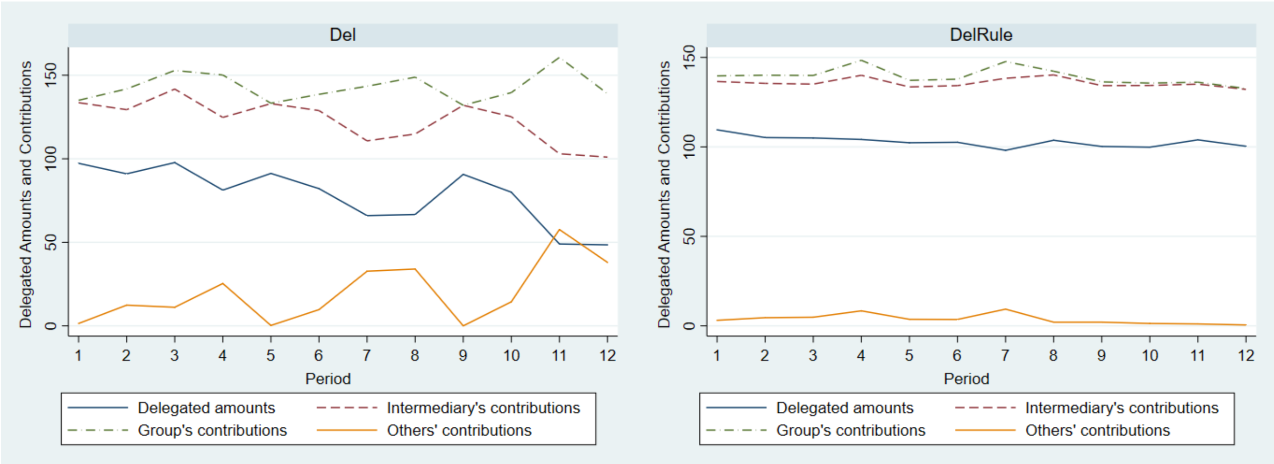

Figure 4. Delegated amounts and contributions to the financed collective account in successful groups with multiple alternatives, by treatment and period.

The figure provides a number of interesting insights. First, in contrast to Figure 3, we document no substantial difference between *Del* and *DelRule* in the group's aggregate contributions, settling in both treatments around 140 tokens. Second, successful groups transfer more resources to the intermediary in *DelRule* than in *Del*, a result that confirms what was reported in Result 6. Third and more surprisingly, when focusing on successful groups, we document a positive difference between the intermediary's contributions and the delegated amounts in both treatments, with its size being somewhat bigger in *Del* than in *DelRule*. Table 6 formally investigates the validity of the previous graphical observations.

According to a (two-sided) Mann-Whitney rank-sum test, over all periods, there are no significant differences in group's aggregate contributions to the financed collective account between *Del* and *DelRule* ($p = 0.493$). Nevertheless, we document remarkable differences in the way in which delegation is used in the two treatments. First, the presence of the destination rule significantly increases the groups' willingness to trasfer money to the intermediary (for the difference in the delegated amounts between *Del* and *DelRule*, $p = 0.002$). Second, in order to reach the threshold and due to the difference in the delegated amounts, the intermediary contributes a larger share of her own endowment in *Del* than in *DelRule* ($p = 0.014$). A reasonable explanation of this result is that, by providing an insurance to group members against the risk of expropriation by the intermediary, the destination rule stimulates delegation and, therefore, reduces the necessity of the intermediary to use their own money to reach the threshold.

Result 7. With multiple collective accounts, the destination rule makes delegation more effective within successful groups: it increases the delegated amounts and reduces the necessity for the intermediary to use her own endowment to reach the threshold.

TABLE 6. Delegated amounts and contributions in successful groups with multiple collective accounts

Period	1	1 − 4	5	5 − 8	9	9 − 12	12	*All*
Group's cont.								
Del	135.000	143.764	133.250	142.242	132.000	141.000	139.000	141.807
DelRule	139.667	143.026	137.167	141.859	136.333	135.794	132.625	139.915
Del − DelRule	−4.667	0.738	−3.917	0.383	−4.333*	5.206	6.375**	1.892
Del. am.								
Del	97.286	87.194	91.250	71.017	90.667	72.125	48.500	78.701
DelRule	109.556	103.099	102.333	100.823	100.250	135.794	100.375	101.940
Del − DelRule	−12.270	−15.905*	−11.083	−29.806***	−9.583	−63.669***	−51.875**	−23.239***
Int.'s cont.								
Del	36.286	42.215	41.750	46.075	41.333	45.75	52.500	43.789
DelRule	27.000	34.526	31.167	36.224	34.000	33.211	31.750	33.792
Del − DelRule	9.286	7.689	10.583	9.851*	7.333	12.539**	20.750**	9.997**
Others' cont.								
Del	1.429	14.354	0.250	25.150	0.000	23.125	38.000	19.317
DelRule	3.111	5.401	3.667	4.813	2.083	1.8	0.500	4.182
Del − DelRule	−1.682	8.593*	−3.417	20.337**	−2.083	21.325	37.500**	15.135*
Obs.	26	28	16	26	15	21	10	30

Notes. This table reports the mean delegated amounts, the mean of the group's aggregate contributions, the mean of the intermediary's contributions, and the mean contributions made by the other three non-intermediary group members to the financed collective account in *Del* and *DelRule*, by restricting the attention to successful groups. The table also shows results from a nonparametric (two-sided) Wilcoxon rank sum tests for the null hypotheses that means in the two treatments are the same. The other remarks of Table 2 apply.

5.4.1. *Intermediary's behavior.* The previous evidence suggests that only in *DelRule* is delegation successfully used by group members to increase the likelihood of coordination. We now focus on the intermediary's behavior to investigate its determinants and its effects on contributions and delegated amounts.

Table 7 reports frequency of alternative types of intermediary behavior in *Del* and *DelRule*, by using the following three categories: (a) crowding-in, occurring when the intermediary contributes more than the delegated amounts, (b) expropriation, referring to a situation in which the intermediary contributes less than what is transferred by the group, and (c) balance, namely when the intermediary's total contributions coincide with the delegated amounts. In all cases, we restrict out attention to observations that are associated with strictly positive delegated amounts. Of course, due to the presence of the destination rule, expropriation cannot be observed in *DelRule*.

Over all periods, 36.6% of the intermediaries in *Del* expropriate resources received from group members in the delegation phase, with the large majority (31.5%) of these cases being associated with full expropriation (namely, the intermediary contributes nothing and entirely expropriates the delegated amounts). The proportion of intermediaries contributing more than what is received from the group is substantially larger in *DelRule* (68.5%) than in *Del* (42.6%), with the difference being highly significant according to a proportion test ($p < 0.001$).

What factors contribute to the intermediary's behavior? On the one hand, conditional reciprocity might induce the intermediary to contribute a larger portion of their own endowment when faced with larger transfers from others in the group. When others are perceived to be doing their part to reach a threshold, the intermediary may feel compelled to do the same. Moreover, at a more fundamental level, higher contributions from others, thereby providing the intermediary with enough funding to unilaterally reach the threshold, can increase the viability of a collective account and minimize the risks of miscoordinating contributions. On the other hand, the intermediary may have incentives to expropriate transfers. This is the case if she does not expect expropriation to trigger players to coordinate on substantially worse outcomes in the future. It may also occur when donors do not provide sufficient transfers to bring the collective account thresholds within reach of the intermediary.

TABLE 7. Intermediary's behavior with multiple collective accounts

Period	1	1 − 4	5	5 − 8	9	9 − 12	12	*All*
Del								
$f(Expropriation)$	0.389	0.361	0.500	0.361	0.500	0.375	0.222	0.366
$Cont. - Del.Am.$	−46.857	−40.846	−40.111	−41.038	−36.222	−41.296	−38.250	−41.063
$f(Balance)$	0.000	0.000	0.000	0.000	0.000	0.014	0.000	0.005
$f(Crowding - in)$	0.611	0.556	0.389	0.458	0.222	0.264	0.222	0.426
$Cont. - Del.Am.$	36.000	40.500	36.857	43.152	39.750	44.842	46.250	42.348
DelRule								
$f(Balance)$	0.500	0.319	0.333	0.250	0.333	0.306	0.444	0.292
$f(Crowding - in)$	0.500	0.681	0.667	0.736	0.667	0.639	0.444	0.685
$Cont. - Del.Am.$	33.111	34.551	35.750	39.302	38.583	35.261	31.750	36.473
$Obs.\ (per\ treat)$	18	72	18	72	18	72	18	216

Notes. This table reports proportions of the three possible intermediary's behaviors, crowding-in, expropriation, and balance, in *Del* and *DelRule*, as well as the corresponding mean difference between the intermediary's total contributions and the delegated amounts.

In line with these preliminary considerations, Table 8 parametrically investigates the determinants of both the intermediary's contributions and the probability of the two main categories of the intermediaries' behavior: expropriation and crowding-in.

As confirmed by columns (2) and (4), in both *Del* and *DelRule*, the intermediary responds positively to what was transferred by the group, with the response being stronger when group members transfer at least 77 tokens. In particular, the coefficient of $d(Del.Am. \geq 77)$ is positive, large in size, and significant in both treatments (in *Del*, $p = 0.025$; in *DelRule*, $p < 0.001$). Moreover, as confirmed by the positive and highly significant ($p < 0.001$) coefficient of *Del.Am.* in column (2), we find that in *Del* the more group members transfer to the intermediary, the higher the intermediary's own contributions are. Also in *DelRule* the intermediary's contributions respond positively to the delegated amounts although in this case, the relationship is concave (the coefficient of $Del.Am.^2$ is negative, with $p < 0.001$) and reaches its maximum when the delegated amounts approach 130 tokens.

Columns (6) and (8) document a concave relationship between the probability of observing the intermediary's crowding-in and the delagated amounts, as the coefficient of $Del.Am.^2$ is negative and significant in both regressions (in *Del*, $p = 0.020$; in *Del*, $p = 0.061$). Estimates allow us to compute the levels of delegated amounts at which the relationships reach their maximum: 95 tokens in *Del* and 109 tokens in *DelRule*, respectively. When focusing on *DelRule*, we also find that the probability of observing the intermediary's crowding-in increases when the group transfers at least 77 tokens (the coefficient of $d(Del.Am. \geq 77)$ is positive, with $p = 0.004$), but decreases when the delegated amounts are already sufficient to reach the threshold (the coefficient of $d(Del.Am. \geq 132)$ is negative, with $p < 0.001$).

Finally, when looking at results in column (10), we find that the probability of observing expropriation decreases when the intermediary receives at least 77 tokens from the group in the delegation phase (the coefficient of $d(Del.Am. \geq 77)$ is negative, with $p = 0.001$). However, the previous effect is somewhat counterbalanced by the positive and significant effect of the delegated amounts ($p = 0.018$), thus confirming that the more group members transfer to the intermediary, the larger her incentive becomes to expropriate resources.

Table 8. Contributions, crowding-in, and expropriation by the intermediary: parametric analysis

	Total contributions				Pr(Crowding − in)				Pr(Expropriation)	
	Del		DelRule		Del		DelRule		Del	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$d(Del.Am. \geq 77)$	67.150***	25.099**	58.857***	29.678***	0.429***	0.066	0.419***	0.189***	−0.199***	−0.440***
	(7.847)	(11.199)	(4.118)	(4.147)	(0.045)	(0.127)	(0.022)	(0.065)	(0.074)	(0.127)
$d(Del.Am. \geq 132)$			18.594***	13.405**			−0.488***	−0.389***		
			(7.149)	(6.419)			(0.075)	(0.091)		
$Del.Am.$		0.754***		1.794***		0.014***		0.013**		0.004**
		(0.145)		(0.133)		(0.003)		(0.006)		(0.002)
$Del.Am.^2$				−0.007***		$-7.2 * 10^{-5}$**		$-6.0 * 10^{-5}$*		
				(0.001)		$(3.1 * 10^{-5})$		$(3.2 * 10^{-5})$		
$cons$	30.695***	7.456	68.803***	−5.647						
	(6.751)	(6.567)	(4.786)	(4.895)						
$ll(lpl)$	−1116.023	−1105.243	−981.442	−904.625	−125.321	−104.502	−77.598	−68.502	−138.020	−134.465
$Wald - \chi^2$	73.24	123.23	225.58	964.02	26.81	36.55	42.42	57.32	6.99	11.70
$p > \chi^2$	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.003
$Obs.$	216	216	216	216	216	216	216	216	216	216

Notes. Columns (1)-(4) of this table report coefficient estimates (standard errors in parentheses) from two-way linear random effects models accounting for both potential individual dependency over periods and dependency within group and using the intermediary's total contributions as dependent variable. Columns (5)-(10) report Probit marginal effect estimates (robust standard errors clustered at the group level in parentheses) over all periods. In particular, models in columns (5)-(8) use a dummy that takes a value of 1 if the intermediary's total contributions are (strictly) greater than the delegated amounts as dependent variable. Models in columns (9)-(10) use a dummy that takes a value of 1 if the intermediary's total contributions are (strictly) lower than the delegated amounts as dependent variable. $Del.Am.$ ($Del.Am.^2$) is the (square of the) delegated amounts. $d(Del.Am. \geq 77)$ and $d(Del.Am. \geq 132)$ are dummies that take a value of 1 if the delegated amounts are (weakly) greater than 77 and 132, respectively. In models that refer to Del, we exclude $d(Del.Am. \geq 132)$ from the covariates because of lackness of observations. Indeed, in this treatment, there is a single observation (out of 216) in which the intermediary received more than 132 tokens from the group. $Del.Am.^2$ is excluded from models in columns (2), (6), and (10) because its coefficient is never significant. The other remarks of Table 1 apply.

Result 8. With multiple collective accounts, both contributions and the probability of observing crowding-in positively depending on the delegated amounts, with the relationship being particularly pronounced up to the level that allows the intermediary to reach the threshold. The probability of observing the expropriation by the intermediary in *Del* is stimulated by the delegated amounts, although it substantially decreases when the group transfers enough resources to allow the intermediary to reach the threshold.

The last step in analyzing the intermediary's behavior is aimed at assessing its effects on the behavior of the other group members. As highlighted in the theoretical section, the repeated nature of the experiment allows for the possibility of dynamic conditional strategies. Delegation and cooperation may be sustained in *Del* through strategies in which observing the expropriation of transfers in one period leads players to behave less cooperatively in the future. We parametrically investigate these intuitions in Table 9. In particular, the table analyzes the effects of the intermediary's crowding-in and expropriation on the group's aggregate contributions and the delegated amounts, by accounting for the number of times that specific behavior has occurred.

TABLE 9. The effects of the intermediary's behavior on contributions and delegated amounts: parametric results

	Total contributions				Delegated amounts			
	Any amount		Full		Any amount		Full	
	Crowd − in	*Exprop.*	*Crowd − in*	*Exprop.*	*Crowd − in*	*Exprop.*	*Crowd − in*	*Exprop.*
From 1st occurrence	0.787	−7.812*	0.186	−7.188*	−0.623	−4.522***	1.586	−3.386**
	(3.502)	(4.127)	(2.803)	(3.928)	(1.248)	(1.451)	(1.071)	(1.400)
From 2nd occurrence	1.703	−10.079**	4.209	−11.455***	0.065	−9.821***	−0.926	−9.406***
	(3.669)	(4.127)	(4.287)	(4.157)	(1.328)	(1.492)	(1.601)	(1.521)
From 3rd occurrence	4.032	−13.435***	3.804	−17.771***	0.471	−13.071***	1.597	−14.886***
	(3.851)	(4.567)	(4.742)	(4.755)	(1.377)	(1.647)	(1.756)	(1.729)
From 4th occurrence	4.762	−14.609***	−2.219	−21.731***	2.078	−15.739***	−0.446	−20.825***
	(3.951)	(5.407)	(5.667)	(7.985)	(1.410)	(1.946)	(2.137)	(2.794)
Del	−0.227		0.024		−4.442*		−5.632**	
	(4.574)		(4.072)		(2.694)		(2.661)	
DelRule	4.693		5.247					
	(4.216)		(3.644)					
Cons	24.457***		24.457***		28.318***		27.791***	
	(2.606)		(2.484)		(1.949)		1.852	
ll	−13042.316		−13042.811		−5055.255		−5056.624	
$Wald - \chi^2$	40.10		41.38		194.92		191.13	
$p > \chi^2$	0.011		0.002		0.000		0.000	
Obs.	2592		2592		1296		1296	

Notes. Results reported in this table are based on two-way linear random effects models accounting for both potential individual dependency over periods and dependency within group. The dependent variable in the first two models is the total contributions made by the subject to the twelve collective accounts in the period in *NoDel* (used as baseline), *Del*, and *DelRule*. The dependent variable in the last two models is the delegated amounts in *Del* and *DelRule* (used as baseline). The covariates in the first and third models are the treatment dummies, *Del* and *DelRule*, the constant, 9 dummies, $d_{exp}(1), ..., d_{exp}(9)$, for situations in which the intermediary expropriates delegated resources, and 11 dummies, $d_{crowd-in}(1), ..., d_{crowd-in}(11)$ for situations characterized by the intermediary's crowding-in. The generic dummy $d_{exp}(s)$ ($d_{crowd-in}(s)$) assumes value 1 from the period after the group observes for the s-th time the intermediary contributing less (more) than what received from the group in the delegation phase. The only difference in the second and fourth models is that, in these specifications, there are 9 dummies for expropriation, 8 dummies for crowding-in, and the definitions used to build the dummies is more restrictive as it refers to full expropration (full crowding-in), namely when the intermediary received strictly positive transfers from the group and contributed nothing (her overall endowment). The table reports tests for linear combinations across the first four dummies of crowding-in (expropriation). Results remain qualitatively unchanged when we include a set of interaction terms between the dummies capturing crowding-in and the treatment dummies (which, moreover, are found to be never significant). The other remarks of Table 1 apply.

Results suggest that controlling for the intermediary's crowding-in and expropriation substantially reduces differences in contributions across treatments. Indeed, for both types of intermediary's behaviors and under both the general and the more restrictive definitions, treatment dummies, as well as their difference, are not significant any longer (in the first model, $p = 0.960$ for *Del*, $p = 0.266$ for *DelRule*, and $p = 0.269$ for their difference; in the second model, $p = 0.995$ for *Del*, $p = 0.150$ for *DelRule*, and $p = 0.194$ for their difference). Moreover, as expected, while experiencing crowding-in does not seem to substantially affect contributions, the cumulative effects of observing expropriation for the first, the second, the third, and the fourth time are significant and monotonically increase in magnitude (passing from -7.812 to -14.609 in the first model and from -7.188 to -21.731 in the second model).

Moving to the delegated amounts, while the main considerations on the significance and magnitude of the effects of the intermediary's crowding-in and expropriation are confirmed, in the last two models we document a significant difference between *Del* and *DelRule*. Indeed, after including the crowding-in and expropriation covariates, the coefficient of the treatment dummy *Del* is marginally significant in the first model ($p = 0.099$) and significant in the second model ($p = 0.034$).

Result 9. With multiple collective accounts, observing the intermediary expropriating delegated resources in *Del* substantially reduces the group's contributions and the delegated amounts in subsequent periods. On the other hand, in both *Del* and *DelRule*, observing intermediary's crowding-in does not exert any relevant effect on the group's behavior.

5.5. **Treatments with a single collective account.** In order to investigate the interplay between delegation and multiplicity of public goods, the Appendix provides a detailed analysis of the three alternative treatments in which there is only one collective account, as opposed to the 12 collective accounts in the primary treatments considered in the previous pages. Here, we provide a brief summary of the main results.

With a single collective account, coordination among donors is likely to be easier than in the setting with multiple collective accounts. This is because successfully funding a single public good only requires that subjects contribute enough in total to reach the threshold; there is no risk that subjects contribute enough to reach a threshold, but inefficiently spread their contributions out across different goods. It is this aspect of miscoordination that delegation most-directly addresses. Therefore, we expect delegation to be potentially less effective at improving donor coordination and payoffs in the single public good environment. At the same time, in the environment with unrestricted delegation, the risk of expropriation by the intermediary is independent of the number of collective accounts. Therefore, we expect that the lack of a destination rule in a delegation environment has a similar detrimental effect on coordination and payoffs with a single public good as it had in the multiple public good setting. The experimental evidence is generally consistent with these expectations.

Figure 5 shows the mean contributions to the single collective account and the mean earnings over periods in *NoDel*[1], *Del*[1] and *DelRule*[1].

Averaging over all periods, subjects contribute 30.51 tokens in *NoDel*[1], 20.63 in *Del*[1] and 31.22 tokens in *DelRule*[1]. In all periods, contributions in *DelRule*[1] are well above those in *Del*[1], suggesting that even in the setting with a single collective account, the destination rule strongly increases group's overall contributions. No remarkable difference is observed between *NoDel*[1] and *DelRule*[1], while contributions in *Del*[1] are lower than those in the other two treatments. These observations are confirmed by non parametric tests. According to a two side Mann-Whitney rank-sum test, mean contributions (over all periods) in *Del*[1] are significantly lower than those in *DelRule*[1] ($p = 0.019$) and *NoDel*[1] ($p = 0.025$), while no difference is detected between *DelRule*[1] and *NoDel*[1] ($p = 0.912$). When accounting for multiple null hypotheses testing, both the differences between *Del*[1] and *DelRule*[1], and between *Del*[1] and *NoDel*[1] remain significant (for the former: $p = 0.017$; for the latter: $p = 0.032$).

Contrary to what is observed with multiple collective accounts, there is no reshuffling of the efficient collective accounts, and no corresponding decrease in contributions in periods 1, 5 and 9 in the single public good case. Finally, even in the single public good environment, contributions tend to decline over periods in treatments *NoDel*[1] and *Del*[1]. Contributions in *DelRule*[1] are relatively more stable

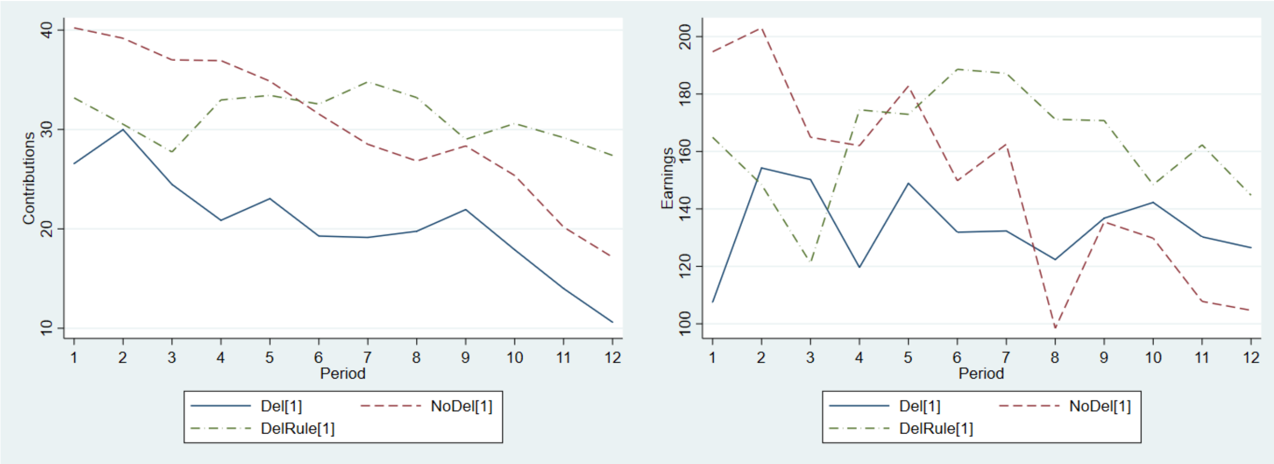

FIGURE 5. Contributions and earnings with a single collective account, by treatment and period.

over periods, suggesting that it is easier to maintain cooperation in the delegation environment with a destination rule than in an environment without delegation.[8]

We observe a similar pattern in mean earnings. Averaging over all periods, subjects earn 149.67 points in $NoDel[1]$, 133.58 points in $Del[1]$, and 162.93 points in $DelRule[1]$. $Del[1]$ exhibits the worst earning performance over periods, confirming the fact that, with a single collective account and no destination rule, delegation undermines cooperation. According to a Mann-Whitney rank-sum test (two-sided), both the difference between $Del[1]$ and $NoDel[1]$ as well as the difference between $Del[1]$ and $DelRule[1]$ are negative, although only in the latter, it reaches statistical significance (in the first case: $p = 0.146$; in the second case: $p = 0.025$). The difference between $Del[1]$ and $DelRule[1]$ remains significant when accounting for multiple null hypotheses testing ($p = 0.070$).

Moving to groups' ability to successful finance the public good, over all periods, $DelRule[1]$ is associated with the highest percent of successful contribution (63.9%), followed by $NoDel[1]$ (53.7%) and $Del[1]$ (35.6%). According to a Mann-Whitney rank-sum test (two sided), only the difference between $Del[1]$ and $DelRule[1]$ is significantly different from 0 ($p = 0.026$). Instead, the other two differences are less pronounced, reaching marginal significance between $NoDel[1]$ and $Del[1]$ ($p = 0.069$) and being not significant between $NoDel[1]$ and $Del[1]$ ($p = 0.238$). When accounting for multiple null hypotheses testing, only the difference between $DelRule[1]$ and $Del[1]$ remains significant ($p = 0.040$). Thus, with a single collective account, delegation is either useless (when comparing $DelRule[1]$ with $NoDel[1]$) or detrimental for successful provision of the collective account (when comparing $Del[1]$ with $NoDel[1]$).

In aggregate, the results from the treatments with a single collective account are consistent with our expectations. Delegation with a destination rule is less important for facilitating cooperation in the single public good environment than it is in the multiple public good environment, as evidenced by the smaller differences between the outcomes in $DelRule[1]$ and $NoDel[1]$ than were previously observed between *DelRule* and *NoDel*. At the same time, the presence of unrestricted delegation in $Del[1]$ is detrimental for contributions, coordination and payoffs, just as previously observed in *Del*. The detrimental effects of unrestricted delegation are perhaps even more surprising in the single public good environment than it was with multiple public goods. Subjects could simply ignore the intermediary; any strategies that were possible in the no-delegation environment are also possible in the single public good environment. Although this is also true in the multiple threshold public good environment, the fact that delegation has less benefit may make ignoring delegation a more-salient strategy in the single public good case.

That unrestricted delegation leads to worse options even when it could easily be ignored suggests that the possibility of delegation increases the perceived risk or strategic complexity associated with contributing directly or through the intermediary. The fact that delegation leads to worse outcomes only in the

[8]This could be due to the presence of an intermediary. But, it could also be due to fact that delegation treatments introduce an extra stage in each period, allowing for players to essentially contribute across two phases each period.

unrestricted case and not with the destination rule suggests that it is not the increased complication to the strategic setting introduced by delegation that discourages contributions. Instead, the detrimental effects of unrestricted delegation are consistent with an increase in the perceived uncertainty about the contributions of others and the risk of essentially wasting one's contributions by directing them to an otherwise underfunded good that discourage giving.

By comparing contributions in *NoDel* and *NoDel*[1], the analysis in the Appendix also provides insights into the effects of multiplicity of public goods on contributions and coordination. This investigation is closely related to the analysis conducted by CCV. Among other results, CCV found that contributions and coordination were significantly lower when subjects faced four identical public goods than when they are presented with a single public good; when there were four goods and one good stood out as being more efficient than the other three, contributions were similar to what was observed in the single public good setting. The current multiple public good environment is different from any of the cases considered in CCV in that donors face 12 alternative public goods and four of them stand out as being more efficient than the other eight. In the current environment, multiplicity only plays a marginal role in affecting group performance. Going from an environment with a single public good to one in which there are 12 public goods and four of them stand out as efficient is less detrimental for contributions than going to an environment with only four public goods, all equally efficient. We discuss this difference in more detail in the appendix, but we hypothesize that the efficiency differences between the public goods leads the subjects to initially shift their focus to achieving coordination on an efficient good rather than shifting their attention to a no-contribution strategy.

6. Discussion

Intermediary NGOs, community chest organizations, Telethons and other philanthropic initiatives play prominent roles in charitable giving. They collect contributions from individual donors and coordinate their efforts across causes and projects. Such organizations potentially offer several benefits, from encouraging giving to helping donor learn about the most pressing issues. Of particular interest to the current paper is the role these organizations play in improving the efficiency of philanthropic initiatives, helping facilitate coordination among donors. Intermediary organizations, for example, can direct donors' contributions to a select set of programs, increasing their chance of making a difference, and reducing the risk that well-intentioned donors spread their contributions too thinly across too many programs and causes to have a meaningful impact.

From earlier experiments, we know that such risks of miscoordination among donors can discourage contributions to public goods and lead donors to shy away from charitable giving. This suggests that intermediary organizations, to the extent that they reduce the risk of donor miscoordination, may encourage contributions and increase the success of donor supported programs and projects.

The current paper considers this in a series of lab experiments using threshold public goods, which require donors to coordinate contributions to be successful. This is a similar setting as CCV, except that we add to the environment an intermediary player. Others can choose to provide contributions through the intermediary, to contribute directly to any of several public goods, or to not contribute at all. The intermediary chooses how to allocate their own resources and the contributions provided to her by others across goods.

Perhaps unsurprisingly, we find that under the right conditions, the presence of an intermediary can increase contributions, public good success, and overall welfare. More interestingly, however, we show how the presence of an intermediary can also have the opposite effect, as it discourages contributions and reduces the probability of public goods receiving enough funding to be successful. In our experimental setting, the benefit of an intermediary depends on whether or not the intermediary is formally committed not to redirect donations received from others to uses that may be beneficial to the intermediary but are not preferred by the donors themselves. Although the theoretical analysis shows that formal commitment is not needed for an intermediary for directing delegated contributions to the socially optimal public goods, the experimental analysis finds that formal commitment is essential for encouraging donor contributions and public good success.

Traditionally, the introduction of destination rules in the nonprofit sector has been justified by the necessity to guarantee institutional transparency, justice and correspondence between donors' initial intent and NGOs' actions. Our results add a further economic justification to introduce these formal restrictions.

By reducing the perceived risk that an NGO could misuse donations, destination rules encourage donations, while allowing the intermediary to facilitate coordination across alternative projects, producing substantial welfare improvements for the society.

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TABLE A.1. Total contributions with a single collective account: parametric analysis

Total contribution	(1)	(2)	(3)	(4) $NoDel[1]$	(5) $Del[1]$	(6) $DelRule[1]$
$Del[1]$	-9.882^{***}	-7.936^{***}	-14.481^{***}			
	(3.349)	(2.832)	(4.711)			
$DelRule[1]$	0.703	0.765	-8.028^{*}			
	(3.349)	(2.819)	(0.357)			
$Coord(t-1)$		7.937^{***}	5.065^{*}			
		(1.452)	(2.607)			
$Del[1] * Coord(t-1)$			7.314^{*}			
			(3.743)			
$DelRule[1] * Coord(t-1)$			-0.152			
			(3.560)			
$Trend$		-1.050^{***}	-1.777^{***}	-2.018^{***}	-1.311^{***}	0.053
		(0.187)	(0.357)	(0.184)	(0.276)	(0.593)
$Del[1] * Trend$			0.545			
			(0.479)			
$DelRule[1] * Trend$			1.521^{***}			
			(0.479)			
$d1$				-1.321	-1.151	2.018
				(1.950)	(2.926)	(6.284)
$d5$				1.390	0.564	2.057
				(1.699)	(2.549)	(5.474)
$d9$				2.949^{*}	4.710^{*}	-2.571
				(1.748)	(2.623)	(5.633)
$d12$				-2.191	-2.691	-4.354
				(1.974)	(2.961)	(6.360)
$cons$	30.513^{***}	31.403^{***}	37.404^{***}	41.544^{***}	27.721^{***}	31.162^{***}
	(2.368)	(2.497)	(3.666)	(2.192)	(3.427)	(3.883)
ll	-12516.05	-11415.19	-11407.77	-3530.07	-3874.19	-4500.94
$Wald - \chi^2$	12.49	91.88	109.58	238.20	47.84	1.11
$p > \chi^2$	0.002	0.000	0.000	0.000	0.000	0.953
Obs.	2592	2376	2376	864	864	864

Notes. This table replicates the parametric analysis presented in Table 1 by pooling data from $NoDel[1]$, $Del[1]$, and $DelRule[1]$. $Del[1] * Trend$, $DelRule[1] * Trend$, $Del[1] * Coord(t-1)$, $DelRule[1] * Coord(t-1)$ are interaction terms. The other remarks of Table 1 apply.

Appendix A. Treatments with a single collective account

A.1. **Total contributions.** Table A.1 replicates the parametric analysis of Table 1 by using data from the three treatments with a single collective account.

From column (1), and in line with the results in the setting with multiple collective accounts, delegation with no destination rule discourages contributions. Both the differences between $Del[1]$ and $NoDel[1]$, and between $Del[1]$ and $DelRule[1]$ are negative and highly significant (in the first case, $p = 0.003$; in the second case, $p = 0.002$). Again, although positive, the difference between $DelRule[1]$ and $NoDel[1]$ is not significant ($p = 0.277$).

Result A.1. With a single collective account, subjects make larger contributions in $DelRule[1]$ and $NoDel[1]$ than in $Del[1]$. There is no significant difference in contributions between $DelRule[1]$ and $NoDel[1]$.

TABLE A.2. Mean proportion of successful provision with a single collective account

Period	1	$1-4$	5	$5-8$	9	$9-12$	12	*All*
$NoDel[1]$	0.833	0.764	0.777	0.542	0.444	0.306	0.167	0.537
$Del[1]$	0.278	0.403	0.444	0.347	0.389	0.319	0.222	0.356
$DelRule[1]$	0.667	0.583	0.722	0.750	0.667	0.583	0.500	0.639
$NoDel[1] - Del[1]$	0.555^{***}	0.361^{***}	0.333^{**}	0.195	0.055	-0.013	-0.055	0.181^{*}
$NoDel[1] - DelRule[1]$	0.166	0.181^{**}	0.055	-0.208^{*}	-0.223	-0.277^{**}	-0.333^{**}	-0.102
$Del[1] - DelRule[1]$	-0.389^{**}	-0.180	-0.278^{*}	-0.403^{***}	-0.278^{*}	-0.264^{**}	-0.278^{*}	-0.283^{**}
Obs. (per treat)	18	18	18	18	18	18	18	18

Notes. This table reports mean proportions of successful provision (namely, reaching the threshold on one collective account) over periods in $NoDel[1]$, $Del[1]$, and $DelRule[1]$. The other remarks of Table 3 apply.

Concerning the other determinants of individual contributions, column (2) confirms that even in the setting with a single collective, contributions decline over repetitions (the coefficient of *Trend* is negative and highly significant, $p < 0.001$) and positively respond to the group's successful provision in the previous period (the coefficient of $Cood(t-1)$ is negative and highly significant, $p < 0.001$).

Column (3) documents some differences across treatments in the decaying pattern and the effects of past successful provision on contributions. In particular, the interaction term $DelRule[1] * Trend$ is positive and highly significant ($p < 0.01$), suggesting that the linear time trend is less pronunced in $DelRule[1]$ than in $NoDel[1]$. Similar conclusions emerge when comparing the coefficient of the linear time trend in $Del[1]$ and $DelRule[1]$, as the difference between the two interaction terms, $DelRule[1] * Trend$ and $Del[1] * Trend$, is positive and significant ($p = 0.031$). Moreover, $DelRule[1]$ is the only treatment in which the linear time trend presents a non significant coefficient (for the linear combination of *Trend* and $Del[1] * Trend$: $p = 0.421$). When looking at the effects of the past successful provision, no difference is detected between $NoDel[1]$ and $DelRule[1]$ (for the coefficient of $DelRule[1] * Coord(t-1)$: $p = 0.966$), while the effect is significantly stronger in $Del[1]$ than in the other two treatments (for the coefficient of $Del[1] * Coord(t-1)$: $p = 0.051$; for the difference between the two interaction terms, $DelRule[1] * Coord(t-1)$ and $Del[1] * Coord(t-1)$, $p = 0.039$).

Finally, the last three columns document no remarkable differences in contributions in periods 1, 5, 9, and 12, thus confirming that the effects documented in the setting with multiple collective accounts can be genuinely attributed to the reshuffling procedure used to select the four efficient collective accounts.[9]

A.2. **Successful provision of the collective account.** In the setting with a single collective account, group members do not face the risk of miscoordinating contributions to different alternatives. Nevertheless, even in the single collective account setting, delegation might be effectively used by group members to stimulate cooperation. For instance, by delegating resources, other group members might signal their intention to cooperate to reach the threshold and trigger the delegate's positive response. We investigate these considerations in Table A.2. Results are discussed in the paper.

Result A.2. With a single collective account, delegation either reduces group's ability to reach the threshold when there is no destination rule, or it does not exert any significant effect when the intermediary's choices are constrained by the destination rule.

A.3. **Subjects' earnings.** Table A.3 reports the mean earnings in $NoDel[1]$, $Del[1]$, and $DelRule[1]$ over periods. The results concerning the differences in subjects' earnings across treatments are discussed in the paper.

Result A.3. With a single collective account, delegation is detrimental for subjects' earnings: it either reduces earnings when there is no destination rule, or it does not affect their level when the intermediary's choices are constrained by the destination rule.

[9]Only in $NoDel[1]$ and $Del[1]$ the coefficient attached to the dummy for period 9 is positive and reaches marginal significance, $p = 0.092$ and $p = 0.073$, respectively.

TABLE A.3. Subject's earnings with a single collective account

Period	1	1 − 4	5	5 − 8	9	9 − 12	12	*All*
NoDel[1]	194.722	181.181	182.778	148.396	135.472	119.444	104.694	149.674
NoDel[1] − 110	84.722***	71.181***	72.778***	38.396***	25.472	19.444	−5.306	39.674***
Del[1]	107.528	132.903	148.917	133.875	136.778	133.951	126.500	133.576
Del[1] − 110	−2.472	22.903*	38.917	23.875	26.778	23.951	16.500	23.576
DelRule[1]	164.917	152.250	172.917	179.979	170.750	156.563	144.778	162.931
DelRule[1] − 110	54.917***	42.250***	62.917***	69.979***	60.750***	46.563***	34.778*	52.931***
NoDel[1] − *Del*[1]	87.194***	48.278***	33.861	14.521	−1.306	−14.507	−21.806	16.098
NoDel[1] − *DelRule*[1]	29.805**	28.931**	9.861	−31.583*	−35.278	−37.119**	−40.084	−13.257
Del[1] − *DelRule*[1]	−57.389*	−19.347	−24.000	−46.104**	−33.972	−22.612	−18.278	−29.355**
Obs. (per treat)	18	18	18	18	18	18	18	18

Notes. This table reports mean earnings over periods in *NoDel*[1], *Del*[1], and *DelRule*[1]. The other remarks of Table 4 apply.

A.4. **Delegated amounts and contributions.** The previous results suggest that delegation does not stimulate contributions and the ability to reach the threshold when group members face a single collective account. To better investigate the negative role of delegation, we now focus our attention on the intermediary's contributions and the amounts transferred by the other group members in the delegation phase. Figure A.1 shows the mean delegated amounts and the mean contributions of the intermediary over periods in *Del*[1] and *DelRule*[1]. Table A.4 reports descriptive statistics and results from non parametric tests.

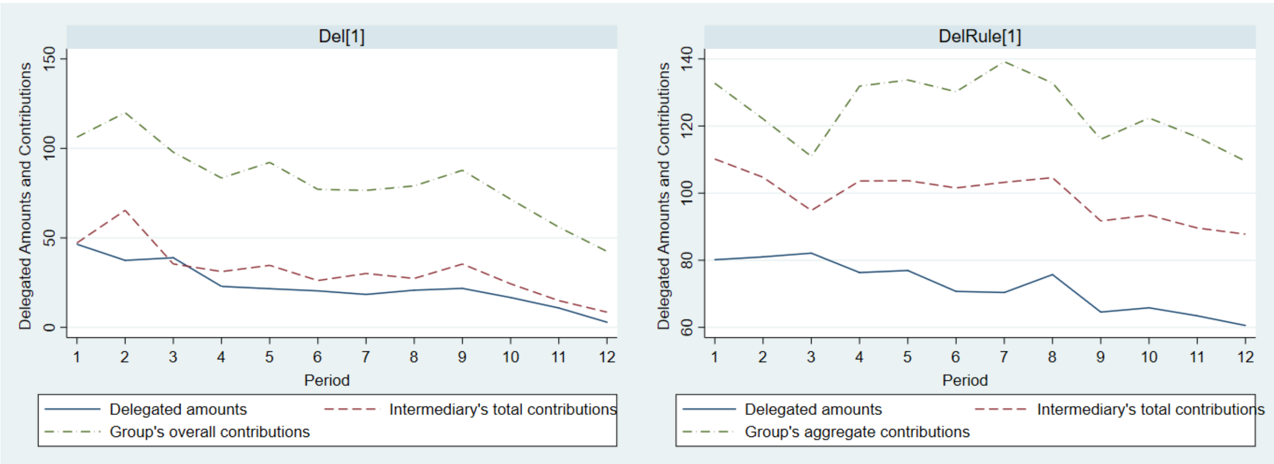

FIGURE A.1. Delegated amounts and contributions with a single collective account, by treatment and period.

Interestingly, although there are relevant differences in their magnitude, the previous graphs confirm the two main empirical observations drawn with multiple collective accounts. First, the delegated amounts are higher when delegation is combined with the destination rule. Indeed, across all periods, the mean delegated amounts are 72.32 tokens in and 23.25 tokens in *DelRule*[1] and *Del*[1], respectively. Second, on average, only in *DelRule*[1] do we observe the intermediaries', total contributions to be higher than the delegated amounts: across all periods, the difference is 26.77 tokens in *DelRule*[1] but drops to 8.47 in *Del*[1].

Over all periods, both the delegated amounts and the intermediary's total contributions in *DelRule*[1] are substantially higher than those in *Del*[1]. According to a Mann-Whitney rank-sum test (two-sided), for both variables, the differences between *Del*[1] and *DelRule*[1] are negative and highly significant (for the delegated amounts, $p < 0.001$; for the intermediary's total contributions, $p < 0.001$) and remain highly significant after accounting for multiple null hypotheses testing (for both the delegated amounts

TABLE A.4. Delegated amounts and the intermediary's total contributions with a single collective account

Period	1	$1-4$	5	$5-8$	9	$9-12$	12	*All*
Del. am.								
Del[1]	46.444	36.417	21.611	20.292	21.778	13.042	2.889	23.250
DelRule[1]	80.167	79.903	76.944	73.444	64.556	63.597	60.556	72.315
Del[1] − *DelRule*[1]	-33.723^{***}	-43.486^{***}	-55.333^{***}	-53.152^{***}	-42.778^{***}	-50.555^{***}	-57.667^{***}	-49.065^{***}
Int.'s Cont.								
Del[1]	47.167	44.792	34.667	29.569	35.389	20.792	8.500	31.718
DelRule[1]	110.167	103.333	103.722	103.278	91.722	90.639	87.778	99.083
Del[1] − *DelRule*[1]	-63.000^{***}	-58.541^{***}	-69.055^{***}	-73.709^{***}	-56.333^{***}	-69.847^{***}	-79.278^{***}	-67.365^{***}
Int.'s cont. − Del.am.								
Del[1]	0.723	8.375	13.056	9.277	13.611^{**}	7.750	5.611	8.468^{*}
DelRule[1]	30.000^{***}	23.430^{***}	26.778^{***}	29.834^{***}	27.166^{***}	27.042^{***}	27.222^{***}	26.768^{***}
Obs. (per treat)	18	18	18	18	18	18	18	18

Notes. This table reports mean delegated amounts and the mean of the intermediary's total contributions over periods in *Del*[1] and *DelRule*[1]. The other remarks of Table 5 apply.

and the intermediary's total contributions, $p < 0.001$). Moreover, even in the single collective account setting, the intermediary contributes significantly more than what is received from the group in *DelRule*[1] ($p < 0.001$), while the difference, although still positive, is only marginally significant in *Del*[1] ($p < 0.067$).

Result A.4. Even with a single collective account, the destination rule increases the delegated amount and on average induces the intermediary to contribute 37.02% more than what is transferred by the group.

Appendix B. Impact of multiplicity on group performance

The last part of our analysis focuses on the pure effects of introducing multiple collective accounts on group performance. In their study, CCV find a strong, negative effect of multiplicity on contributions, subjects' earnings and the group's ability to reach the threshold. In particular, they identify the negative effect of multiplicity by comparing results from the same benchmark treatment with a single collective account with a setting in which subjects could contribute to four identical collective accounts. In addition, the authors find that enhancing salience facilitates contributions and coordination only when the salient collective account stands out as the most efficient alternative.

Since the present study is aimed at analyzing the effects of delegation in a threshold public good experiment with multiple alternatives, we deliberately decided to design *NoDel* as a hybrid version of the CCV treatment with four identical collective accounts. Indeed, subjects in *NoDel* faced twelve collective accounts, four of which were reshuffled every four periods and were thus indistinguishable but still associated with a higher bonus relative to the remaining eight alternatives. Of course, this ad-hoc design feature of *NoDel* is motivated by our interest in assessing the role of delegation in a setting that is characterized by the risk of miscoordinating contributions across multiple alternatives. However, it might also alter the pure (negative) effect of multiplicity (as documented by CCV), as subjects in *NoDel* might respond to the presence of the four salient and efficient alternatives by increasing their contributions.[10] Table A.5 parametrically assesses the effects of multiplicity by comparing individual contributions, proportions of successful provision and earnings between *NoDel* and *NoDel*[1].

Estimates in columns (1), (3), and (5) suggest that when not controlling for differences between treatments in the linear time trend and the effects of past successful provision, multiplicity plays only a marginal role in affecting group's performance. Indeed, as shown by estimates in column (1), although negative, the coefficient of *NoDel* is not significant ($p = 0.103$) thus confirming no remarkable difference in contributions between *NoDel* and *NoDel*[1]. Similar conclusions emerge when looking at earnings and

[10]This intuition finds supporting evidence in Result 3 which confirms that, even in *NoDel*, subjects contribute substantially more to the efficient collective accounts.

TABLE A.5. The effects of multiplicity on total contributions, earnings, and the proportions of successful provision

	Total contributions		*Earnings*		*Successful provision*	
	(1)	(2)	(3)	(4)	(5)	(6)
$NoDel$	-6.056	-11.158^{***}	-16.278	-63.543^{***}	-0.144	-0.287^{**}
	(3.711)	(4.135)	(12.460)	(15.895)	(0.101)	(0.137)
$Trend$		-1.973^{***}		-8.360^{***}		-0.052^{***}
		(0.173)		(0.808)		(0.012)
$NoDel * Trend$		1.069^{***}		10.787^{***}		0.048^{***}
		(0.232)		(1.086)		(0.014)
$Coord(t-1)$		1.881		6.385		0.427^{***}
		(1.328)		(6.188)		(0.085)
$NoDel * Coord(t-1)$		-0.330		-14.316		0.013
		(1.872)		(8.715)		(0.140)
$cons$	30.513^{***}	40.398^{***}	149.674^{***}	192.094^{***}		
	(2.624)	(3.046)	(8.810)	(11.920)		
ll	-7241.05	-6520.89	-9813.55	-8872.90	-293.91	-220.73
$Wald - \chi^2$	2.66	227.38	1.71	163.70	1.95	91.38
$p > \chi^2$	0.103	0.000	0.191	0.000	0.163	0.000
$Obs.$	1728	1584	1728	1584	432	396

Notes. Results reported in this table are obtained by pooling data from $NoDel[1]$ and $NoDel$. Columns (1)-(4) of the table report coefficient estimates (standard errors in parentheses) from two-way linear random effects models accounting for both potential individual dependency over periods and dependency within-group. The dependent variable in columns (1) and (2) is the overall contribution made by the subject to the twelve collective accounts in the period. The dependent variable in columns (3) and (4) is subject's earnings in the period. Columns (5) and (6) report Probit marginal effect estimates (robust standard errors clustered at the group level in parentheses) over all periods and using a dummy that takes a value of 1 if the aggregate contributions made by members of the group in the period is (weakly) greater than the threshold, 132. The other remarks of Table (1) apply.

probability of successful contributions. From columns (3) and (5), $NoDel[1]$ and $NoDel$ do not significantly differ either in earnings ($p = 0.191$) or in the ability of groups to reach the threshold ($p = 0.157$).

As suggested by columns (2), (4) and (6), the previous results substantially change when accounting for treatment specific effects of the linear time trend and past successful provision.

Looking at contributions, both $NoDel[1]$ and $NoDel$ exhibit a significant decaying pattern (both the coefficient of *Trend* and the linear combination of *Trend* and $NoDel * Trend$ are negative, with $p < 0.001$). In both treatments the past successful provision plays no significant role in inducing subjects to contribute (neither the coefficient of $Coord(t-1)$ nor the linear combination of $Coord(t-1)$ and $NoDel * Coord(t-1)$ are significant, with $p = 0.157$ and $p = 0.240$, respectively). Interestingly, when controlling for the additional covariates, the difference in contributions between $NoDel$ and $NoDel[1]$ becomes highly significant (for the coefficient of $NoDel$: $p = 0.007$).

Moving to subjects' earnings in column (4), we detect a strong difference in the effect of the linear time trend between $NoDel[1]$ and $NoDel$ (for the coefficient of $NoDel * Trend$: $p < 0.001$). In particular, while earnings in $NoDel[1]$ significantly decrease over repetitions (the coefficient of *Trend* is negative with $p < 0.001$) they exhibit an increasing time pattern in $NoDel$ (the linear combination of *Trend* and $NoDel * Trend$ is positive, $p < 0.001$). Again, the past successful provision has no significant effects on earnings (both the coefficient of $Coord(t-1)$ and the linear combination of $Coord(t-1)$ and $NoDel * Coord(t-1)$ are not significant, with $p = 0.302$ and $p = 0.196$, respectively). As for contributions, after including treatment specific covariates in the regression, the difference in earnings between $NoDel[1]$ and $NoDel$ becomes negative and highly significant (for the coefficient of $NoDel$: $p < 0.001$).

Finally, column (6) focuses on the probability to reach the threshold. We detect a significant decaying pattern in $NoDel[1]$ (for the coefficiet of *Trend*: $p = 0.036$) while $NoDel$ exhibits no significant time trend (for the linear combination of *Trend* and $NoDel * Trend$: $p = 0.568$). The past successful provision makes groups more able to reach the threshold in both $NoDel[1]$ and *NoDel* (for both the coefficient of $Coord(t-1)$ and the linear combination between $Coord(t-1)$ and $NoDel * Coord(t-1)$: $p < 0.001$), with no significant difference in the effect being detected between the two treatments (for the coefficient of $NoDel * Coord(t-1)$: $p = 0.924$). As with contributions and earnings, after controlling for the additional covariates, the negative effects of multiplicity on groups' ability to reach the threshold become significant (for the coefficient of *NoDel*: $p = 0.036$).

Appendix C. Theoretical Analysis

In this Appendix section, we present an analysis of the game theoretic model of multiple threshold public goods described in the body of the paper.

C.1. **One-shot threshold public good game.** Consider first the threshold public good environment without delegation as presented in the body of the paper. For the purpose of theoretical analysis, we initially allow for players to differ in their endowments, $\hat{y}_j \geq 0$. To maintain consistency with the experimental setting, assume there are four players, $J = 4$, and four public goods, $N = 4$, each with bonus level $b_n = 30$ and contribution threshold $\tau = 132$.

When $\hat{y}_j = 55$ for each player, this environment describes the game without delegation. Assuming asymmetric endowments sum to 220 (i.e. $\sum_j \hat{y}_j = 220$) we are then describing the contribution stage of the unrestricted delegation game. For now, we focus on pure strategy Nash Equilibria of this environment.

From the perspective of any player, the marginal benefit of an additional contribution to any public good is 0 below the threshold, 1 above the threshold, and 162 ($= \tau + b_n$) for the contribution that brings the total contribution to the threshold. The marginal benefit of a contribution to a player's private account is 2.

First, we can establish that there does not exist an equilibrium in which any public good is funded above its threshold. Given that the marginal benefit of a contribution to one's public account exceeds the marginal benefit to an individual player of a contribution above the threshold of a public account, the players would always have an incentive to reduce their contribution to a public good that is funded in excess of its threshold.

Second, we can establish that there does not exist an equilibrium in which any public good receives positive contributions below its threshold. Any player that contributed to an underfunded good would have an incentive to deviate and instead direct their contributions to their private account (or potentially to increase their contribution such that total contributions reach the threshold).

Therefore, any equilibrium must involve either no contributions to any good, or contributions to only one good with total contributions equal to the threshold, τ.

Now, we determine player j's best response contribution given the contribution strategies of other players. Suppose that the total contributions of all players besides j to public good n sum to C_{-j}.

If $\hat{y}_j < \tau - C_{-j}$, then player j cannot afford a contribution level that ensures that the public good reaches its threshold. In this case, player j's best response regarding good n is to contribute nothing. Similarly, if $\tau \leq C_{-j}$, then the public good reaches its threshold regardless of any contribution level from j and j's best response is again to contribute nothing.

The more interesting case involves $0 < \tau - C_{-j} \leq \hat{y}_j$. Here, player j can afford a contribution that funds the public good at its threshold. We already know that j prefers not to provide a contribution that leads to group's aggregate contributions falling below or above the threshold. Therefore, we must determine when j prefers to contribute $c^* = \tau - C_{-j}$ versus when j prefers to direct that amount to his private account.

Directing contribution c^* to good n results in a benefit to player j from this contribution of $\tau + b_n = 162$. In contrast, directing $c^*_{j,n}$ to the private account results in benefit of $2c^*_{j,n} = 264 - 2C_{-j}$. When $\hat{y}_j > c^*_{j,n}$, player j's best response involves contributing if

$$264 - 2C_{-j} \leq 162 \;\Rightarrow\; 51 \leq C_{-j}.$$

Players want to contribute to a good only if they expect that the contributions from others are at least 51. This shows that a player would never want to unilaterally fund a public good, which then implies that there is an equilibrium in which no player contributes to any good.

Players are willing to contribute up to $132 - 51 = 81$ to a good if it means that the good will reach its threshold. In the case where $\hat{y}_j \leq 81$ for each player (including the case where $\hat{y}_j = 55$ for each player), this implies that players are willing to contribute their entire endowments if this is what is required to reach the threshold given the contribution profile of others. Therefore, any feasible contribution profile c^* such that players only contribute to good n and total contributions to n equal the threshold is an equilibrium.

In the case where $\hat{y}_j > 81$ for one or more players, the equilibrium contribution profile is restricted to involve contributions of no more than 81 from each player.

Finally, suppose that one of the players, i, chooses how to allocate both her endowment, $\hat{y}_i$, and another source of funds, $\hat{z}_i$. The other players only have their endowments, $\hat{y}_j$. Total funding is the same as before with $\hat{z}_i + \sum_j \hat{y}_j = 220$. This revised environment better captures the contribution stage subgame of the delegation environment.

In the case of unrestricted delegation, $\hat{z}_i$ and $\hat{y}_i$ are equivalent from the perspective of player i and the environment is equivalent to one where $\hat{y}_i$ is increased to account for both of i's funds and $\hat{z}_i$ is set to zero. Therefore, the analysis of the unrestricted delegation subgame is captured by the analysis of the asymmetric endowment game above.

In the case with a destination rule, player i is restricted in that its contribution to a public good must be at least $\hat{z}_i$. Player i will have an incentive to use $\hat{z}_i$ effectively and direct it to the funded public good, if feasible. This means that player i's best response depends on $\hat{z}_i$ in much the same way that the best responses of others depend on C_{-j} as described in the above analysis. Player i prefers to contribute to a public good if

$$\tau - C_{-i} \leq \hat{z}_i + \hat{y}_i \quad \text{and} \quad 51 \leq C_{-i} + \hat{z}_i.$$

If $\hat{z}_i \geq \tau - C_{-i}$, then i prefers to contribute $c_i = \hat{z}_i$. If i prefers to contribute and $\hat{z}_i < \tau - C_{-i}$, then i prefers $c_i = \tau - C_{-i}$. The other players still prefer to contribute when $51 < C_{-j}$.

In this environment, player i is willing to contribute up to $\hat{z}_i + \min\{\hat{y}_i, 81\}$ to reach the threshold of a good. In the case where $\hat{y}_i = 55$, player i is willing to unilaterally fund a public good at its threshold as long as $\hat{z}_i \geq 132 - 55 = 77$, and there will be equilibria where i contributes $c_i = \tau$ and others contribute nothing. There are other equilibria in such an environment as well, including those that exist with unrestricted delegation and others that involve player i contributing more than $\hat{z}_i$ but less than τ to a good that also receives funding from other players.

An equilibrium refinement. In our multiple threshold public good environment, the alternative goods are identical and therefore indistinguishable to the players at the beginning of the game. This means that equilibria that require multiple players to coordinate contributions on the same good, in the absence of communication or focal points, is likely unreasonable. To eliminate these concerns, we can limit attention to player strategies that do not distinguish between the four goods. Specifically, we can relax the focus on pure strategy equilibria and instead consider contribution strategies in which players choose how much to contribute, but randomly choose which good receives these contributions.

Imposing such an equilibrium refinement eliminates equilibria that require players to correctly anticipate which of the goods others will contribute to. When two players contribute, there is now only a 1/4 probability that they both contribute to the same good. When all players contribute, there is only a 1/64 probability that they all contribute to the same good. These low probabilities of successful coordination mean that the expected benefits of contributing are greatly reduced. In the initial multiple threshold public good games with symmetric and asymmetric endowments, there do not exist any equilibria that survive this refinement and in which players contribute to public goods. Only the no-contribution equilibrium survives this refinement.

In the environment with a destination rule on $\hat{z}_i$, whenever there exists equilibria in which player i unilaterally funds a public good, there also exists a payoff equivalent equilibrium in which she unilaterally funds a public good chosen at random. There is no need to coordinate contributions with other players, and therefore randomly choosing which public good to fund does not decrease the probability that a threshold will be reached. This equilibrium survives the refinement requiring that contribution strategies not distinguish between identical goods.

C.2. **Adding a delegation stage to the one-shot game.** Here, we extend the multiple threshold public good framework to allow delegation during an initial stage of the game, as discussed in the body of the paper. In the first (delegation) stage of the game, four players are each endowed with $y = 55$, and one player, say i, is randomly selected to serve as the intermediary. Then the other players must decide how much of their endowments to transfer to player i. Let d_j denote the amount that player j delegates to player i. Let $D = \sum_{j \neq i} d_j$ denote the sum of transfers.

In the contribution stage of the game, all players including i engage in the threshold public good game with multiple alternatives described previously. For all players besides the intermediary, $\hat{y}_j = y - d_j$. For the intermediary, i, $\hat{y}_i = y$ and $\hat{z}_i = D$.

In the game with unrestricted delegation, there does not exist an equilibrium in which non-intermediaries provide contributions only through the intermediary. That is, there does not exist an equilibrium in which players provide transfers to the intermediary with the expectation that the intermediary passes the transfers received along to a public good in the contribution stage. This is because, as we previously established, there does not exist a subgame equilibrium in which player i is willing to unilaterally fund a public good.

This does not mean that there does not exist an equilibrium in which non-intermediaries provide transfers in the unrestricted delegation environment. Such equilibria exist, but they require that other players also contribute directly to the same public good that the intermediary contributes to in the contribution stage of the game. No such equilibria survive an equilibrium refinement requiring that contribution strategies not distinguish between specific goods. The only equilibrium to survive such a refinement is the no-contribution equilibrium in which no player provides a transfer in the delegation stage or a direct contribution in the contribution stage of the unrestricted delegation environment.

In the game with a destination rule, there exist equilibria in which players provide transfers to the intermediary in the delegation stage and only the intermediary provides a contribution to a public good in the contribution stage.

We can restrict attention to equilibria in which each subgame equilibrium survives the refinement requiring that contribution strategies not distinguish between identical goods. This means that players anticipate that the intermediary will unilaterally fund a public good whenever $D \geq 77$ (player i would be willing to fund a good for any $D \geq 51$, but can only afford to do so when D is within y of the threshold). This means that, in any subgame perfect equilibrium under the refinement in which a public good receives funding, the non-intermediaries transfer a total of $D = 77$ to player i in the delegation stage, and player i contributes $c_i = 132$ to a randomly selected good in the contribution stage. In addition to such equilibria, the no-delegation no-contribution equilibrium continues to exist.

C.3. **Repeated game.** The experimental treatments involve twelve rounds of repeated interactions between the players in each group. Therefore, the one-shot analysis applies only to the final round of play. Furthermore, the refinement that focuses attention on strategies that do not distinguish between identical goods only applies in the initial period before differences in past contributions across goods may allow groups to distinguish otherwise identical goods from one another. It is the repeated interaction that may provide rational players an incentive to contribute to goods they do not expect to reach their threshold in early periods with the hopes that early contributions may increase coordination in later periods. Furthermore, the intermediary in the game with unrestricted delegation may not redirect transfers to her private account in order to maintain future cooperation, even if she would have an incentive to expropriate such transfers in a one shot game.

In this section, we establish that the repeated nature of the experimental treatments implies the existence of equilibria in both delegation environments in which players only contribute through the intermediary in most periods.

Establishing this is straightforward for the game with delegation and a destination rule. Such an equilibrium exists for the one-shot version of the game, and therefore continues to exist in each round of the repeated version of the game.

To establish this for the game with unrestricted delegation, we start with a three-round version of the game. Once we establish that two repetitions are enough to sustain an equilibrium in which players only contribute through the intermediary in the first round, it follows that, with additional rounds of the game, we can sustain such strategies as part of an equilibrium in all but the final two rounds of play.

Consider the following subgame perfect equilibrium strategy in the second and third (final) rounds of the repeated interaction.

(1) If, in the previous round, a public good was successfully funded at its threshold and each player contributed no more than 22 to the private account, then contribute 33 directly to the same public good that was previously funded.
(2) Otherwise, delegate nothing and contribute nothing.

If all players adopt such a strategy, then depending on the first round outcome, the second and third rounds will either involve a no-delegation, no-contribution equilibrium or an equilibrium in which players coordinate to successfully fund a public good at its threshold. Unlike in the one-shot game, coordinating contributions on the same public good chosen by other players is feasible here because by the second round of play, the previous successful funding of a good may serve as a focal point.

In the first round of play, the players choose the actions that ensure cooperation in the second round. Each of the non-intermediaries transfers 33 and the intermediary contributes $c_i = 132$ to one of the goods at random. Such a strategy assures a payoff to all players over the two rounds of play equal to

$$(2 \times 22 + 162) \times 3 = 618.$$

The intermediary could expropriate the transfers made by the group in the delegation stage to instead receive

$$(2 \times 154) + (2 \times 55) \times 2 = 308 + 220 = 528.$$

In order to maintain cooperation in the later two rounds, the intermediary does not expropriate contributions in the first round. Similar incentives keep the non-intermediaries from reducing their contribution below 33.

Delegation in the first stage, when the public goods are indistinguishable, does not require that players choose a specific good to which to direct their contributions. Because players contribute through the intermediary who can then randomly choose a public good to which to allocate contributions, this equilibrium survives the refinement that requires strategies to treat indistinguishable goods similarly.

This analysis has established that, in both delegation environments, there are equilibria in which contributing through an intermediary helps groups overcome the coordination problem among donors that arises with multiplicity of public goods. In the unrestricted delegation game, this requires that players employ conditional strategies that are more complicated than the history independent delegation strategies that may be employed by non-intermediaries in the delegation game with destination rule.

Appendix D. Instructions

[Instructions were originally written in Italian. The following sample refers to the treatment *DelRule*]

INSTRUCTIONS

Welcome. Thanks for participating in this experiment. If you follow the instructions carefully you can earn an amount of money that will be paid to you in cash at the end of the experiment. During the experiment you are not allowed to talk or communicate in any way with the other participants. If you have questions raise your hand and one of the assistants will come to you. The rules that you are reading are the same for all participants.

General rules

In this experiment there are 24 persons who will interact for 12 periods. At the beginning of the experiment you will be randomly and anonymously assigned to a group of four people. Therefore, of the other three people in your group you will know neither the identity nor the earnings. Finally, the composition of your group will remain unchanged throughout the experiment.

How earnings are determined

In each of the 12 periods you and each other subject in your group will be assigned an endowment of 55 tokens. Thus, the group will have a total of 220 tokens.

During each period you participate in two consecutive phases.

PHASE 1: How many tokens do you want to transfer to the DELEGATE?

At the beginning of PHASE 1, the computer will randomly select one of the four members of your group to be designated to the role of DELEGATE. If you are selected to play the role of DELEGATE, then you will not make any choice in PHASE 1. On the contrary, if another member of your group is selected to play the role of DELEGATE, then you have to choose how many of the 55 tokens of your initial endowment to transfer to the DELEGATE. At the end of PHASE 1, the computer will inform you about how many tokens have been transferred by the members of your group to the DELEGATE as well as your EFFECTIVE endowment in PHASE 2. In particular, if you are selected to play the role of DELEGATE, you will participate in PHASE 2 with an effective endowment of 55 tokens plus those transferred to you by the other group members. Instead, if another member of your group is selected to play the role of DELEGATE, you will participate in PHASE 2 with an effective endowment of 55 tokens minus what you have transferred to the DELEGATE. Note that, regardless of the choices made your group members in PHASE 1, your group will dispose of 220 tokens in PHASE 2.

PHASE 2: How many tokens do you want to allocate to the PRIVATE ACCOUNT and COLLECTIVE ACCOUNTS?

In PHASE 2, you have to decide how to allocate your effective endowment of tokens between an PRIVATE ACCOUNT and twelve COLLECTIVE ACCOUNTS respectively denominated WHITE, YELLOW, GREEN, RED, LIGHT BLUE, BLUE, GRAY, VIOLET, BROWN, PINK, BLACK and ORANGE. The thirteen accounts generate a return expressed in points according to the following rules.

PRIVATE ACCOUNT. You receive points from the PRIVATE ACCOUNT every time you allocate tokens to it. In particular, for each token allocated by you to the PRIVATE ACCOUNT, you receive 2 points.

COLLECTIVE ACCOUNTS WHITE, YELLOW, GREEN, RED, LIGHT BLUE, BLUE, GRAY, VIOLET, BROWN, ROSE, BLACK and ORANGE. You receive points from any of the twelve COLLECTIVE ACCOUNTS if and only if the number of tokens allocated to it by your group is greater than or equal to a pre-specified number that is called “threshold”. The threshold is the same across the twelve collective accounts and is represented by 132 tokens.

In particular: (a) If the number of tokens allocated to a COLLECTIVE ACCOUNT by your group is less than or equal to the threshold on 132 tokens, then you do not receive any point from those tokens.

(b) If the number of tokens allocated to a COLLECTIVE ACCOUNT by your group is equal to or greater than the threshold of 132 tokens, then:

- for each token allocated by you or by any other person in your group in that COLLECTIVE ACCOUNT, you receive 1 point;

- additionally, you receive a "bonus" in points. The size of the bonus depends on the COLLECTIVE ACCOUNT to which the tokens are allocated. In periods 1, 5 and 9, the computer will randomly select four of the twelve COLLECTIVE ACCOUNTS. The bonus assigned to the four selected COLLECTIVE ACCOUNTS will consist of 30 points, while the bonus assigned to the remaining eight COLLECTIVE ACCOUNTS will consist of 20 points. The four COLLECTIVE ACCOUNTS with higher bonus will be the same for all members of the group and will remain unchanged for the three subsequent periods (i.e. the four COLLECTIVE ACCOUNTS selected in period 1 will remain the same in periods 2, 3 and 4; the four COLLECTIVE ACCOUNTS selected in period 5 the same remain in periods 6, 7 and 8; finally, the four COLLECTIVE ACCOUNTS selected in period 9 will remain the same in the periods 10, 11 and 12).

How to make your choice in PHASE 2.

At the beginning of PHASE 2, the computer will display your effective endowment and thirteen input fields, one for the PRIVATE ACCOUNT and one for each of the twelve COLLECTIVE ACCOUNTS. In each of the twelve input fields associated with the COLLECTIVE ACCOUNTS, the computer will display the bonus size, 20 or 30 points, assigned to the COLLECTIVE ACCOUNT in that period. For each subject in the group, the order in which the twelve input fields for the COLLECTIVE ACCOUNTS are displayed on the screen is randomly determined by the computer. The number of tokens you allocate to an account cannot be greater than your effective endowment and the sum of your allocations must be equal to your effective endowment.

Moreover, if you are selected to play the role of DELEGATE, the sum of your allocations in the twelve COLLECTIVE ACCOUNTS cannot be less than the number of tokens transferred to you by the other group members in PHASE 1. This means that the DELEGATE of the group is required to allocate in the twelve COLLECTIVE ACCOUNTS at least as much as transferred by the group members in PHASE 1.

At the end of PHASE 2 of each period, the computer will display how many tokens you have allocated to the PRIVATE ACCOUNT, how many tokens you have allocated to each of the twelve COLLECTIVE ACCOUNTS, how many tokens have been allocated by your group to each of the twelve COLLECTIVE ACCOUNTS, how many points you have obtained from the PRIVATE ACCOUNT, how many points you have obtained from each of the twelve COLLECTIVE ACCOUNTS and how many points you have obtained in total in the period. At the end of the experiment the total number of points you have obtained in the 12 periods will be converted into Euro at the rate 120 points = 1 Euro.

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