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Normative Conflict and Cooperation in Sequential Social Dilemmas

By Jakob Neitzel and Lauri Sääksvuori*

This paper shows how conflicting normative views of fair contribution rules can be used to design sequential contribution mechanisms to foster human cooperation in heterogeneous populations. Our model predicts that a sequential mechanism which solicits contributions first from wealthy actors generates greater public good provision and narrows wealth inequality more than any alternative sequential mechanism. Our experimental data show that the mechanism with rich first-movers generates greater contributions than alternative mechanisms, as predicted. Results suggest how altering the sequential order of contributions may affect public good provision and help organizations to increase the total value of solicited contributions.

JEL: C92, D63, H41

Keywords: Equity, Heterogeneous Wealth, Normative Conflict, Sequential Public Good Provision

The conflict of individual interest and collective efficiency under resource heterogeneity is a pervasive feature of human social organization. Team members in schools and work places have different amounts of time, tal-

* Neitzel: University of Hamburg, Department of Economics, Von-Melle-Park 5, 20146 Hamburg, Germany, jakob.neitzel@wiso.uni-hamburg.de. Sääksvuori: University of Hamburg, Department of Economics, Von-Melle-Park 5, 20146 Hamburg, Germany, lauri.saaksvuori@wiso.uni-hamburg.de.

ent and skills available for joint undertakings. Farmers cultivating soil and raising livestock regularly face collective environmental hazards and severe weather phenomena, while accumulated wealth and opportunities to reckon with prevailing crises often substantially differ across the farmers. At international level, countries differ in their capabilities and incentives to contribute to greenhouse gas reduction and engage in abatement activities designed to curb the effects of global climate change. Likewise, the heterogeneity of resources is apparent in many collective decisions of everyday life varying from jointly purchased gifts to contributions to charitable organizations.

Economic science has responded to the pervasive challenge of free-riding in collective action by suggesting numerous sophisticated mechanisms to enhance cooperation and generate efficient allocations to public good (Clarke, 1971; Groves, 1973; Groves and Ledyard, 1977; Walker, 1981; Moore and Repullo, 1988; Falkinger, 1996). A common characteristic of these mechanisms is that they assume narrowly self-interested economic agents and require strong institutional arrangements to implement centralized sanctions or transfer payments to generate socially efficient contributions. However, these theoretically optimal schemes are rarely implemented and offer only limited opportunities to develop new practical solutions to foster cooperation in naturally-occurring situations. In practice, several different types of public goods have to be provided in the absence of strong institutions and coercive power to punish violators.

Most of the economic literature on public good provision assumes that contributions are solicited simultaneously. Yet, in practice, negotiation processes over global public goods and the characteristics of numerous fund-

raising campaigns suggest that contributions are often made in a sequential order. For example, the European Union has regularly made an advance commitment to increase its emission reductions before the next round of post-Kyoto negotiations on greenhouse gas emissions if other major emitting countries accept to contribute a reasonable share to the emission targets. Likewise, observations from fund-raising campaigns show that the campaign organizers regularly announce prior contributions to the cause and if this is not the case, persons solicited for contributions often ask themselves about the previously donated amounts.

The economics literature on public good provision in sequential move games complements the literature on theoretically optimal provision mechanisms. Bergstrom, Blume and Varian (1986) provide an early theoretical model for voluntary contributions to public goods and show that the fund-raiser prefers not to announce past contributions to future donors. Bagloni and Lipman (1989) study sequential contribution mechanisms which condition public good provision on private contributions and show that such mechanisms implement social optimum if the sum of private contributions is sufficiently high. Varian (1994*a*) describes a two-stage mechanism which implements efficient allocations as a subgame-perfect equilibrium. In a similar vein, Varian (1994*b*) studies public good provision in a sequential game with quasi-linear utility functions and shows that simultaneous contributions generate greater public goods provision than sequential contributions if the sequential order enables the first-mover to free-ride on the subsequent contributions of others. However, Andreoni (1998) shows that announcing binding commitments to contribute may increase the total value of donations if this enables donors to coordinate on positive provision levels. Bracha, Me-

nietti and Vesterlund (2011) provide experimental evidence in support of the proposition that early contributions may increase the total value of donations if the fixed costs of providing public goods are reasonably high. Vesterlund (2003) studies the impact of announcing contributions in environments where there is uncertainty about the quality of the soliciting organization and shows that the initial contributions can serve as credible signals about the quality of the organization. Potters, Sefton and Vesterlund (2005) show that sequential move structures may result in larger public good provision if the followers mimic a responsible leader. They also report that, when given an opportunity to choose between sequential and simultaneous move structures, donors predominantly choose to contribute sequentially. List and Lucking-Reiley (2002) conduct a field experiment to test the impact of various amounts of seed money and report that increasing the amount of announced contributions resulted in a manifold increase in contributions by the general public.

Besides the large theoretical interest and experimental literature directly testing the empirical relevance of proposed models of public good provision, a substantial experimental effort has been devoted to understand the empirical nature of free-riding. There are a growing number of stylized facts describing human behavior in public good games. The individually optimal null provision hypothesis is typically rejected and groups attain better outcomes than foreseen by theories based on narrowly self-interested motivations (Ledyard, 1995). Positive contributions to public good are frequent even after dozens of repetitions within the same group, but typically decline in time towards the equilibrium (Gächter, Renner and Sefton, 2008). Likewise, the importance of social norms and decentralized norm enforcement for

sustaining positive contributions has been demonstrated in numerous economic experiments where individuals derive equal benefits from the public good (Fehr and Gächter, 2000; Rege and Telle, 2004; Chaudhuri, Graziano and Maitra, 2006). However, it is likely that observed behavior patterns from homogeneous groups, where equal contributions create a natural and intuitively appealing contribution norm, do not readily generalize to environments characterized by resource heterogeneity. Hence, research has lately begun to investigate the emergence and enforcement of contribution norms in heterogeneous groups. Data from surveys and experimental investigations show that people have in heterogeneous populations well-defined but differing normative views of fair contribution rules (Reuben and Riedl, 2013). Consequently, in such situations, determining the most appealing and appropriate level of contributions becomes more difficult and may lead to unpredictable and destructive normative conflicts about how one ought to agree upon contribution levels under resource heterogeneity.

The emergence of normative rules and fairness principles is gaining growing attention as an important phenomenon in economic decision-making.[1] There are three important observations. First, there is a plurality of normatively appealing rules which may lead to conflicting normative views of fair contributions (Cappelen et al., 2007; Winter, Rauhut and Helbing, 2012; Nikiforakis, Noussair and Wilkening, 2012). Second, normative views of

[1]Literature often points out that normative contribution rules differ from social norms. According to a definition by Bicchieri (2006), as cited in Nikiforakis, Noussair and Wilkening (2012), unlike normative rules the establishment of a social norm requires a sufficient number of individuals who know what the rule is and conform to this rule, provided that they believe that (a.) a sufficient number of others conforms to the rule, and (b.) a sufficient number of others expects the individual to conform. In many occasions where a social norm emerges, these requirements are supplemented by willingness to punish those who do not conform. According to this definition, a normative contribution rule, which suggests how one ought to behave in a given situation, differs from a social norm, unless the aforementioned conditions are satisfied.

fair contribution rules often relate to the principles of *equity* and *equality* (Konow, 2003; Reuben and Riedl, 2013). Third, people exhibit both unconscious (Babcock, Wang and Loewenstein, 2004) and calculated distortions (Dahl and Ransom, 1999; Konow, 2001) in fairness principles which often leads to self-serving use of equity norms. Consequently, Lange et al. (2010) show that the self-interested use of equity arguments can lead to distortions with large economic costs when negotiating about important economic and social issues such as international environmental agreements.

In contrast to the prevailing view, which emphasizes the destructive nature of conflicting normative rules, the innovation of this paper is to show how normative views of fair contribution rules can be used to design sequential contribution mechanisms to foster human cooperation in heterogeneous populations. In addition, we implement a laboratory experiment which renders it possible to test our predictions in a controlled environment. In the experiment, we enable conflicting normative views of fair contribution rules by introducing a real-effort tournament and rewarding the best performers within each group with greater initial endowments from which individuals can contribute to the public good. In particular, we analyze the role of conflicting normative contribution rules for the financing of public goods through sequential contributions.

Our paper contributes to economic literature by proposing a simple sequential contribution mechanism to spur human cooperation in heterogeneous populations in the absence of coercive institutions. Moreover, our experimental data show that the proposed sequential mechanism which solicits contributions first from wealthy actors generates greater public good provision and narrows wealth inequality more than alternative sequential

mechanisms. These results suggest how altering the sequential order of contributions may affect public good provision and help organizations to increase the total value of solicited contributions in heterogeneous populations.

We observe that the emergence of well-defined normative contribution rules is more likely in sequential than simultaneous games. Hence, our paper contributes to a long-standing question regarding the impact of wealth heterogeneity on public good provision by enabling to examine the effect of increasing wealth heterogeneity in populations where normative contribution rules are prevalent.[2] By comparing the performance of sequential contribution mechanisms in treatments with weak and strong wealth heterogeneity, we provide new empirical evidence showing that increasing wealth heterogeneity decreases voluntary public good provision. At the same time, we show that increasing wealth heterogeneity hampers the performance of sequential contribution mechanisms with wealthy first-movers in contrast to alternative sequential mechanisms.

The remainder of this paper is organized as follows. Section I presents

[2]The impact of wealth heterogeneity on public good provision is a long-standing question with considerable policy implications. However, the theoretical and empirical evidence regarding the role of heterogeneity is largely inconclusive. Bergstrom, Blume and Varian (1986) provide a neutrality theorem stating that the total supply of the public good is independent of the income distribution among givers. Meltzer and Richard (1981) show that, under majority rule, income inequality may result in greater public good provision if the mean income rises relative to the median voter. Alesina and Drazen (1991) propose that the existence of heterogeneous interest groups in the society may lead to large distortions in public good supply. In the experimental literature, Ostrom, Gardner and Walker (1994), van Dijk, Sonnemans and van Winden (2002) and Cherry, Kroll and Shogren (2005) report evidence showing that contributions to public goods are lower in groups with heterogeneous endowments than in groups with homogenous endowments. Chan et al. (1996) and Chan et al. (1999) report experimental results that income heterogeneity among the actors increases voluntary contributions, whereas Sadrieh and Verbon (2006) find evidence that neither the extent nor the skew of inequality affects public goods provision. Alesina and la Ferrara (2000) use survey data on group membership and data on U.S. localities and show that inequality decreases privately provided public goods in local communities.

a model which studies the properties of alternative sequential contribution mechanism in heterogeneous populations characterized by conflicting normative views of fair contribution rules. In Section II, we describe the experimental design and procedures. In Section III, we present the results from the experiment. Section IV concludes.

I. Model and Propositions

We study the private provision of public good in a population of $n \geq 2$ players where players differ in their capacity to contribute due to wealth heterogeneity. There are two different types of players: rich players with an endowment w_h and poor players with an endowment w_l, where $w_h > w_l$. We model public good provision such that player i receives after the contribution decision earnings equal to

$$\text{(PG)} \qquad \pi_i(c_i, c_{-i}) = w_i - c_i + \alpha \sum_k c_k,$$

where $\frac{1}{n} < \alpha < 1$ is the return on investment, $w_i \in \{w_h, w_l\}$ is player i's endowment, c_i is his or her own contribution to the public good and $c_{-i} = \sum_{k \neq i} c_k$ are the contributions of the other players.

We assume that players value both monetary income and adherence to a fair contribution norm when deciding about the public good provision. We posit that wealth heterogeneity between actors raises varying views about fair contributions. In particular, we are interested in analyzing the coexistence of two prominent fairness norms that relate contributions to initial wealth. *Equality* suggests the equalization of *absolute* contributions with no necessary link to individual characteristics such as capacity to contribute.

By contrast, *equity* links contributions to individual characteristics such as wealth in a proportional manner and stipulates the equalization of *relative* contributions to public projects.

In compliance with a large body of empirical observations, we assume that individuals apply potential contribution norms in a self-serving manner. In other words, we assume that individuals choose the contribution norm which yields the highest utility for the given player type. Thus, we model a situation in which players face two different types of decisions. First, players choose their preferred contribution norm in a self-serving manner. Second, players decide about the private provision of the public good given a type-specific utility function with preferred contribution norm. More formally, we assume that player i maximizes a following utility function when contributing to public good:

$$u_i(c_i, c_{-i}) = \pi_i(c_i, c_{-i}) - \frac{\beta}{2}\left(c_i - m^{k(i)}(c_{-i})\right)^2$$

where the parameter $\beta \geq 0$ determines the weight that is attached to deviations from the norm $m^{k(i)}(c_{-i})$ and index $k(i)$ represents the norm preferred by player i, $k \in \{eqa, eqi\}$.[3]

When applying the equality norm, players use the absolute contributions of other players as a reference point with no link to initial endowments. Hence, the equality norm can be written as

$$m^{eqa}(c_{-i}) = \frac{c_{-i}}{n-1}.$$

[3]The utility function has been introduced to economic literature by Cappelen et al. (2007).

By contrast, when player i applies the equity norm, she additionally accounts for the initial endowments and the norm is specified as

$$m^{eqi}(c_{-i}) = \frac{c_{-i}}{w_{-i}} w_i,$$

where $w_{-i} = \sum_{k \neq i} w_k$ denotes the sum of other players' initial endowments. We first study the selection of the preferred norm and state that

Proposition 1 *Rich players prefer the equality norm, whereas poor players prefer the equity norm.*

The intuition behind the proposition is straightforward. For rich players, adherence to the equality norm requires lower contributions than adherence to the equity norm ($\frac{c_{-i}}{n-1} \leq \frac{c_{-i}}{w_{-i}} w_i$, since $w_i > \frac{w_{-i}}{n-1}$), whereas for poor players the opposite applies and the equity norm stipulates lower contributions than the equality principle ($\frac{c_{-i}}{w_{-i}} w_i \leq \frac{c_{-i}}{n-1}$, since $w_i < \frac{w_{-i}}{n-1}$). A complete proof of the proposition is provided in the appendix.

Our primary interest pertains to the impact of conflicting normative views of fair contribution rules in simultaneous and sequential move contribution games. In a simultaneous contribution game, all players act simultaneously and are regarded as first-movers. In a sequential contribution game (SEQ), we separate players into first- and second-movers. In conjunction with wealth heterogeneity, this leads to three different possible combinations of first- and second-movers: (a.) all rich players contribute first, (b.) all poor players contribute first, or (c.) rich and poor players contribute in a mixed order such that there is at least one first- and second-mover of each type. Moreover, we consider the impact of varying wealth distributions.

In the following, we study the characteristics of alternative sequential

mechanisms and assume that first-movers contribute a fixed proportion, $0 \leq x \leq 1$, of their endowment if the resulting contribution is not larger than the endowment of the poor, in which case their contribution is w_l. Hence, formally $c_i = \min\{xw_i, w_l\}$, if player i is a first-mover. Consequentially, we define a society to be subject to *weak wealth heterogeneity* if $xw_h \leq w_l$ and to *strong wealth heterogeneity* if $xw_h > w_l$. We call x the *cooperativeness* of the society. We assume that second-movers contribute according to their preferred norm. Thus, rich second-movers contribute the same average absolute amount as first-movers, while poor second-movers contribute the same amount relative to initial endowments. Formally, $c_i = \frac{c_{-i}}{n-1}$, if player i is a second-mover and has an endowment w_h, and $c_i = \frac{c_{-i}}{w_{-i}} w_i$, if player i is a second-mover and has endowment w_l.[4] Consequently, we derive the following proposition concerning the public good provision across the distinct sequential contribution mechanisms:

Proposition 2 *Under weak wealth heterogeneity, SEQ with rich first-movers generates greater public good provision than alternative sequential move mechanisms.*

The proof of the proposition is driven by the fact that the equality norm dictates rich second-movers to contribute xw_l, while rich first-mover contributions equal xw_h. Thus, since $w_h > w_l$, rich players obviously contribute less as second-movers than as first-movers. In contrast, the contributions made by poor players do not differ when acting either as a first- or second-mover and amount to xw_l. Therefore, the more rich players there are as

[4]The optimal solution of utility maximization implies that the norm is undercut by the fraction $\frac{1-\alpha}{\beta}$. However, to simplify, we assume that β is large enough such that deviations from the preferred norm are negligible.

first-movers, the higher the public good provision. This result also triggers the next proposition regarding income inequality between the rich and poor:

Proposition 3 *Under weak wealth heterogeneity, SEQ with rich first-movers diminishes wealth inequality between rich and poor players more than alternative sequential move mechanisms.*

The intuition behind the proposition is self-evident. Wealth inequality diminishes whenever rich individuals contribute larger absolute amounts than poor individuals. By definition, this happens only in sequential mechanisms with rich first-movers. Thus, the mechanism with most rich first-movers induces the lowest inequality. We now turn to societies with strong wealth heterogeneity in which case the results are more nuanced.

Proposition 4 *Under strong wealth heterogeneity, the relative performance of the sequential move mechanisms depends on the cooperativeness of the society.*

Similar to the situation with weak wealth heterogeneity, rich individuals contribute less as second-movers than as first-movers. However, as a result of strong wealth heterogeneity, poor individuals portray similar tendency to decrease their contributions when acting as a second-mover. As a consequence, the ordering of alternative sequential mechanisms depends on the cooperativeness of the society. We characterize various levels of cooperativeness which change the ordering of sequential contribution mechanisms in the appendix.

Finally, we investigate the effect of increasing wealth heterogeneity on public good provision under different mechanisms, while keeping the level of total wealth constant.

Proposition 5 *With constant overall wealth, increasing wealth heterogeneity decreases public good provision under all mechanisms.*

We provide the intuition behind the proposition studying the mechanism with rich first-movers. Note that, as long as a society adheres to weak wealth heterogeneity, the provision level is $x \sum_i w_i$. However, when the threshold to strong wealth heterogeneity is transcended, rich players contribute a smaller share of their endowment. As a reaction to this, poor individuals lower their contributions. Contributions are now only based on the wealth of the poorer type and increasing wealth heterogeneity lowers the total value of solicited contributions. A complete proof of the proposition is provided in the appendix.

II. Experiment

A. Experimental design and procedure

We implement a laboratory experiment which renders it possible to study public good provision across sequential contribution mechanism in a controlled environment. The experiment consists of two parts. The first part involves a real-effort task. This task is used to determine which individuals have high initial endowments and which individuals have low initial endowments when contributing to the public good in the second part of the experiment. We use the Encryption task (Erkal, Gangadharan and Nikiforakis, 2011) which proceeds as follows. Participants are divided into groups of four and given an encryption table which assigns a number to each letter of the alphabet. During the next ten minutes, participants are presented words which need to be encrypted by substituting the letter with numbers using the encryption table. The words are presented in a predetermined sequence

and are the same for all participants. A subject cannot proceed to the next word until the word has been correctly encrypted. After the real-effort task, the two group members with the highest number of encrypted words receive a high initial endowment, w_h, while the two other members receive a low initial endowment, w_l. Ties for the second place are broken at random.

We employ a real-effort task with tournament incentives to facilitate the emergence of conflicting normative views of fair contributions. In compliance with the literature, we expect that earned endowments decrease the normative appeal of the equal earnings principle and increase the salience of equal contributions as an alternative normative principle under wealth heterogeneity.[5] Consequently, participants stay in the same group of four throughout the experiment and know in the second part of the experiment if they were among the two most productive individuals in the group in the first part. However, no information about the exact number of encrypted words is revealed to the participants after the first part. After completing the first part, participants receive new instructions concerning the second part.

The second part involves six different treatments. Common to all treatments is the linear public goods game (PG) which is played in groups of four for 15 consecutive periods. In our experiment, we set α to be 0.4.

We investigate public goods provision under alternative sequential contribution mechanisms and varying degree of endowment heterogeneity. In

[5]Reuben and Riedl (2013) study the emergence of contribution norms in heterogeneous populations and use a random procedure to induce wealth heterogeneity among the participants. They do not find evidence for contribution norms other than free-riding in simultaneous public goods games in the absence of opportunities to punish norm violations. Nikiforakis, Noussair and Wilkening (2012) study normative conflict and feuds in a laboratory experiment using varying return rates from the public account based on participants' performance in a real-effort task and find clear evidence for the emergence of conflicting normative views of fair contributions.

sequential move games, we have two first-movers who contribute simultaneously and two second-movers who contribute simultaneously after observing the contributions made by the first-movers. This gives rise to three possible combinations of first movers: two rich players (HH), two poor players (LL) and one rich and poor player each (HL). In addition, we conduct a treatment (SIM) with simultaneous move structure. We consider two different levels of endowment heterogeneity among the players. In treatments with weak heterogeneity (W), rich players are assigned an endowment of 25 points, while poor players are assigned an endowment of 15 points. In treatments with strong heterogeneity (S), rich players are assigned an endowment of 30 points, while poor players are assigned an endowment of 10 points. Thus, in all treatments the average endowment is 20 points. We performed six treatments, whereof four with weak endowment heterogeneity (SIM-W, HH-W, LL-W and HL-W) and two with strong wealth heterogeneity (HH-S and LL-S).

In addition to the contribution decisions, we elicit participants' beliefs about the behavior of other group members in the current period. Participants are asked to predict the contribution of the same participant type than they are and the average contribution of two other type of participants. Participants are paid a small reward based on the accuracy of their estimates. In all treatments, participants are informed at the end of each period about the group's total contribution to public good, the contribution of each individual and whether the individual making a specific contribution is low or high endowed participant. In order to track the individual behavior during the interaction, every participant is assigned a unique identification letter A, B, C, D and the individual contributions are listed in the same

order such that for the two first movers are assigned letters A and B, while for the two second-movers we use letters C and D.

Table 1—Experimental treatments

Treatment	w_h	w_l	Sequential order	Number of groups
SIM-W	25	15	Simultaneous	12
HH-W	25	15	Rich first	12
LL-W	25	15	Poor first	12
HL-W	25	15	Mixed sequence	12
HH-S	30	10	Rich first	12
LL-S	30	10	Poor first	12

The experiment was conducted at the experimental laboratory of the School of Business, Economics and Social Sciences at the University of Hamburg. We used z-tree (Fischbacher, 2007) for programming and ORSEE (Greiner, 2004) and h-root (Bock, Nicklisch and Baetge, 2012) for recruiting. A total of 288 subjects participated in the experiment in 12 different sessions. The vast majority of 147 female (Age Mean: 24.1, Std: 2.86, Min: 18, Max: 38) and 141 male (Age Mean: 25.1, Std: 3.73, Min: 19, Max: 39) subjects were undergraduate students representing a wide range of different disciplines. Upon arriving at the laboratory, participants received written instructions and were randomly assigned to their cubicles preventing communication and visual interaction. Instructions were read publicly by a member of the research team. Subjects then took a post instruction quiz and were not allowed to continue until all answers were correct.

At the end of the experiment, one of the 15 rounds was chosen at random to determine the earnings from the public goods game. Likewise, one of the 15 rounds was chosen at random to determine the earnings from the prediction task. The random draws were performed publicly by two different

participants who draw a card from a deck of cards numbered from 1 to 15. The sessions lasted approximately 75 minutes including instructions, post instruction quiz, demographic questionnaire and payment procedure. Earnings per participant were on average 12.65 €.

B. Experimental predictions

Following the analysis developed in Section I, we are able to compare the expected performance of alternative contribution mechanisms across treatments and predict a following ranking of public good provision across treatments with weak wealth heterogeneity:

$$\text{SIM-W} = \text{HH-W} > \text{HL-W} > \text{LL-W}.$$

Based on Proposition 3, we predict that the same ranking applies to wealth inequality between poor and rich participants. As discussed, the expected relative performance of alternative sequential mechanisms in treatments with strong wealth heterogeneity is conditional on average cooperativeness in the considered population. Given the degree of wealth heterogeneity in treatments with strong heterogeneity, we expect that the treatment HH-S generates greater public goods provision than LL-S, if the average contributions to the public good by first-movers are smaller than $\frac{2}{3}$ of the initial endowments. At the same time, if the average first-mover contributions to the public good are greater than $\frac{2}{3}$ of the initial endowments, we expect that more public good is provided in LL-S than in HH-S. Based on Proposition 5, when comparing the performance of sequential contribution mechanisms HH and LL in treatments with weak and strong wealth heterogeneity, we expect that increasing wealth heterogeneity decreases voluntary public good provision independent of the sequential order of contributing participants.

III. Results

In this section, we characterize the impact of conflicting normative views of fair contribution rules for public good provisions. We begin the analysis by demonstrating the emergence of well defined, but conflicting normative views of fair contributions. Thereafter, we investigate the potency of varying sequential contribution mechanisms for the financing of public good. Finally, we examine the impact of increasing wealth heterogeneity on contributions in an environment characterized by conflicting norms.

A. First- and Second-mover Behavior

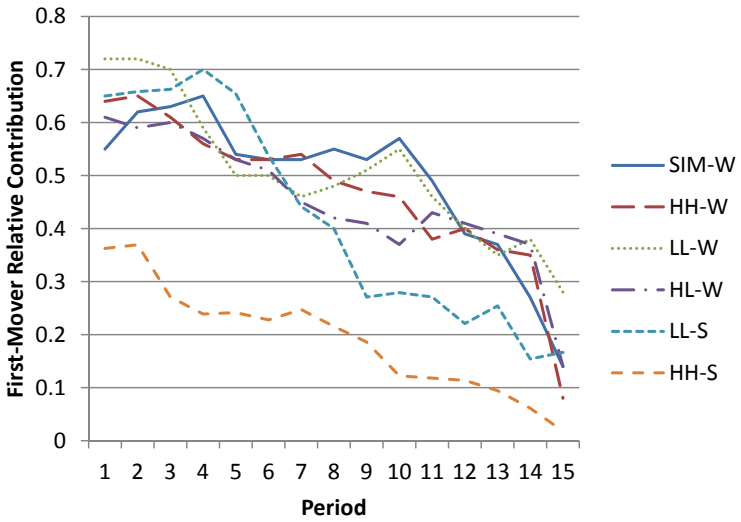


FIGURE 1. FIRST-MOVER RELATIVE CONTRIBUTIONS

Figure 1 sets the stage for our analysis by illustrating the development of first-mover relative contributions by treatment. Figure 1 shows that there are no differences in first-mover relative contributions in treatments with weak heterogeneity and in treatment LL-S (Average relative contributions

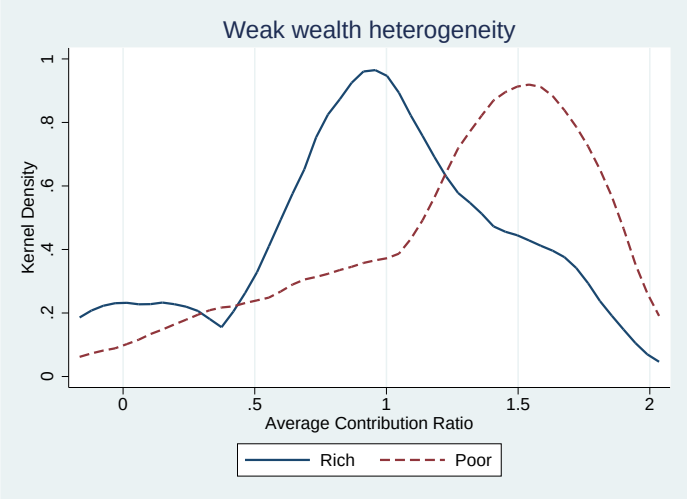
in SIM-W are 49% of the initial endowment, in HH-W 47%, in LL-W 51%, in HL-W 45% and in LL-S 42%), while subjects in HH-S exhibit lower relative contributions (19% percent). These observation are confirmed by a linear random effect regression model presented in table B1[6], where HH-W is the baseline. The model shows that there are no significant differences between the treatments except for HH-S (-0.294 over all periods, $p < 0.01$). There is a strong decline in relative contributions over time in all treatments ($p < 0.01$).

Turning to second-mover behavior, we plot the kernel densities of the average contribution ratios by rich and poor second-movers for treatments with weak heterogeneity in Figure 2(a). We calculate for each rich second-mover a contribution ratio based on subject's own contribution and the contributions made by the poor first-movers in the same group. For each poor second-mover, we calculate the same contribution ratio based on subjects' own contribution and the contributions made by the rich first-movers in the same group. The ratios are thereafter averaged over the 15 periods in order to obtain one contribution ratio per subject. These ratios represent the preferred normative principle for each subject. If subject's ratio equals to 1, she applies the equality norm, and if subject's ratio equals to $\frac{25}{15} \approx 1.66$, she applies the equity norm. Figure 2(b) plots the distributions for treatments with strong wealth heterogeneity. Again, a ratio of 1 relates to the equality principle, while the equity principle is represented by a ratio of 3 ($= \frac{30}{10}$).

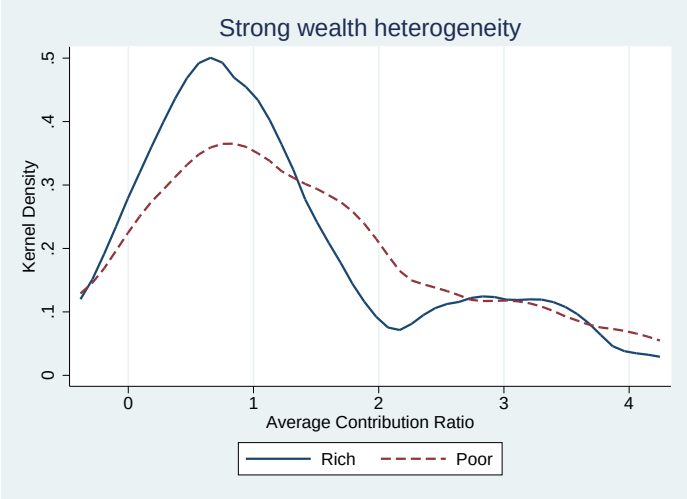
We make three observations from Figures 2(a) and 2(b). First, distributions have multiple peaks. Plotted densities have peaks at 1 and $\frac{5}{3}$ corre-

[6]Regression tables are attached in Appendix B. Demographic control variables are included in all regressions. These variables are age, a dummy variable for the gender, a dummy variable for native German speaker, a dummy variable for East- or West-German origin and a variable for the work hours per week.

(a)



(b)



(c)

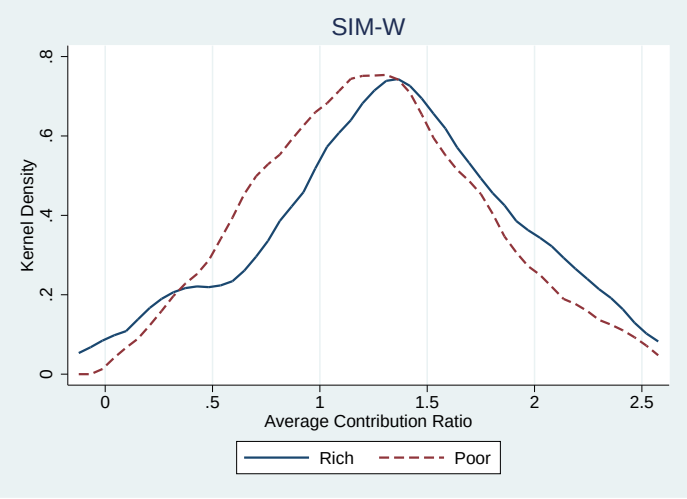


FIGURE 2. KERNEL DENSITIES OF AVERAGE CONTRIBUTION RATIOS USING THE EPANECHNIKOV KERNEL FUNCTION. BANDWIDTHS ARE CALCULATED AS TO MINIMIZE THE MEAN INTEGRATED SQUARED ERROR FOR AN UNDERLYING GAUSSIAN DENSITY.

sponding with the normative principles related to equality and equity. The observation suggests that normative views of fair contribution rules play a prominent role in behavior of second-movers in weak treatments. Second, in treatments with weak wealth heterogeneity, the preferred normative principle differs between player types. Rich players display behavior coinciding with the equality norm, while poor players exhibit behavior associated with the equity norm. These observations suggest that participants have a self-serving interpretation of desirable contribution rules which leads to conflicting normative views of fair contributions. A two-sample Kolmogorov-Smirnov test for group level observations suggests that the differences between the player types are significant (D = 0.6667, $p = 0.005$). Third, in contrast to treatments with weak wealth heterogeneity, under strong wealth heterogeneity both rich and poor individuals display cooperation levels corresponding with the equality principle (Kolmogorov-Smirnov test for group level observations, D = 0.3333, $p = 0.256$). As a consequence, poor players are more likely to apply a normative principle which evokes higher overall contributions than a principle which generates the highest individual earnings.

For comparison, in Figure 2(c) we plot the kernel densities of the average contribution ratios in SIM-W. We calculate average contribution ratios as above, with the difference that lagged contributions of the respective other player type are used. Figure 2(c) suggests that neither the wealthy nor the poor follow a clear contribution norm in a treatment with simultaneous contributions. Rather, on average there seems to be a compromise between the equality and equity norms as the peaks are at around 1.3 for both rich and poor players. A two-sample Kolmogorov-Smirnov test for group level

observations confirms that there are no difference in the behavior between player types (D = 0.25, p = 0.854).

We summarize the observations as follows. First, in line with our assumptions, all first-movers contribute the same relative amount to the public good in treatments with weak wealth heterogeneity. In treatments with strong wealth heterogeneity, poor players contribute the same relative amount as the players in treatments with weak wealth heterogeneity, while rich players contribute substantially less. Second, the preferred normative principle differs across player types. Rich players display behavior coinciding with the equality norm, while poor players exhibit behavior associated with the equity norm. Players are more likely to discard the equity principle as the degree of wealth heterogeneity increases.

B. Public Good Provision

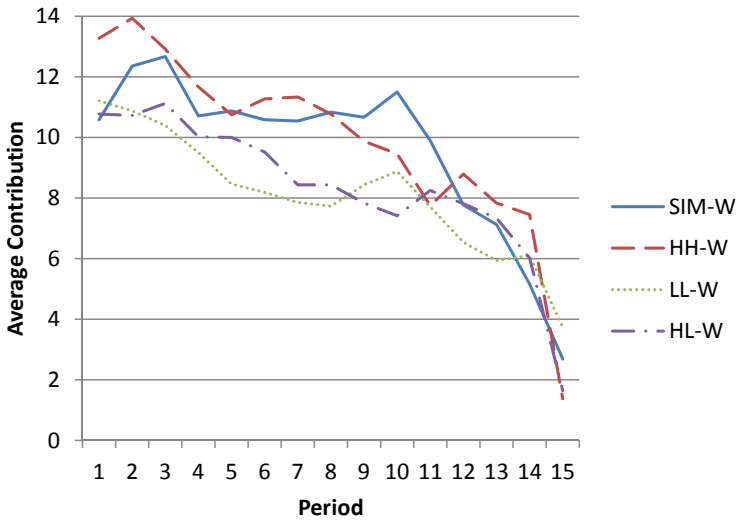


FIGURE 3. CONTRIBUTIONS IN W TREATMENTS

Our theoretical analysis provides clear predictions about the relative performance of sequential contribution mechanisms in treatments with weak wealth heterogeneity. In the following, we investigate the impact of alternative contribution mechanisms on public good provision and income inequality using our experimental data. If contributions are lower in treatments HL-W and LL-W than they are in HH-W and SIM-W, we have strong evidence supporting the proposition that the order in which contributions are solicited from individuals affects public good provision. Figure 3 depicts the evolution of average contributions over time in treatments with weak wealth heterogeneity. We find that the contribution levels are the highest in treatment HH-W (average contribution per player 9.9) followed by SIM-W (9.6), HL-W (8.4) and LL-W (8.1). At the same time, there is a strong negative time trend in contributions across all treatments.

Table B2 provides statistical support for these observations. The first model (1) compares average contributions between the treatments and shows that contributions are lower in LL-W than in HH-W/SIM-W. Models (2) and (3) add time trends separated by treatment by introducing interaction terms between period and treatment dummies. Model (3) excludes period 15 in order to correct for a strong last-period effect. Model (4) comprises of the same variables as model (2) but includes standard errors clustered at the group level. In all models, LL-W exhibits lower contributions than HH-W/SIM-W. Models (2) and (3) indicate that HL-W generates lower contributions than treatments HH-W and SIM-W if the varying time trends are accounted for. Overall, the observations from the experiment lend empirical support for our proposition that altering the sequential order of contributions may affect the total value of solicited contributions.

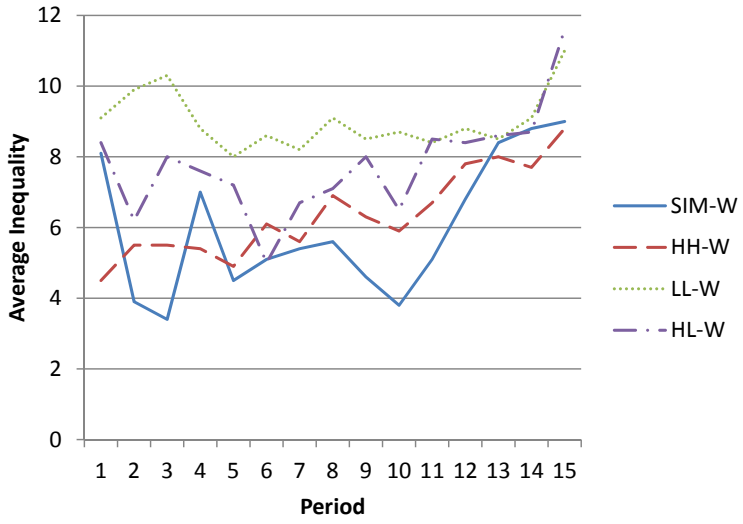


FIGURE 4. INCOME INEQUALITY IN W TREATMENTS

Common to all treatments is that inequality between players may change through positive contributions. Figure 4 illustrates the evolution of income inequality over time in treatments with weak wealth heterogeneity. It shows that the income inequality is highest in treatment LL-W (average difference in earnings between the rich and poor players is 9.0) followed by HL-W (7.8), HH-W (6.4) and SIM-W (6). At the same time, the initial inequality between players diminishes in all treatments due to higher absolute contributions by rich individuals. Table B3 provides statistical support for these observations. The first two models (1, 2) use the difference in average income between rich and poor players in each group as the dependent variable. These regressions indicate that income inequality is significantly higher in treatment LL-W and HL-W than in HH-W and SIM-W. We investigate the underlying dynamics behind the diminishing income inequality and observe differences between treatments when estimating separate regression models

for the monetary income of rich and poor individuals. We observe that rich players receive equal monetary income in all treatments, whereas poor players receive significantly lower income in LL-W and HL-W than in SIM-W and HH-W. In sum, these observations lend empirical support to our proposition that the order in which contributions are solicited from individuals affects the ex-post income inequality between the rich and poor individuals.

As discussed in Section I, under strong wealth heterogeneity the sequential contribution mechanism which solicits contributions first from wealthy actors does not necessarily generate greater public good provision than alternative sequential contribution mechanisms. Consequently, the expected relative performance of alternative sequential mechanisms in treatments with strong wealth heterogeneity is conditional on the average cooperativeness of considered population. However, given the overall rate of cooperativeness (45% - 50%) observed in our experiment, we can expect higher average contributions in HH-S than in LL-S. Figure 5 depicts the evolution of average contributions and the average income difference over time in treatments with strong wealth heterogeneity. Figure 5 illustrates that the contribution levels in treatments HH-S (average contribution 4.8) and LL-S (5.5) are practically identical. At the same time, there is a strong negative time trend in contributions similar to treatments with weak heterogeneity. A linear random effect regression in Table B4 confirms that there is no statistically significant difference in contributions between treatments HH-S and LL-S. Furthermore, we find that both treatments decrease the initial wealth difference, but there is no statistically significant impact on income inequality between the treatments HH-S and LL-S.

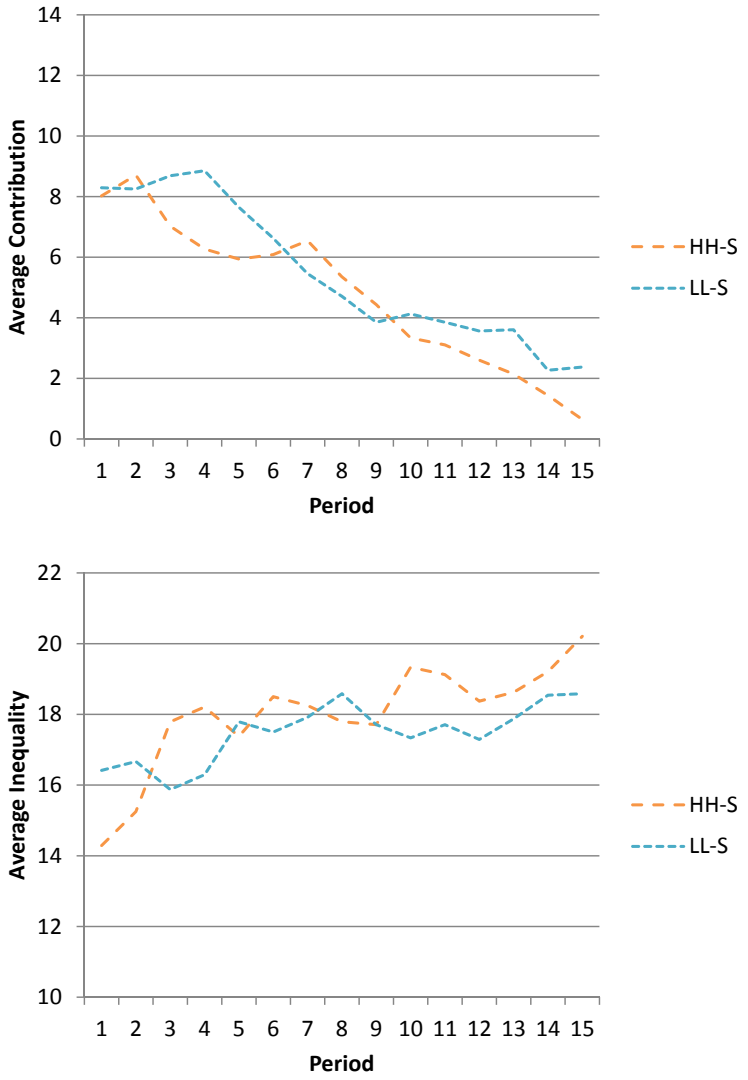


FIGURE 5. CONTRIBUTIONS AND INCOME INEQUALITY IN S TREATMENTS

C. The Impact of Increasing Wealth Heterogeneity

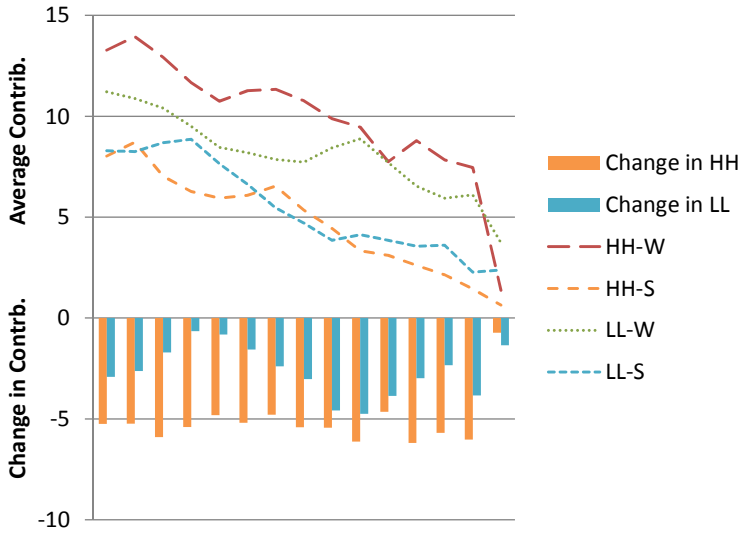


FIGURE 6. IMPACT OF INCREASING WEALTH HETEROGENEITY ON HH AND LL

The impact of wealth heterogeneity on public good provision is a long-standing question with considerable policy implications. However, as previously summarized, evidence regarding the role of heterogeneity is largely inconclusive. Our data contribute to this discussion by rendering it possible to examine the impact of increasing wealth heterogeneity on public good provision in an environment characterized by conflicting normative views about fair contribution rules. Figure 6 shows the evolution of average contributions over time in treatments HH-W, HH-S, LL-W and LL-S, and the changes in contributions when moving from HH-W to HH-S and from LL-W to LL-S.

First, we observe that there seems to be a distinct difference in contributions between treatments with weak and strong wealth heterogeneity independent of the sequential mechanism. Average contributions in HH-W

are always higher than in HH-S and in LL-W always higher than in LL-S. Second, the bars indicating the change in contributions show that the HH mechanism (average change in contribution -5.1) experiences a sharper decline in public good provision than the LL mechanism (-2.6). Regression analyzes presented in Table B5 test the statistical significance of increasing wealth heterogeneity on public good provision. The regressions confirm that contributions in treatments with strong wealth heterogeneity are lower than in treatments with weak wealth heterogeneity. While the effect is statistically significant for HH ($\beta = -6.069$, $p < 0.01$), it is not for LL ($\beta = -2.335$, $p = 0.12$). Thus, as indicated by Figure 6, the HH mechanism is more vulnerable to increasing wealth heterogeneity than the LL mechanism.

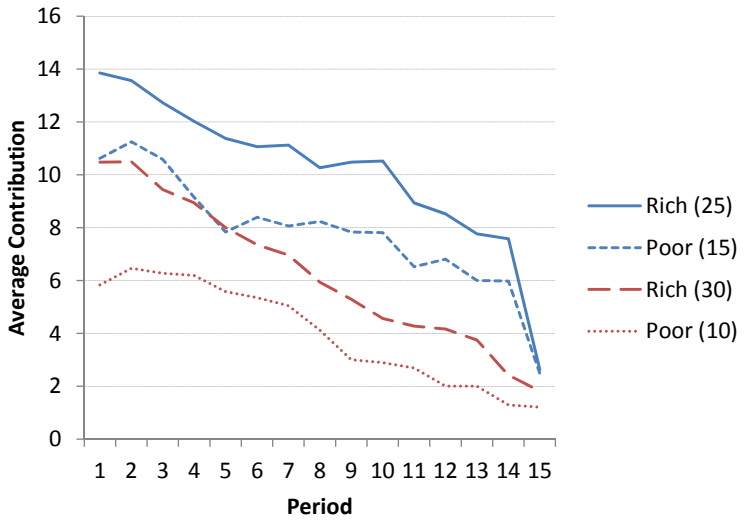


FIGURE 7. ABSOLUTE CONTRIBUTIONS BY WEALTH

We provide a more nuanced view of how the increasing wealth heterogeneity impacts public goods provision by separating the effect on rich and poor individuals. Figure 7 presents average absolute contributions by wealth.

The figure shows that rich individuals contribute greater absolute amounts to the public good than poor individuals. Strikingly, we observe that the absolute contributions by rich individuals are smaller in treatments with strong heterogeneity than in treatments with weak heterogeneity. In other words, individuals with an endowment of 30 in treatments with strong heterogeneity contribute less than the individuals with an endowment of 25 in treatments with weak heterogeneity. Regression models (1) and (2) presented in Table B6 confirm the statistical significance of divergent absolute contributions between the rich and poor and the inverse effect of increasing wealth among the rich individuals.

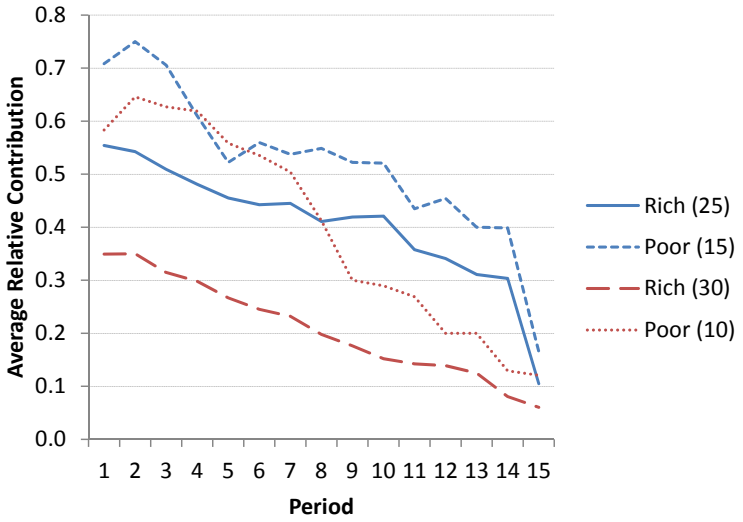


FIGURE 8. RELATIVE CONTRIBUTIONS BY WEALTH

Figure 8 exhibits type-specific average relative contributions by endowment. We observe that poor individuals contribute a higher percentage of their endowments to the public good than rich individuals. The regression analyzes (3) and (4) in Table B6 corroborate the statistical significance

of divergent relative contributions between rich and poor individuals. In sum, rich individuals contribute more to the public good in absolute terms, whereas poor subjects contribute a larger relative share of their endowments. When wealth heterogeneity increases, both types decrease their contributions by the same amount in absolute terms as well as in relative terms.

IV. Conclusion

Numerous complex transfer payments schemes and coercive institutional solutions have been designed to overcome the problem of free-riding and achieve socially optimal levels of public good contributions. However, these theoretically optimal mechanisms have led to few successful applications to foster human cooperation in naturally-occurring situations. In practice, several different types of public goods have to be provided in the absence of strong institutions and coercive power to punish violators. The heterogeneity of resources among the actors plays an apparent role in numerous problems of collective action without institutional solutions. In particular, the plurality of normatively appealing fair contribution rules in heterogeneous populations may cause unpredictable and destructive normative conflicts which impede the attainment of economically and socially efficient solutions. In contrast to the prevailing view, which emphasizes the destructive nature of conflicting normative ideals, this paper shows how conflicting equity principles can be used to design sequential contribution mechanisms to foster human cooperation

The goal of this paper is to provide theoretical and empirical evidence on the role of conflicting normative principles for the financing of public goods through sequential contributions. Our data show the coexistence of

equality and *equity* principles in heterogeneous populations. In compliance with prior findings, we find that people have a self-serving interpretation of appropriate contribution rules. Given the conflicting normative views of fair contributions, we are able to show how small changes to the sequential order of contributions may affect public good provision in heterogeneous groups. In particular, our model predicts that a sequential contribution mechanism which solicits contributions first from wealthy actors generates greater public good provision and narrows wealth inequality more than alternative mechanisms. At the same time, we show that increasing degree of wealth heterogeneity attenuates the superiority of sequential contribution mechanisms with rich first-movers in comparison to alternative sequential mechanisms.

When testing the performance of alternative sequential contribution mechanisms in a controlled laboratory experiment, we find strong evidence supporting the proposition that the sequence of solicited contributions affects public goods provision in heterogeneous groups. We observe that the highest contributions are provided in a treatment where contributions are solicited first from wealthy actors. At the same time, we find that the mechanism with wealthy first-movers narrows wealth inequality more than alternative mechanism, as predicted. However, we do not observe significant differences between sequential mechanisms under strong wealth heterogeneity. Our data lend support to the hypothesis that increasing wealth heterogeneity decreases public good provision under all sequential mechanisms.

Our results may have implications for situations where public goods need to be provided in the absence of strong institutions. Likewise, our results may give guidance to various charitable corporations organizing public fund-

raising campaigns. We have provided both theoretical and empirical evidence how altering the sequential order of contributions may affect the total value of solicited contributions. Our results suggest that a sequential mechanism which solicits contributions first from wealthy individuals is at the very least not likely to decrease the total value of solicited contributions, but may increase the value of contributions in contrast to alternative mechanisms. However, much more evidence is needed before we can begin to make forceful arguments that the observed regularities readily generalize to naturally-occurring situations and characterize human behavior in utterly complex economic decisions. At the same time, the need to observe initial wealth distributions among the actors may hinder the applicability of proposed mechanism in naturally-occurring situations.

The robustness of our results can be analyzed in multiple new settings where the behavioral assumptions of the theory cannot necessarily be guaranteed to hold. One particularly promising approach to provide robustness checks for our laboratory results involves field studies in natural environments. In particular, various fund-raising campaigns in pre-existing social groups are likely to provide opportunities for research in an environment where people have information about the initial wealth distribution among the potential donors. In a similar vein, increasing interest to disclose public sector officials' income and assets in many countries is likely to create opportunities to develop new designs to evaluate the robustness of our experimental results in natural settings. Finally, the public disclosure of personal income tax filings in the Scandinavian countries may create a natural test bed for future studies evaluating the proposition that conflicting normative views can be used to design contribution mechanisms to increase public good

provision.

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Mathematical Appendix

A1. Proof of Proposition 1

The optimal solution to maximizing utility function u_i results to

$$c_i(c_{-i}) = m^{k(i)}(c_{-i}) - \frac{1-\alpha}{\beta}.$$

We denote by u_i^{eqa} the utility i gets from following the equality norm and u_i^{eqi} from following the equity norm. The utility amounts to

$$u_i^{eqa}(c_i, c_{-i}) = w_i + c_{-i}(\alpha + (\alpha - 1)\frac{1}{n-1}) + \frac{(1-\alpha)^2}{2\beta}$$

and

$$u_i^{eqi}(c_i, c_{-i}) = w_i + c_{-i}(\alpha + (\alpha - 1)\frac{w_i}{w_{-i}}) + \frac{(1-\alpha)^2}{2\beta},$$

respectively. It is then straightforward to show that $u_i^{eqa}(c_i, c_{-i}) > u_i^{eqi}(c_i, c_{-i}) \Leftrightarrow w_i > \frac{w_{-i}}{n-1}$ and vice versa $u_i^{eqa}(c_i, c_{-i}) < u_i^{eqi}(c_i, c_{-i}) \Leftrightarrow w_i < \frac{w_{-i}}{n-1}$. Hence, if the endowment of player i is larger than the average endowments of the other players, she prefers the equality norm. If the endowment of i is lower than the average, then the equity norm is preferred.

A2. Proof of Proposition 2

Suppose that there are h rich players and $l = n - h$ poor players. Then note that poor players choose the same contribution level xw_l in all mechanisms, since rich players contribute xw_h as first-movers. However, rich players contribute at the most $\frac{(h-1)xw_h + xw_l}{h} = x\frac{(h-1)w_h + w_l}{h} < xw_h$ as second-movers. Hence, the allocation of rich players on first- and second-movers triggers differences in provision levels across mechanism and contributions by the

rich are hxw_h in the rich first mechanism, $(h-1)xw_h + x\frac{(h-1)w_h+w_l}{h}$ in the mixed mechanism with one rich second-movers, etc., and hxw_l in the poor first mechanism. Thus, SEQ with rich first-movers generates the highest provision level and SEQ with poor first-movers the lowest provision level.

A3. Proof of Proposition 4

Let wealth heterogeneity and cooperativeness of the society be such that $w_h x > w_l$ and suppose that there are h rich players and $l = n - h$ poor players. Total provision C of the public good then amounts to

$$C_{rich} = hw_l + l\frac{hw_l}{hw_h}w_l = (h + l\frac{w_l}{w_h})w_l$$

in the rich first mechanism and to

$$C_{poor} = lxw_l + hxw_l = nxw_l$$

in the poor first mechanism. One may easily verify that C_{rich} is larger than C_{poor} if and only if $x < \frac{h+l\frac{w_l}{w_h}}{n}$, and vice versa. Thus, $\frac{h+l\frac{w_l}{w_h}}{n}$ constitutes the threshold where either the rich first or the poor first mechanism becomes more efficient than the other.

Let furthermore $h' \geq 1$ and $l' \geq 1$ be the number of rich and poor first-movers, respectively. Total provision of the mixed mechanisms then amount to

$$\begin{aligned} C_{mixed} &= h'w_l + l'xw_l + (h-h')\frac{h'+l'x}{h'+l'}w_l + (l-l')\frac{h'+l'x}{h'w_h+l'w_l}w_l^2 \\ &= (h'+l'x)(1 + \frac{h-h'}{h'+l'} + \frac{(l-l')w_l}{h'w_h+l'w_l})w_l. \end{aligned}$$

Simple calculations show that $C_{rich} > C_{mixed}$ if and only if

$$x < \frac{h + l\frac{w_l}{w_h} - h'(1 + \frac{h-h'}{h'+l'} + \frac{(l-l')w_l}{h'w_h+l'w_l})}{l'(1 + \frac{h-h'}{h'+l'} + \frac{(l-l')w_l}{h'w_h+l'w_l})},$$

and $C_{mixed} > C_{poor}$ if and only if

$$x < \frac{h'(1 + \frac{h-h'}{h'+l'} + \frac{(l-l')w_l}{h'w_h+l'w_l})}{n - l'(1 + \frac{h-h'}{h'+l'} + \frac{(l-l')w_l}{h'w_h+l'w_l})}.$$

Thus, there is a number of thresholds for the cooperativeness of the society in which the order of mechanisms changes. For small $x > \frac{w_l}{w_h}$, rich first is likely to perform best, while the poor first mechanism attains the highest contribution level when x is large.

A4. Proof of Proposition 5

Let again h be the number of rich players and l the number of poor players. First, we consider the rich first-mover mechanism. In the case of weak wealth heterogeneity, the sum of contributions results to

$$hxw_h + lxw_l = x\sum_i w_i.$$

Since overall wealth is kept constant, the provision of the public good is equal for all possible distributions of weak wealth heterogeneity. When crossing the threshold to strong wealth heterogeneity (i.e., $w_l < xw_h$), both rich and poor players adjust their contributions downward. Rich now contribute w_l and poor $\frac{w_l}{w_h}w_l < xw_l$, resulting into total contributions of

$$(h + l\frac{w_l}{w_h})w_l.$$

It is obvious that further increases in heterogeneity decreases total provision of the public good.

Second, consider the poor first-mover mechanism. Regardless of the degree of wealth heterogeneity total provision of the public good results to

$$lxw_l + hxw_l = nxw_l.$$

Trivially, with increasing heterogeneity and constant total wealth, contributions to the public good are decreasing.

Last, consider the mixed sequence mechanism. Let again $h' \geq 1$ and $l' \geq 1$ be the number of rich and poor first-movers, respectively. In the case of weak wealth heterogeneity, the sum of contributions results to

$$h'xw_h(1 + \frac{h - h'}{h' + l'}) + xw_l(l + \frac{l'(h - h')}{h' + l'}).$$

Suppose that we increase the wealth of rich players by ϵ. Then the wealth of the poor players has to decrease by $\frac{h}{l}\epsilon$. If there is still weak wealth heterogeneity the new total contributions result to

$$h'xw_h(1+\frac{h - h'}{h' + l'})+xw_l(l+\frac{l'(h - h')}{h' + l'})+h'\epsilon x(1+\frac{h - h'}{h' + l'})-\frac{h}{l}\epsilon x(l+\frac{l'(h - h')}{h' + l'}).$$

Hence, in order for total contributions to increase

$$h'\epsilon x(1 + \frac{h - h'}{h' + l'}) - \frac{h}{l}\epsilon x(l + \frac{l'(h - h')}{h' + l'}) > 0$$

needs to be true. It is easy to derive that it requires $l'(1+\frac{h}{l}) < 0$, which constitutes a contradiction to the assumption that $l', h, l > 0$. Therefore, total contribution are decreasing under increasing weak wealth heterogeneity.

Now, assume that the threshold to strong wealth heterogeneity is transcended. From that point on, rich first-movers (contribution w_l), poor first-movers (xw_l) and rich second-movers ($\frac{(h'+l'x)w_l}{h'+l'}$) all contribute less when increasing wealth heterogeneity even more, since w_l is decreasing. It thus remains to show that also contributions of poor second-movers decrease when crossing the threshold. In the case of strong wealth heterogeneity, poor second-movers contribute

$$\frac{(h' + l'x)w_l}{h'w_h + l'w_l^2}.$$

We show that this function is increasing in w_l if overall wealth is kept constant and thus, vice versa, decreasing under constant overall wealth if w_l decreases. In order to do so, we substitute w_h with $w_h = \frac{W}{h} - \frac{l}{h}w_l$, where W is the total wealth of the society. After some simplifications, the derivative of the contribution function results to

$$\frac{w_l(h' + l'x)(\frac{h'}{h}(2W - lw_l) + l'w_l)}{(\frac{h'}{h}(W - lw_l) + l'w_l)^2}.$$

It is easy to see that the derivative is positive for all $w_l > 0$, since $W > lw_l$. Hence, if w_l decreases, so does the contribution of poor second-movers. Thus, the contributions are decreasing in increasing wealth heterogeneity in the mixed order mechanism.

Regression tables

Table B1—First-mover relative contributions

Relative Contribution	Periods 1-15	Periods 1-8	Periods 9-15
SIM-W	0.0371	0.0220	0.0545
	(0.0703)	(0.0746)	(0.0760)
LL-W	-0.00135	-0.0220	0.0223
	(0.0897)	(0.0860)	(0.102)
HL-W	0.00675	-0.00300	0.0179
	(0.0855)	(0.0868)	(0.0940)
HH-S	-0.294***	-0.317***	-0.268***
	(0.0635)	(0.0703)	(0.0674)
LL-S	-0.0319	0.0372	-0.111
	(0.0800)	(0.0825)	(0.0980)
Period	-0.0296***	-0.0264***	-0.0443***
	(0.00232)	(0.00474)	(0.00463)
Constant	0.731***	0.715***	0.908***
	(0.142)	(0.143)	(0.175)
Controls	Yes	Yes	Yes
Observations	2340	1248	1092
χ^2	308.1	124.8	135.6
$Prob > \chi^2$	0.000	0.000	0.000

Note: Random-effects GLS regressions. HH-W is baseline. Std. errors in parentheses adjusted for individual clusters. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table B2— Contributions in W treatments

Contribution	(1)	(2)	(3)	(4)
LL-W	-2.337**	-3.754***	-3.367***	-3.754**
	(1.097)	(1.215)	(1.154)	(1.882)
HL-W	-1.525	-2.390*	-2.340*	-2.390
	(1.074)	(1.376)	(1.298)	(2.182)
Period		-0.607***	-0.480***	-0.607***
		(0.0627)	(0.0675)	(0.0952)
LL-W × Period		0.177*	0.0994	0.177
		(0.0935)	(0.105)	(0.145)
HL-W × Period		0.108	0.0977	0.108
		(0.0917)	(0.102)	(0.136)
Constant	9.110***	13.97***	13.28***	13.97***
	(2.415)	(2.485)	(2.595)	(2.648)
Controls	Yes	Yes	Yes	Yes
Observations	2700	2700	2520	2700
χ^2	24.34	245.1	151.1	178.3
$Prob > \chi^2$	0.001	0.000	0.000	0.000

Note: Random-effects GLS regressions. HH-W/SIM-W is baseline. Std. errors in parentheses adjusted for individual clusters in (1), (2) and (3), and for group clusters in (4). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

TABLE B3—INCOME INEQUALITY AND INCOME BY TYPE IN W TREATMENTS

	Difference in income		Income	
	(1)	(2)	Rich	Poor
LL-W	3.233***	5.125***	0.424	-5.116***
	(0.675)	(0.875)	(1.094)	(1.543)
HL-W	1.772***	2.147**	-0.354	-2.868*
	(0.638)	(0.992)	(1.110)	(1.680)
Period		0.237***	-0.221***	-0.496***
		(0.0443)	(0.0618)	(0.0715)
LL-W × Period		-0.237***	-0.0150	0.245**
		(0.0617)	(0.0989)	(0.0988)
HL-W × Period		-0.0468	0.0391	0.129
		(0.0817)	(0.0910)	(0.114)
Constant	4.974***	3.076*	24.78***	32.92***
	(1.861)	(1.847)	(2.559)	(3.541)
Controls	Yes	Yes	Yes	Yes
Observations	2700	2700	1395	1305
χ^2	36.74	88.26	49.80	118.6
$Prob > \chi^2$	0.000	0.000	0.000	0.000

Note: Random-effects GLS regressions. HH-W/SIM-W is baseline. Std. errors in parentheses adjusted for group clusters in (1) and (2) and for individual clusters in Rich and Poor. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table B4—Contributions and income inequality in S treatments

	Contribution	Diff. in income
LL-S	0.126	0.505
	(1.446)	(1.246)
Period	-0.551***	0.272***
	(0.0846)	(0.0609)
LL-S × Period	0.0579	-0.119
	(0.110)	(0.0886)
Constant	12.67***	12.96***
	(4.473)	(3.837)
Controls	Yes	Yes
Observations	1350	1350
χ^2	105.0	32.66
$Prob > \chi^2$	0.000	0.000

Note: Random-effects GLS regressions. HH-S is baseline. Std. errors in parentheses adjusted for individual clusters. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table B5— Impact of degree of heterogeneity on HH and LL

Contribution	HH	LL
STRONG	-6.069***	-2.335
	(1.451)	(1.497)
Period	-0.660***	-0.430***
	(0.0758)	(0.0696)
STRONG × Period	0.108	-0.0633
	(0.114)	(0.0984)
Constant	22.58***	16.40***
	(4.654)	(5.706)
Controls	Yes	Yes
Observations	1380	1335
χ^2	200.0	107.7
$Prob > \chi^2$	0.000	0.000

Note: Random-effects GLS regressions. HH-W and LL-W are baseline, respectively. Std. errors in parentheses adjusted for individual clusters. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table B6— Impact of degree of heterogeneity on contributions by type

	Contribution		Relative Contribution	
	(1)	(2)	(3)	(4)
Rich	2.585**	3.671***	-0.101*	-0.230***
	(1.244)	(1.334)	(0.0607)	(0.0664)
STRONG	-3.985***	-3.985***	-0.120**	-0.120**
	(0.794)	(0.794)	(0.0562)	(0.0563)
Rich × STRONG	-0.183	-0.183	-0.0914	-0.0914
	(1.638)	(1.639)	(0.0773)	(0.0774)
Period		-0.464***		-0.0380***
		(0.0410)		(0.00340)
Rich × Period		-0.136*		0.0161***
		(0.0742)		(0.00408)
Constant	13.81***	17.53***	0.834***	1.139***
	(3.432)	(3.437)	(0.163)	(0.163)
Controls	Yes	Yes	Yes	Yes
Observations	2715	2715	2715	2715
χ^2	51.31	304.3	51.88	322.7
$Prob > \chi^2$	0.000	0.000	0.000	0.000

Note: Random-effects GLS regressions. Poor in W is baseline. Std. errors in parentheses adjusted for individual clusters. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$