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CONTEXT EFFECTS IN A NEGATIVE EXTERNALITY EXPERIMENT

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Context effects in a negative externality experiment

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Abstract
This study investigates the degree to which framing and context influence observed rates of free-riding behavior in a negative externality laboratory experiment. Building on the work of Andreoni (1995a) and Messer et al. (2007) we frame the decision not to contribute to a public fund as generating a negative externality on other group members. The experimental treatments involving 252 subjects vary communication, voting, and the status quo of the initial endowment. Results indicate that allowing groups the opportunity to communicate and vote significantly reduces rates of free-riding, and this effect is especially pronounced when initial endowments are placed in the private as opposed to the public fund.

Keywords: Negative externality; voluntary contribution mechanism; cheap talk; voting; status quo bias; experimental economics

JEL Codes: C91, C92, H4

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1. Introduction

The framing of economic decisions and the context in which they are made have been found to have a significant impact on individual behavior in social dilemma situations. A consistent result from the behavioral economics literature is that, relative to Nash predictions, individuals have a greater propensity to engage in pro-social behavior and altruism when such behavior is framed as providing external benefits as opposed to being framed as avoiding external costs. This result manifests itself in lower observed instances of free-riding in voluntary contribution (VCM) experiments than in common pool resource (CPR) experiments, where the choice to free ride is framed as generating a negative externality. Andreoni (1995a) summarizes this result by suggesting that individuals are motivated more by the "warm-glow of doing something good than the cold-prickle of doing something bad." (P. 2)

In this paper we revisit the warm-glow/cold prickle result and conduct experiments that vary the context in which decisions are made. Specifically, we investigate the degree to which communication, voting, and the status quo of the initial endowment influence participants' propensity to free-ride in a negatively framed experiment. We then compare our results to the level of free riding observed in Messer et al. (2007), in this journal, who utilize an identical payoff function to investigate the role of the same set of context variables in a positively framed VCM.

Messer et al. (2007) find that allowing participants the chance to engage in non-binding, pre-play communication, to vote on whether or not to participate in the VCM, and changing the

status quo so that initial endowments go toward the public fund dramatically reduces observed free-riding behavior. These results suggest that simply changing the context in which decisions are made has the potential to increase the efficiency of voluntary public goods provision. In the current investigation, our aim is to understand the degree to which these same contextual factors can improve the efficiency of decisions that potentially result in the generation of negative externalities. Our results suggest that context does play a significant role in reducing free-riding behavior when the decision is framed in a negative context, although we find some interesting differences in the role of the context variables when compared to the results of the positively framed VCM.

The remainder of the paper will be organized as follows. In the next section we highlight some key results from the behavioral and experimental economics literature related to decision making in social dilemma settings. In section three we describe the experimental protocol that we follow, and then highlight the experimental results in section four. Section five concludes with a discussion of the policy relevance of this research.

2. Relevant Literature

Early work by Marwell and Ames (1979, 1980) utilized laboratory experiments to investigate the degree to which participants chose to invest their endowments in a private fund, which returned a fixed amount, or a public fund, where the return was dependent on the decisions of all other participants. The experimental results showed that although free-riding does occur, participants consistently contributed to public goods in a laboratory setting, despite theoretical predictions to the contrary. Later work by the same authors employed a more robust set of

VCM experiments to further illustrate that although the strong free-riding predicted by theory did not occur; weak free-riding, which leads to sub-optimal outcomes, was consistently observed (Marwell and Ames, 1981). Consequent field studies have shown that people not only contribute to public goods in laboratory settings but also make contributions in real world settings (Rose et al., 2002, Landry et al., 2006).

Pro-social behavior in a VCM setting cannot be ascribed solely to confusion. Studies have shown that, on average, about half of all cooperation comes from participants who understand free-riding but choose to cooperate out of some form of kindness or altruism (Andreoni, 1995b). Thus, it is important to know which factors lead people to engage in pro-social behavior and how these factors affect decision making.

Group size and the marginal per-capita return (MPCR) are two important factors that have been found to influence decisions in a VCM. Isaac and Walker (1988) found that increasing group size, which reduces the MPCR, leads to lower contribution rates. However, their results do not support a pure numbers-in-the-group effect. Fisher et al. (1995) further investigated the effect of MPCR by offering participants within each group an individual MPCR and continued to find a strong effect from an individual's MPCR as an explanation for the level of contributions to the group fund. In heterogeneous groups, low-MPCR types contributed less than high-MPCR types, however no "poisoning of the well" or "seeding" effect was found. Anderson et al. (1998) employed both linear and quadratic settings in their experimental design and found that total contributions increase with the marginal value of the public good and the number of participants. Additionally, mean contributions lie between the Nash prediction and half the endowment.

Punishment and rewards also have the potential to influence participant decision making in social dilemma games. Anderson and Stafford (2003) reported an experiment with a financial penalty for free-riding. They introduced the punishment mechanism in both a one-time and a repeated treatment and found that contributing to the public good is increasing in expected punishment cost in both treatments. They also found that the punishment's severity has a larger effect on behavior than its probability. In the repeated treatment, however, past punishment had a negative rather than positive effect on contributions. Recent research by Sutter et al. (*forthcoming*) suggests that although participants prefer a policy that offers rewards for contributions made to the public good, punishments for free-riding more effectively induce contributions.

In addition to studies that investigate the role of changes in the explicit costs and benefits of decision making in social dilemma settings, researchers have also evaluated how institutional context influences an individual's decision of whether to free ride. This research utilizes laboratory experiments to study the contextual factors which may affect participants' contributions in a VCM or their willingness to limit their use of a common pool resource. In this paper, we focus on the effect of three contextual factors that have been shown to influence decision making in a laboratory setting; communication, voting, and changes to the status quo. The remainder of this section outlines previous research exploring each of these contextual factors as well the effect of the framing of the contribution decision.

Communication has been extensively discussed in previous experimental studies. For example, Isaac and Walker (1988) introduced active commutation into public good games and found that communication reduced free riding even when the opportunity for communication

followed substantial free riding in a non-communication environment. The ameliorative effects of communication, however, when it followed non-communication, were hampered relative to the case in which communication was present from the beginning. Isaac and Walker (1988) also studied the cross-effect between communication and heterogeneity in endowments, group size, and returns to the public good. In each case, face-to-face communication between periods significantly increased contributions to the public good. Similar results regarding the benefits of communication have been observed in common pool resource settings (Ostrom et al. 1994). Groups that were allowed to engage in non-binding communication displayed significantly lower levels of free-riding and thus improved the efficiency of common pool resource provision.

More recent work (Hackett et al. 1994; Brosig et al. 2003; Bochet et al. 2006) has studied the impact of communication on cooperation in more complicated environments. Hackett et al. (1994) conducted CPR games with heterogeneous appropriators and found that heterogeneity creates a distributional conflict over access to common-pool resources. Brosig et al. (2003) suggested that the success of coordination efforts largely depends on the communication method. A unidirectional communication technology proved to be rather ineffective at enhancing cooperation even in small groups. Video-conferencing that was completed via a computer network was as effective as a face-to-face meeting. Audio communication by itself did much worse than the video-conference. Bochet et al. (2006), however, argued that facial expression was not crucial. They found that verbal communication through a chat room that preserved anonymity and excluded facial expressions and other visual cues was almost as effective at increasing contributions as face-to-face communication proved to be in earlier work. Both studies were conducted using standard public good games so further

investigation is needed to confirm the role of identification in communication in a negative externality setting.

The second contextual treatment variable that we investigate in this study involves voting. Allowing groups the opportunity to vote on whether or not they choose to participate and potentially on the rules of the game can influence decision making even in instances where groups do not explicitly vote on contribution levels. Voting by itself did not appear to increase cooperation in Kroll et al. (2007) and Messer et al. (2007), it did, however, appear to significantly reduce free-riding behavior when paired with the opportunity to engage in communication (Messer et al., 2005; Messer et al., 2007). Further, Ostrom et al. (1992) found that allowing groups the opportunity to vote on punishment regimes in a CPR significantly reduced the amount of free riding observed, compared to a situation where punishments were imposed exogenously.

Status quo is the third contextual factor that we investigate. Studies in economics, psychology, and sociology have shown that individuals disproportionately stick with the status quo decision. In the experiments conducted by Samuelson and Zeckhauser (1988), participants were asked to choose one option out of a fixed number of alternatives. The authors found significant status quo bias in treatments where participants were given a specific option and had to decide whether to switch to another option, compared to treatments where there was no default option. Moreover, the authors analyzed data on selections of health plans and retirement programs by faculty members and found that there was substantial status quo bias in important real-world decisions.

Kahneman et al. (1991) ascribed status quo bias to an implication of loss aversion—that is, individuals have a strong desire to remain at the status quo because the disadvantages of leaving it loom larger than the advantages. In consumer theory, status quo bias can also influence market decisions. This is demonstrated by analysis of consumers' willingness to pay for a particular unpriced product (Hartman et al., 1991). The impact of status quo in a VCM was examined by Messer et al. (2007) and was found to have a significant effect on participants' decision -- though this effect frequently did not persist. Finally, the framing of the contribution decision can also have an impact on free-riding behavior (Andreoni, 1995a). Andreoni conducted VCMs with 40 undergraduate students that were place in groups of five. Participants were asked to allocate their initial endowments between an individual exchange and a group exchange. Under the positive framing, the choices available to participants were described as (P. 18-19):

> *The Individual Exchange:* Every token you invest in the Individual Exchange will yield you a return of one. The other members of your group are not affected by your investment in the Individual Exchange.
>
> *The Group Exchange:* Your return from the Group Exchange will depend on the total number of tokens that you and the other four members of your group invest in the Group Exchange. The more the group invests in the Group Exchange, the greater the return to each member of the group. Every token invested in the Group Exchange yields a return of 1/2 for each member of the group, not just the person who invested it.

Under the negative framing, the two exchanges were described on as (P. 17):

> *The Individual Exchange:* Every token you invest in the Individual Exchange will yield you a return of one. However, each token you invest in the individual exchange will reduce the earnings of the other players by one half cent each.
>
> *The Group Exchange:* Every token you invest in the Group Exchange yields a return of 1/2 for you. The other members of your group are not affected by your investment in the Group Exchange.

The results from this experiment illustrate a significant framing effect. Participants tend to contribute more to the group exchange under positive framing than under negative framing. Park replicated Andreoni's experiment and ascribed the differences in contributions to the value orientations of particular participants (Park, 2000).

Framing effects were also shown to have an impact on participants' decision when the game has an interior Nash prediction (Willinger and Ziegelmeyer, 1999). Cookson (2000) found that participants contribute more when the payoff function is decomposed in terms of a gift which is multiplied and distributed to the other players, rather than the equivalent public good from which everyone benefits. Additionally, participants contributed more following a comprehension task which asks them to calculate the benefits to the group of various actions, rather than the benefits to themselves (Cookson, 2000). Brandts and Schwieren (2007) study Andreoni's negative frame using different parameters (group size, etc.) and their results suggest that the frame manipulation does not have a significant effect on average behavior, but does impact extreme behavior.

Hsu (2003) found that framing alone had no significant effect on cooperation in threshold public goods and common pool resource games, but determined that its interaction with group size was significant. Participants in small groups preferred "giving" to "not taking" and preferred "taking all" to "giving nothing" while participants in large groups preferred just the opposite. Kotani et al. (2008) found that the effect of framing on contribution decisions was negligible in their threshold public goods experiments.

3 Experimental Design

All experiments were conducted in an experimental economics laboratory in a large research university in the northeast part of the United States. Participants were primarily recruited through email solicitation, and all participants were undergraduate students with some background in economics. Each session consisted of twenty rounds with groups composed of seven participants that participated in only one treatment. Individual sessions were conducted with either one or two groups. In sessions with two groups, the groups participated in the same treatment and pre-play communication among group members was completed in separate rooms. Overall 252 participants took part in the experiment.

Participants received written instructions[1] and the experimenter gave a verbal description of the experiment using a PowerPoint presentation. The participants were told that they would need to make a decision in every round and would receive information on aggregate group decision making after all participants had submitted their decisions for a particular round. To reduce potential end-round effects, participants were not given information on the duration of the experiment.

At the start of each round, each participant was endowed with one experimental dollar and was asked to decide how to allocate this dollar between two accounts titled 'Account A' and 'Account B. Account A represented the public fund, while Account B represented the private fund. The money allocated to Account A was multiplied by 1.5 and was theirs to keep. The money allocated to Account B was multiplied by 2.5 and was also theirs to keep. In addition, all participants were required to pay a fee which was calculated by multiplying the total amount allocated to Account B across all participants by the MPRC of 0.214. Therefore, a participant's

[1] Versions of the full instructions can be found in the Reviewer Appendix.

earnings in a round was the Account A payoff plus the Account B payoff minus the Account B loss, which was the same for all group members. A table in the instructions showed how the Account B loss was calculated for different levels of the total amount in Account B. Formally, the payoff function faced by participant *i* was

$$\pi_i = 2.5x_i + 1.5g_i - \frac{1.7}{7}\sum_{i=1}^{7} x_i \qquad (1)$$

where x_i represents funds allocated to Account B (private fund) and g_i represents funds allocated to Account A (public fund).[2]

Participants made decisions via a Microsoft Excel spreadsheet programmed with Visual Basic for Applications and all of the computer terminals were equipped with privacy screens. In each round, participants submitted their decisions confidentially and the experimenter guided them to update the information for the current round and proceed to the next round. The participants could always review information from previous rounds and were able to track cumulative earnings. They were paid US dollars at the end of each session with an exchange rate of 1 US dollar to 2 experimental dollars. Generally, participants' earnings fell between $10 and $15, for sessions lasting between 20 and 45 minutes.

The experimental design incorporates three treatment variables: communication, voting, and status quo, and six treatments in total were conducted. Participants in each treatment were able to identify the members of their group visually. The set of experimental treatments that were conducted are identical to those in Messer et al., 2007, which were undertaken with

[2] Note that this is functionally equivalent to the payoff function used in Messer et al. (2007) $\pi_i = x_i + \frac{1.5}{7} g_i + \frac{1.5}{7}\sum_{j \neq i} g_j$, where $x_i + g_i = 1$.

a positive framing. The payoff scenarios in each of the two papers are identical, as mentioned above. The difference being that contributions made to Account A in Messer et al. were said to increase the payoffs to all other group members, while in the sessions described in this paper contributions made to Account B were said to reduce the payoffs of all other group members. Table 1 gives a description of all treatments that we employed in our experiments.

In treatments 1 and 2 participants were not allowed to communicate at any point during the session. Participants in treatments 3 and 4 were given up to ten minutes to discuss their strategies for the group prior to the first round of the session, but binding deals or threats were not permitted. No discussion was permitted once the first round began.

In treatments 5 and 6, groups had a chance to vote on playing either the group experiment described above, or a private lottery. In the private lottery game, participants choose whether to invest their one experimental dollar endowment in a lottery that paid either two experimental dollars or zero with equal probability.[3] Prior to voting, participants were given the opportunity to communicate with other group members. Each participant then voted anonymously on whether to play the group experiment or the private lottery. After all votes were cast, the results were announced and the game favored by the majority was played. In all experimental sessions where participants had the opportunity to vote, groups chose to play the group experiment rather than the private lottery. As such, an explicit analysis of voting behavior is not included in the results section.

To test the effect of status quo bias, participants in treatments 1, 3, and 5 started each round with an initial balance of one dollar in Account B (the private fund) and were asked

[3] Note that the group experiment payoff dominates the private lottery, which has an expected payoff of one.

whether they wanted to *make a contribution* by moving part or all their endowment from Account B to Account A (the public fund). Any money not contributed to Account A remained in the participant's Account B. Participants in treatments 2, 4, and 6 started each round with their initial endowment in Account A. Participants then decided whether to *request a refund* by moving part or all of their endowment from Account A to Account B. Any money not refunded remained in the participant's Account A.

4. EXPERIMENT RESULTS

Graphical depictions of the results from the experimental treatments are provided in figures 1-3. Each figure presents a specific communication and voting scenario and provides separate results for the status quo of the public fund (Account A) and the private fund (Account B). The participant choices are then analyzed at the group level to formally identify any treatment effects. We also compare the treatments results to the results in Messer et al. (2007). Finally, an individual level analysis of "extreme behavior" (zero contributions and full contributions) is included in the appendix.

Table 2 shows the average contributions made (as a percentage) to the public fund in each treatment. In the discussion that follows, the treatment condition referred to as "status quo" describes the scenario where the funds are initially placed in the public fund whereas the baseline treatment condition is for the endowment to be placed in the private fund. Initial contributions as a fraction of the endowment in the first round ranged from a low of 39.5% for treatment 1 (baseline) to a high of 98.3% for treatment 5 (cheap talk and voting). Contribution rates in the final round 20 ranged from a low of 11.7% in treatment 2 (status quo) to a high of

88.5% in treatment 5 (cheap talk and voting). These results demonstrate that context plays an important role in determining both initial contributions and the decay in contribution rates. To further quantify the effects of contextual factors in the experiment and to formally conduct hypothesis testing, a two-limit Tobit model with random effects was estimated. To account for potential heteroscedasticity and specification errors, Jackknife standard errors, which do not require distributional assumptions, were used (Miller, 1974; Wu, 1986).[4,5]

As shown in the first column of Table 3, TR2–TR6 represent dummy variables for treatments 2–6. The coefficients of these variables show the marginal effect of the treatment conditions on the latent contribution rates. The treatment indicator variables are interacted with the round number to generate variables TR1×Round - TR6×Round, which provide information on the evolution of contribution rates over time in each treatment. The model results are generally consistent with Figures 1-3 and Table 2, as the coefficients on the treatment variables identify that contribution rates are statistically higher than the baseline treatment, except treatment 2 (SQ). Although the difference between the coefficients for TR3(CT) and TR4(SQ/CT) and between TR5(CT/VT) and TR6(SQ/CT/VT) are substantial, the large standard errors imply that the coefficients are not significant at the 10% level (p-value = 0.591 and 0.122, respectively). The effect of changes in status quo on mean contribution rates therefore appears to be muted.

To test the effect of cheap talk we perform pair-wise comparisons of the coefficients from similar treatments with and without cheap talk. The coefficient on treatment 3 of 0.62 is significantly different from zero at a 1% level and suggests that allowing pre-play

[4] Robust standard errors were not used as they are only efficient with large sample size (Hinkley and Wang, 1991).
[5] The model was estimated using the delete-one Jackknife method in STATA 11.

communication increases contributions to the public fund above baseline levels. Similarly, an F-test comparing TR2(SQ) and TR4(SQ/CT) reveals that cheap talk also significantly increases contributions ($p = 0.022$) when the status quo is the public fund.

The effect of voting on contribution rates is tested by applying an F-test to compare TR3(CT) and TR5(CT/VT) as well as to TR4(SQ/CT) and TR6(SQ/CT/VT). Results show that voting by itself does not significantly increase or decrease contributions at the group level ($p = 0.241$ and 0.962, respectively).

To identify how the context treatments influence contribution rates over time, we evaluate the treatment$\times$round interaction coefficients. The interaction variables for treatments one, two, four and six are all negative and significantly different from zero at the 1% level, while the round variables for treatments three and five are not significantly different from zero at conventional levels. In each case, treatments involving a status quo of the public fund exhibit a higher rate of decay in contributions than treatments where the private fund is the status quo. This difference is especially pronounced when comparing the round interaction coefficients for treatments 5 and 6. This result is particularly interesting as it is not immediately clear why having the public fund as the status quo would influence rates of decay. One possible explanation for this outcome is the reciprocating behavior that is generated when participants realize that other group members are going out of their way to free ride.

The analysis described above is summarized with the following three observations:

Observation 1. *Communication has a positive effect on contributions;*

Observation 2. *Voting does not independently have a significant impact on contributions;*

Observation 3. *Contribution rates decay more quickly when the status quo contribution is in the public fund as opposed to the private fund.*

The bottom panels of figures 1-3 provide histograms of the individual contribution decisions for each treatment. It is clear from the figures that in each treatment the majority of decisions are either full contributions to the public fund or contributions of zero. A formal evaluation of the individual decisions utilizing Probit models of the full and zero contribution behavior is presented in the Appendix. These results largely corroborate the evaluation of group decision making provided above.

This final portion of the analysis compares the results observed with the negative framing used in this experiment to the results in Messer et al. (2007), which uses a positively framed VCM. This comparison allows for an understanding of whether framing alters the role of context in influencing participant behavior. Table 4 provides the mean contribution levels from Messer in round 1 and round 10 as well as the comparable contribution levels in our negatively framed experiment. Messer et al. only conducted ten experimental rounds, where the number of rounds was unknown to the subjects, and therefore our comparison focuses on the first ten rounds of the current experiment. The baseline results, with no communication or voting, are in line with the results from Messer. In particular, the mean initial contribution level when the endowment allocated to the private fund is 47.0% in Messer et al. and 39.5% in our sessions. This difference of roughly 8% associated with changing the frame of the experiment from positive to negative is in the same direction, although smaller than the results found in Andreoni (1995a).

Communication on its own and communication combined with voting significantly increase contributions in both the positively and negatively framed experiments, but it appears

that the status quo has opposing effects across the two studies. In the communication and communication plus voting treatments in Messer et al. when the status quo endowment is the public fund, contributions to the public fund are at least as high as when the status quo is the private fund. In addition, the decay in contribution levels are considerably lower when the public fund is the status quo. The opposite is observed in the negatively framed sessions that we undertake in the current paper. In the communication and communication plus voting treatments, initial contributions to the public fund are higher and the decay is significantly lower when the status quo is in the private fund (treatments 3 and 5) compared to the case where the status quo is the public fund (treatments 4 and 6).

The comparison across studies allows us to make two final observations related to the role of framing in social dilemma settings:

> ***Observation 4***. *With cheap talk and voting, initial contribution rates are higher when the status quo is the private fund relative to the public fund in the negative frame and lower in the positive frame;*
>
> ***Observation 5***. *When cheap talk and voting occur, there is less decay in contribution rates when the status quo is the private fund with the negative frame and more decay with the positive frame;*

The apparent reversal of the status quo effect is somewhat puzzling. Our expectation was that although the effect of communication, voting, and having the initial endowment in the public fund would be more muted in the negative setting, the direction of the effect would remain the same. The fact that the effect of the initial endowment reverses across the positively and negatively framed experiments is interesting and worthy of further attention. Anecdotal evidence suggests that groups in the negatively framed experiment with a status quo of the public fund were less likely to reach a consensus on a particular strategy and this led to

lower initial contributions. Reciprocity in standard VCM experiments has been shown to have a significant effect on contribution decisions, as participants in VCMs tend to match the contributions of others (Croson et al., 2005). The intuition for why we observe greater decay seems to stem from an increased sensitivity to reciprocating behavior in the negatively framed experiment. When one participant went out of their way to impose costs on other group members by moving funds from the public fund to the private fund, this appears to encourage reciprocating behavior from other group members.

5 Conclusion

This paper utilizes results from a series of laboratory economics experiments to investigate the role of context and framing on rates of free riding. The payoff function faced by participants is identical to the VCM experiments of Messer et al. 2007, with the difference being that the decision not to donate to the public fund is framed as generating a negative externality. Echoing the results of Andreoni (1995a), we find that in the baseline treatment participants in our negatively framed experiment engage in more free-riding behavior than in the positively framed experiments summarized in Messer et al.

To investigate the role of context in a negative externality setting, we introduce as treatment variables communication, voting, and changes to the nature of the initial endowment. Our results suggest that, similar to the findings of Messer et al., allowing groups to communicate and vote leads to significantly lower rates of free riding. In contrast to the findings of Messer et al., however, we find that having the private fund as the status quo (i.e., placing the initial endowment in the private fund) actually reduces free riding when groups

communicate and vote, relative to treatments where the status quo is the public fund. In contrast, Messer et al., found that the lowest sustained rates of free-riding were observed with communication, voting, and the public fund status quo.

For policy makers, it is clear that in cases where there is a desire to increase contributions to a public good it makes sense to frame donations positively, rather than trying to guilt individuals into contributing by suggesting that if they do not contribute they will impose costs on others. So, for example, public radio stations looking to increase contributions will likely be more successful by touting all of the positive benefits associated with an individual choosing to make a contribution, rather than highlighting how the choice not to contribute imposes costs on other listeners because fewer programs will be offered.

The second take home message for policy makers is more nuanced. We find that in cases where a choice is framed as potentially generating negative externalities and groups are communicating, an initial condition under which individuals must take some action not to free ride is preferable. As an example, suppose that a municipality is attempting to deal with a severe drought by asking citizens to take voluntary measures to reduce water consumption rates. The consumption of water in this case is framed as a negative externality because it reduces the amount of water available for all other users. According to our results, it would be advisable to use as a status quo the current rates of water consumption rather than having a status quo of zero water consumption. In other words, rather than focus on how much water each household is using, overall water conservation will be improved if policy makers instead focus on how much less water a household uses compared to previous periods. In this way, the difference between changes in status quo and differences in framing become more difficult to

differentiate. Altering the status quo so that the default position is that the externality will be generated makes actions to reduce the externality analogous to conservation, which is very similar to framing the decision as making a contribution to a public good.

Furthermore, many environmental problems are caused by externalities that have the default behavior being socially sub-optimal. The good news from our research is that status quo does not have to be manipulated to set the default as the socially optimal behavior to have a significant and long-lasting positive effect. Thus, authorities may not need to worry about altering the status quo when trying to solve externality problems, but instead focus on developing meaningful forums by which the participants can communicate and vote.

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Table 1. Treatment summary

	Cheap Talk	Vote	Status quo	Number of Participants
Treatment 1	No	No	Private Fund	42
Treatment 2	No	No	Public Fund	42
Treatment 3	Yes	No	Private Fund	42
Treatment 4	Yes	No	Public Fund	42
Treatment 5	Yes	Yes	Private Fund	42
Treatment 6	Yes	Yes	Public Fund	42

Table 2. Contributions to the public fund.

	1st round	10th round	20th round
Treatment 1	0.395 [3,4,5,6]	0.173 [3,4,5,6]	0.117 [3,4,5]
Treatment 2	0.452 [3,4,5,6]	0.147 [3,4,5,6]	0.147 [3,4,5]
Treatment 3	0.815 [1,2,5]	0.773 [1,2,4,5,6]	0.643 [1,2,4]
Treatment 4	0.767 [1,2,5]	0.581 [1,2,3,5]	0.417 [1,2,,3,5]
Treatment 5	0.983 [1,2,3,4,6]	0.932 [1,2,3,4,6]	0.885 [1,2,3,4,6]
Treatment 6	0.752 [1,2,5]	0.420 [1,2,3,5]	0.295 [3,5]

Note: Two sample Wilcoxon rank-sum (Mann Whitney) tests.
Combined sample size of each test is 84.
[1] denotes different from treatment 1 at the 0.05 level.
[2] denotes different from treatment 2 (status quo) at the 0.05 level.
[3] denotes different from treatment 3 (cheap talk) at the 0.05 level.
[4] denotes different from treatment 4 (cheap talk, status quo) at the 0.05 level.
[5] denotes different from treatment 5 (cheap talk, voting) at the 0.05 level.
[6] denotes different from treatment 6 (cheap talk, voting, status quo) at the 0.05 level.

Table 3. Random-effects Tobit model on group-level contributions to the public fund.

Variable	Coefficient
Intercept	0.3379**
	(0.0404)
TR2 (SQ)	0.0475
	(0.0572)
TR3 (CT)	0.6203**
	(0.1663)
TR4 (SQ/CT)	0.4923*
	(0.1851)
TR5 (CT/VT)	0.9510**
	(0.2381)
TR6 (SQ/CT/VT)	0.4791*
	(0.2199)
TR1×Round	-0.0125**
	(0.0018)
TR2×Round	-0.0158**
	(0.0017)
TR3×Round	-0.0120
	(0.0073)
TR4×Round	-0.0187**
	(0.0039)
TR5×Round	-0.011
	(0.0153)
TR6×Round	-0.0286**
	(0.0052)
Log likelihood	361.6318
Left-censored	3
Uncensored	544
Right-censored	173

Notes: Sample size of balanced panel is 720 with 20 in each group.
Jackknife standard errors are reported in parentheses.
* denotes significant at 0.05 level; ** denotes significant at 0.01 level.

Table 4. Comparison of mean contributions

	Messer et al. 2007		Negative frame results	
	1st round contribution	10th round contribution	1st round contribution	10th round contribution
Treatment 1	0.470	0.178	0.395	0.173
Treatment 2	0.690	0.145	0.452	0.147
Treatment 3	0.886	0.112	0.815	0.773
Treatment 4	0.950	0.574	0.767	0.581
Treatment 5	0.971	0.761	0.983	0.932
Treatment 6	0.971	0.943	0.752	0.420

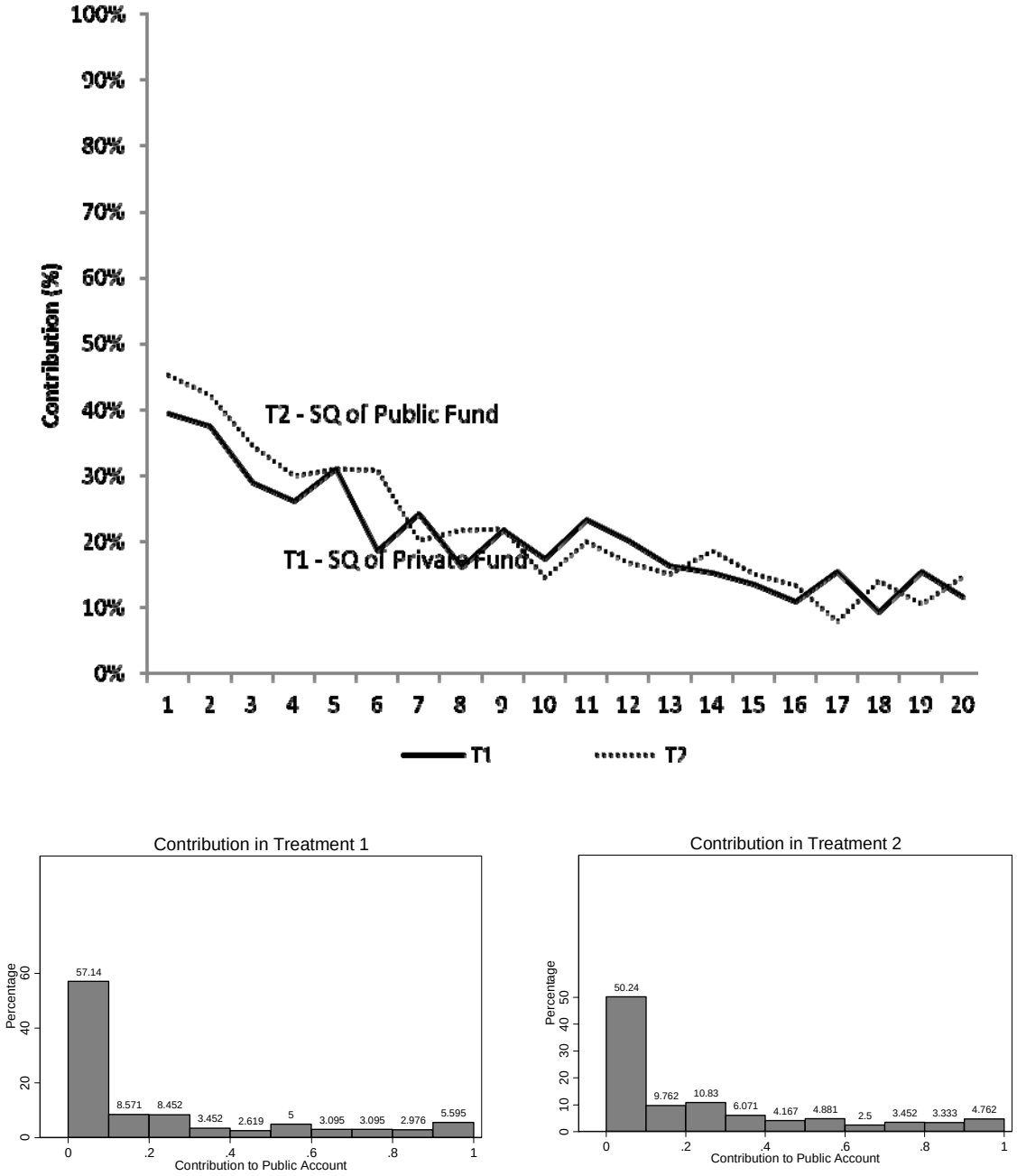

Figure 1. Aggregate and individual contributions in treatments 1 and 2

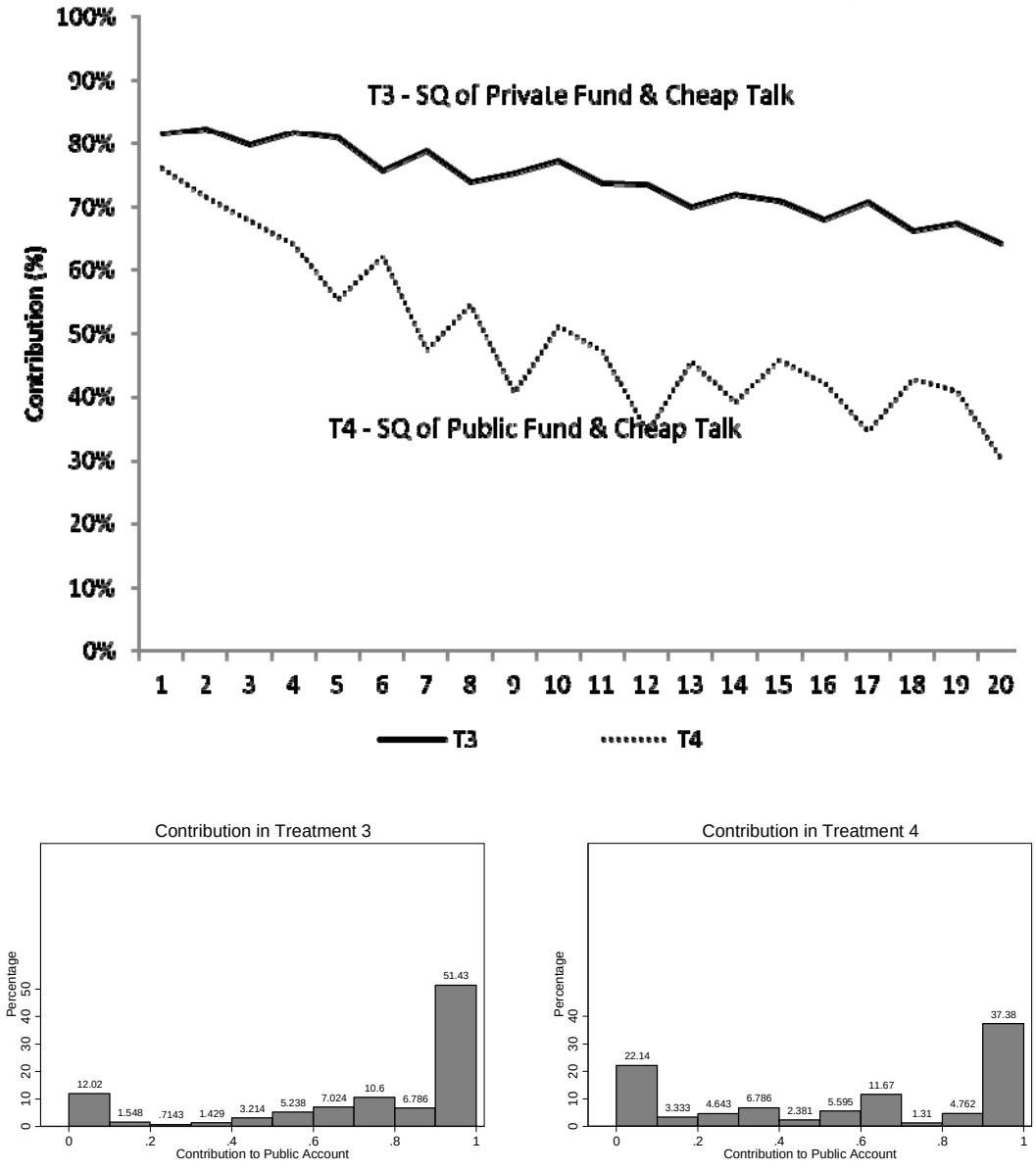

Figure 2. Aggregate and individual contributions in treatments 3 and 4

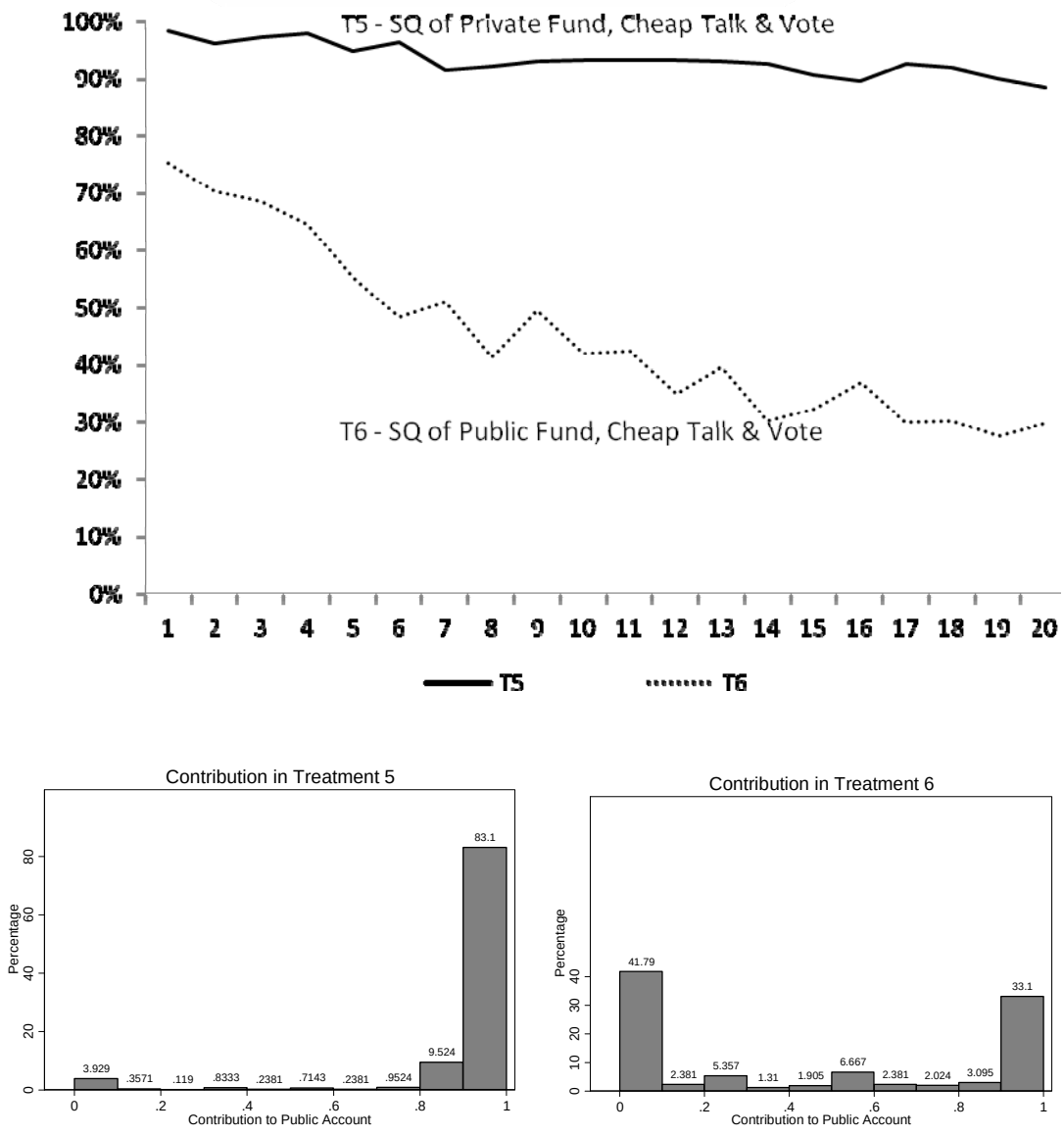

Figure 3. Aggregate and individual contributions in treatments 5 and 6.

Appendix – Analysis of Individual Contribution Behavior

The trends of the extreme values from round 1 to round 20 are shown in Figure A1. To further study the effect of these factors, a Probit model with random effects was estimated to test the treatment effects on the probability of full contributions and zero contributions (Table A1). This analysis shows that people generally contribute "something" instead of "nothing" in the negative externality VCM settings, which contradicts Nash equilibrium prediction regarding contributions to a public good but is consistent with previous studies of the VCM. Each of the cheap talk and cheap talk plus voting treatment variables have negative coefficients and most are significantly different from zero, which suggests that these context factors tend to reduce the frequency of zero contributions.

The predicted probability of a zero or full contribution in a specific treatment and round can be determined by converting the z-values in the Probit regression. In treatment 1 (baseline), the predicted probability that a participant will make a zero contribution in the first round is 22.25% while it is 60.93% in the last round. In the first round of treatment 5, the probability of a zero contribution is nearly zero; while in the last round it is still less than 2%. This is strong evidence that cheap talk and voting together significantly reduce the probability of making a zero contribution.

Since nearly all of the coefficients of the round variables in the zero contributions model are significantly positive, repeated play tends to increase the probability of a zero contribution. In treatment 6 (cheap talk, voting and status quo), this effect is especially obvious. Although the combination of cheap talk, voting, and a status quo of the public fund provided the most

efficient outcomes in the positively framed VCM (Messer et al., 2007), it did not generate the best outcomes in the negatively framed experiment. Instead this treatment tends to increase the likelihood that participants will donate nothing in later rounds.

The same analysis is also applied to full contribution situations. In the baseline treatment (treatment 1), the predicted probability of a full contribution in the first round is 2.01% and decreases to 0.02% by the last round. For the "best" treatment (treatment 5), the probability is 99.89% in the first round and 99.80% in the last. Another noticeable feature in this regression is that the round variable does *not* always have an effect on the probability of a full contribution. The coefficients of TR3(CT) and TR5(CT/VT) are not significant at the 0.1 level, which implies that participants in these treatments are more likely to maintain the full contribution strategy.

Table A1. Random-effects Probit models of zero and full contributions at the individual level.

Variable	Zero Contributions	Full Contributions
Intercept	-0.8187*	-1.9569**
	(0.3207)	(0.3791)
TR2 (SQ)	-0.3353	-0.3956
	(0.4469)	(0.4539)
TR3 (CT)	-3.2506**	2.1231**
	(0.7418)	(0.6688)
TR4 (SQ/CT)	-1.5874**	1.5235*
	(0.4766)	(0.6091)
TR5 (CT/VT)	-4.1691	5.0198**
	(2.2790)	(1.0238)
TR6 (SQ/CT/VT)	-0.8765*	2.6603**
	(0.4438)	(0.5788)
TR1×Round	0.0548**	-0.0770**
	(0.1368)	(0.0242)
TR2×Round	0.0629**	-0.0736**
	(0.1436)	(0.0238)
TR3×Round	0.1119**	-0.0224
	(0.0354)	(0.0230)
TR4×Round	0.0660**	-0.0729*
	(0.1851)	(0.0293)
TR5×Round	0.1042	-0.0096
	(0.1086)	(0.0382)
TR6×Round	0.1029**	-0.1551**
	(0.1074)	(0.0220)
Log likelihood	-1561.9014	-1,100.0737

Notes: Sample size of balanced panel is 5,040 with 20 in each group.
Jackknife standard errors are reported in parentheses.
* denotes significant at 0.05 level; ** denotes significant at 0.01 level.

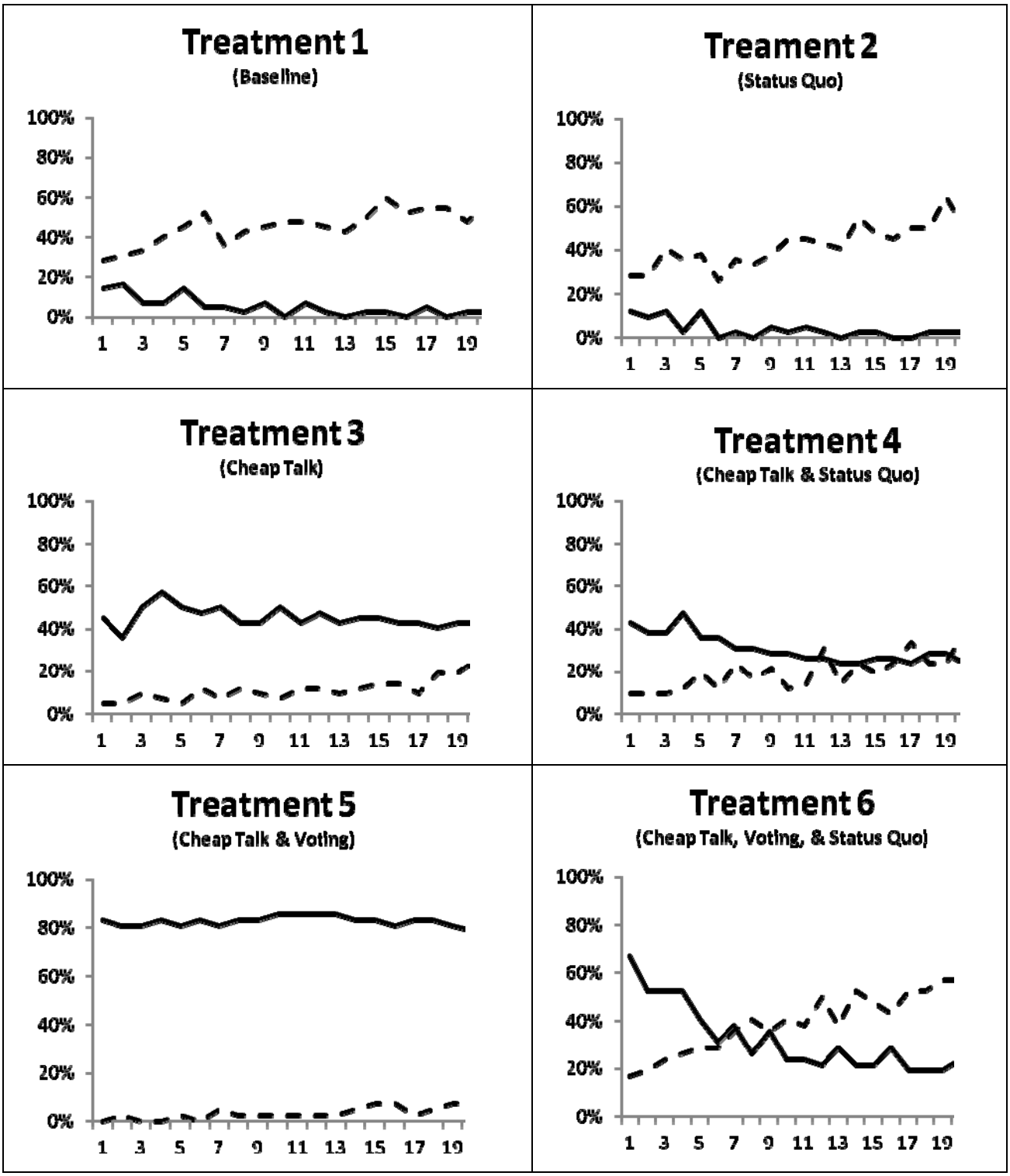

Figure A1. Percentage of Full (solid line) and Zero (dotted line) Contributions by Round

Reviewer Appendix

Experiment Instructions – Treatment 1 (baseline)

Welcome to an experiment in the economics of decision making. In the course of the experiment, you will have opportunities to earn money. Any money earned during this experiment is yours to keep. Please read these instructions carefully and do not communicate with any other participants during the experiment.

In today's experiment, you will participate in a number of rounds. The number of rounds has been determined prior to the start of the experiment. Throughout the experiment, you will be in a group of seven participants.

At the start of reach round, you and everyone else in your **group** will initially have $1.00 allocated to your **Account B**. Therefore, initially $7.00 has been allocated to Account B in total ($1.00 x 7 subjects). You, and everyone else in your group, will need to decide whether to give a **contribution** of this allocation by moving some or all of the $1.00 from Account B to **Account A**. For each round, three different items will determine the payoff for you and everyone else in your group:

The **Account A Payoff** is the amount of money that you contribute to Account A multiplied by 3/2 (=1.5).

The **Account B Payoff** is the amount of money that you do not give as a contribution to Account A, and thus keep in Account B, multiplied by 5/2 (=2.5).

The **Account B Loss** is the total amount of money that your group keeps in Account B multiplied by 3/14 (~0.214). The table on the right shows how the Account B Loss varies depending upon the total amount of money in Account B at the end of the round.

In summary, your earnings in each round are equal to your Account A Payoff, plus your Account B Payoff, minus the Account B Loss.

To give a contribution from Account B to Account A, enter the amount, if any, into the yellow cell in your spreadsheet, hit "Enter"

Total Amount in Account B	Account B Loss
$0.00	$0.00
$0.25	$0.05
$0.50	$0.11
$0.75	$0.16
$1.00	$0.21
$1.25	$0.27
$1.50	$0.32
$1.75	$0.38
$2.00	$0.43
$2.25	$0.48
$2.50	$0.54
$2.75	$0.59
$3.00	$0.64
$3.25	$0.70
$3.50	$0.75
$3.75	$0.80
$4.00	$0.86
$4.25	$0.91
$4.50	$0.96
$4.75	$1.02
$5.00	$1.07
$5.25	$1.13
$5.50	$1.18
$5.75	$1.23
$6.00	$1.29
$6.25	$1.34
$6.50	$1.39
$6.75	$1.45
$7.00	$1.50

on the keyboard, and then click the "Submit" button. After every participant has submitted their decision, the administrator will calculate the Account B Loss, which you can view once you are instructed to click the "Update" button.

Your earnings will be calculated automatically. You will then proceed to the next round and follow the same procedures.

At the end of the experiment, your earnings will be converted to US dollars with an exchange rate of 2. (If you make $30 in the experiment, you will get $15 US dollars)

Experiment Instructions – Treatment 2 (Status Quo)

Welcome to an experiment in the economics of decision making. In the course of the experiment, you will have opportunities to earn money. Any money earned during this experiment is yours to keep. Please read these instructions carefully and do not communicate with any other participants during the experiment.

In today's experiment, you will participate in a number of rounds. The number of rounds has been determined prior to the start of the experiment. Throughout the experiment, you will be in a group of seven participants.

At the start of reach round, you and everyone else in your **group** will initially have $1.00 allocated to your **Account A**. Therefore, initially $7.00 has been allocated to Account A in total ($1.00 x 7 subjects). You, and everyone else in your group, will need to decide whether to request a **refund** of this allocation by moving some or all of the $1.00 from Account A to **Account B**. For each round, three different items will determine the payoff for you and everyone else in your group:

The **Account A Payoff** is the amount of money that you do not request as a refund to Account B, and thus keep in Account A, multiplied by 3/2 (=1.5).

The **Account B Payoff** is the amount of money that you request as a refund from Account A to Account B, multiplied by 5/2 (=2.5).

The **Account B Loss** is the total amount of money that your group requests as a refund from Account A to Account B multiplied by 3/14 (~0.214). The table on the right shows how

Total Amount in Account B	Account B Loss
$0.00	$0.00
$0.25	$0.05
$0.50	$0.11
$0.75	$0.16
$1.00	$0.21
$1.25	$0.27
$1.50	$0.32
$1.75	$0.38
$2.00	$0.43
$2.25	$0.48
$2.50	$0.54
$2.75	$0.59
$3.00	$0.64
$3.25	$0.70
$3.50	$0.75
$3.75	$0.80
$4.00	$0.86
$4.25	$0.91
$4.50	$0.96
$4.75	$1.02
$5.00	$1.07
$5.25	$1.13
$5.50	$1.18
$5.75	$1.23
$6.00	$1.29
$6.25	$1.34
$6.50	$1.39
$6.75	$1.45
$7.00	$1.50

the Account B Loss varies depending upon the total amount of money in Account B at the end of the round.

In summary, your earnings in each round are equal to your Account A Payoff, plus your Account B Payoff, minus the Account B Loss.

To request a refund from Account A to Account B, enter the amount, if any, into the yellow cell in your spreadsheet, hit "Enter" on the keyboard, and then click the "Submit" button. After every participant has submitted their decision, the administrator will calculate the Account B Loss, which you can view once you are instructed to click the "Update" button.

Your earnings will be calculated automatically. You will then proceed to the next round and follow the same procedures.

At the end of the experiment, your earnings will be converted to US dollars with an exchange rate of 2. (If you make $30 in the experiment, you will get $15 US dollars)

Treatment 5 (Cheap Talk/Voting)

(Other parts same as treatment 1)

……..

In today's experiment, you will participate in a number of rounds. The number of rounds has been determined prior to the start of the experiment. Throughout the experiment, you will be in a group of seven participants. First, you will have the opportunity to vote on which market rules will be used for your group for the proceeding trading periods. A **majority vote** will determine which market rules will be implemented. Your vote will be confidential and will not be shared with any other members of the experiment. Before the vote, you will be given **up to five minutes** to discuss your opinions about the vote and donations to the **Group Account** with other subjects in your group. This discussion is free and open, except that no deals or threats are allowed. After the discussion, you will select your preference in your spreadsheet and click the "Submit Vote" button. After all of the votes have been submitted, the administrators will announce the outcome. There are two possible sets of market rules:

1) ***Private Lottery*****.** Initially, you and everyone else in you group will be given a lottery ticket in each round. At the start of each round, you will need to decide whether you would like to keep the lottery ticket or sell it. If you decide to sell the lottery ticket, you will be paid $1.00. If you keep the lottery ticket, a coin toss will determine the payoff for this lottery ticket. If the coin toss is **heads**, the payoff is $2.00. If the coin toss is **tails**, the payoff is $0.00. The coin will be provided and flipped by a volunteer subject; therefore the odds for either a heads or a tails are equal.

2) ***Group Activity.*** At the start of reach round, you and everyone else in your **group** will initially have $1.00 allocated to your **Account B**. Therefore, initially $7.00 has been allocated to Account B in total

($1.00 x 7 subjects). You, and everyone else in your group, will need to decide whether to give a **contribution** of this allocation by moving some or all of the $1.00 from Account B to **Account A**. For each round, three different items will determine the payoff for you and everyone else in your group: