Coordinating Resistance through Communication and Repeated Interaction*

Timothy N. Cason[a] and Vai-Lam Mui[b]

[a]Department of Economics, Krannert School of Management, Purdue University, 403 W. State St., West Lafayette, IN 47907-2056, U.S.A.

[b]Department of Economics, Monash University, P.O. Box 11E, Clayton, Victoria 3800, Australia

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Abstract

Successful deterrence of leader expropriation is important for economic development. This paper studies theoretically and experimentally the effectiveness of repeated interaction and communication in deterring leaders who can use divide-and-conquer (DAC) to expropriate surplus from victims and share some with beneficiaries to buy their support. We show theoretically that repetition can have limited effectiveness in deterring DAC even when the beneficiary is motivated by social preferences and prefers that DAC be defeated. The experiment shows that repetition alone is far from sufficient to deter DAC. Consistent with the predictions of an informative cheap talk equilibrium, in all repeated game treatments with communication the "intended choice" communicated by the beneficiary is critical for increasing coordinated resistance to DAC, and adding communication reduces DAC substantially even in the presence of repetition.

JEL Classification: C92, D74

Key words: Communication, Cheap Talk, Collective Resistance, Divide-and-Conquer, Laboratory Experiment, Repeated Games, Social Preferences

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1. Introduction

This paper reports an economic experiment to evaluate the effectiveness of repeated interactions and communication in deterring leaders' attempts to employ divide-and-conquer strategies to extract surplus from their subjects. Since the seminal work of North and Weingast (1989), a sizable economic literature has emphasized that an important condition for successful economic development is the existence of mechanisms that can deter the predatory behavior of the state: if political leaders can confiscate the wealth of citizens without any repercussion, no one will have the incentive to engage in costly production and investment (North, 1990; Weingast, 1995, 1997, 2005; Acemoglu et al., 2006; Grief, 2006; Acemoglu and Robinson, 2012). Some contributions to this literature have emphasized that coordinated resistance by citizens is a key mechanism in deterring leader expropriation (Weingast, 1995, 1997; Acemoglu and Robinson, 2006, chapter 11). Researchers, however, have also pointed out that leaders may expropriate wealth from one group, and share it with another group to "bribe" them and secure their support (Weingast, 1995, 1997). Such divide-and-conquer strategies are difficult to defeat. Citing the former Congo ruler Mobutu as an example, Acemoglu et al. (2004) argue that divide-and-conquer tactics allow rulers to adopt socially costly policies to extract surplus without meeting effective challenges, and this is an important cause for under-development.

Using a game-theoretic model in which a leader first decides whether to engage in divide-and-conquer and responders then decide simultaneously whether to incur the cost to challenge the transgression, Weingast (1995, 1997) emphasizes the importance of repeated interaction in deterring divide-and-conquer (hereafter DAC). This paper uses this coordinated resistance (hereafter CR) game to study theoretically and empirically how repetition *and* communication may facilitate coordinated resistance against DAC. Our study has several novel features, and we first highlight those regarding repeated interaction here. First, Weingast focuses on how repetition may enable *victims* and *beneficiaries* of DAC to use history-dependent strategies to facilitate cooperation to defeat DAC, but he does not consider how repetition can also enable the leader to use history-dependent strategies to punish any beneficiary who refuses to cooperate with him. This paper derives theoretically the implications of the observation that repetition is a two-edged sword in affecting cooperation in this social dilemma with endogenous roles. It also tests these implications in an experiment. Second, the literature on divide-and-conquer cited above does not consider social preferences. Recent studies of this CR game (Cason and Mui, 2007, Rigdon and Smith, 2010), however, find that social preferences can affect behavior even in the one-shot CR game. This study, to our knowledge, is the first that provides empirical support to the novel observation that even in the presence of social preferences, repetition can be limited in its effectiveness in deterring divide-and-conquer.

To illustrate this observation intuitively, consider a repeated CR game played by the leader and two responders A and B, in which DAC is defeated only when it is challenged by both A and B. Suppose that in period one, the leader picks A as the victim and extracts surplus from A and shares part of this surplus with B. Furthermore, the leader plans to continue to target A as the victim and share the extracted surplus with B in the future if B, as the beneficiary, does not challenge the leader. The leader, however, will switch to target B as the victim in the future if B refuses to cooperate with him and challenges him as a beneficiary. Suppose B is an agent who has social preferences and prefers that the DAC be defeated even against her material self-interest. Despite such preferences and the existence of repeated interaction, B may prefer not to take the risk to attempt to coordinate with A to challenge the DAC: if there is a good chance that A actually has standard preferences, then when B challenges the DAC in the current period, the leader will switch to target her as a victim in the future and A will not challenge the DAC. In short, B may prefer not to challenge for fear that the leader may adopt the strategy of punishing a challenging beneficiary.

Our experiment includes three different forms of repetition, including finite and indefinite matching, to investigate the robustness of our results. We find that in all of these repeated game treatments, leaders target beneficiaries who previously challenge DAC. Consistent with a repeated game equilibrium in which responders use their action to signal their type and future intentions while the leader adopts a strategy of "punishing the challenging beneficiary," successful resistance to DAC occurs more frequently in early rounds of the repeated games. Overall, both indefinite and finite repetitions reduce DAC compared to the one-shot game, and by similar rates. Leaders still choose DAC at least half the time, however, which suggests that repetition alone is far from sufficient to deter DAC effectively.

These findings support the insight that the ability of the leader to use history-dependent strategies to punish a beneficiary who refuses to cooperate with him can limit the effectiveness of repetition in deterring DAC. This inspired a follow-up treatment to directly investigate the effect of reducing the leader's ability to target challenging beneficiaries. In this treatment the responders are randomly re-assigned the A/B labels each period, effectively hiding their identity from the leader while still maintaining fixed matching groups. Therefore, if a responder challenges as a beneficiary, the leader cannot determine who this "non-cooperating" beneficiary is in the next period for targeting. We find that in this treatment beneficiaries are significantly more likely to resist and coordinated resistance against DAC occurs more frequently.

Our finding that repetition alone is far from sufficient in deterring DAC suggests the need to study other mechanisms that can complement repetition in deterring DAC, and it is natural to consider communication as one such mechanism. Compared to repetition, communication has received a lot less attention in the emerging literature on DAC. For example, the important work by Weingast (1995, 1997) focuses on repetition in his model on DAC, but does not consider communication. We show theoretically that in the repeated CR game with incomplete information about preferences, an informative equilibrium exists. In this equilibrium, a beneficiary with standard preferences will communicate an intention to acquiesce, while a beneficiary with social preferences will communicate an intention to challenge, and coordinated resistance occurs only when the beneficiary indicates an intention to challenge.

This theoretical result suggests that the "intended choice" communicated by the beneficiary is critical for increasing resistance to DAC, and that communication will reduce the rate of "mis-coordinated resistance" in which one responder challenges while the other does not. These predictions are supported by findings in additional repeated game treatments that add opportunities for responders to communicate privately a binary signal indicating intentions. We also find that adding communication reduces DAC substantially even in the presence of repetition, and find that intentions communicated by the responders is more effective than the history of past resistance to coordinate responders' current resistance. Besides these findings regarding repetition treatments with communication, we also compare repetition treatments without communication to the Random Matching with Communication treatment that adds communication only to the one-shot CR game. We find that repetition alone is no more effective than non-binding communication in one-shot game in reducing DAC.

To our knowledge, this paper is the first that derives theoretically the implications of the insight that repetition is a two-edged sword in facilitating cooperation in the divide-and-conquer social dilemma and tests these implications experimentally. While the existing literature on the predatory state abstracts from social preferences, informed by theoretical analysis of the repeated CR game with incomplete information, our experiment shows that even in the presence of social preferences, repetition can be limited in its the effectiveness in deterring DAC. This result, together with our findings showing that communication can be informative and effective in deterring DAC even in the presence of repetition, strongly suggest it is important to consider the effects of repetition in conjunction with communication or other mechanisms that may also enable potential challengers to DAC to reveal whether they have standard or social preferences to others. As we discuss further in the conclusions, our study also suggests that understanding how leaders may engage in strategic actions to prevent citizens from taking advantage of communication and repeated interaction to defeat DAC can be an extremely promising new direction for better understanding how society can restrain predatory behavior by the leader, which is widely-regarded as a root cause for under-development.

While concerns about leader expropriation and under-development motivate our study, DAC is widely observed in many other settings. A defendant facing multiple plaintiffs may make different settlement offers to the plaintiffs to induce plaintiffs to settle their claims for less than they are jointly worth (Che and Spier, 2008). An incumbent monopolist can use DAC to achieve "naked exclusion" (Rasmusen et al., 1991). A firm that is negotiating contracts with several unions may offer poor terms to some and more favorable terms to others to create divergent interests among the unions. Kutalik and Biddle (2006) discuss how concessions imposed through bankruptcy court in recent management-union disputes at several airlines have targeted specific unions, and some unions have joined forces to form the *Airline Workers United*—an across occupations and airlines organization—to counter this divide-and-conquer strategy. We highlight some implications of our findings for DAC in other settings in the concluding section.

Besides contributing to the literature on DAC, this paper also contributes to the emerging experimental literature on the indefinitely repeated games. The importance of infinitely repeated interaction in facilitating cooperation has been widely-studied in the literature (see Mailath and Samuelson, 2006, for a survey), and the laboratory offers a useful environment in which one can implement a probabilistic termination design to directly assess the effects of indefinite repetition (Roth and Murnigham, 1978). As Duffy and Ochs (2009) point out, surprisingly few studies have exploited this possibility to identify the empirical conditions under which indefinitely repeated play actually facilitates cooperation. Overall, our empirical knowledge about indefinitely repeated games lags far behind the theoretical literature. For example, the theoretical prediction that there should be a sharp difference between the cooperation rate in the finitely repeated and infinitely repeated prisoner's dilemma has been widely emphasized in the literature. Direct supporting evidence regarding this prediction, however, only became available recently in Dal Bó (2005), which compares the cooperation rate for these two types of repeated interaction while holding the expected duration of the repeated game constant across the two treatments.

The small number of experimental studies on indefinitely repeated games focus on widely studied games such as the public goods games (Palfrey and Rosenthal, 1994) and the prisoner's dilemma (Camera and Casari, 2009; Dal Bó. 2005; Duffy and Ochs, 2009; Normann and Wallace; 2011, Blonski et al., 2011; Dal Bó and Frechette, 2011, and Fudenberg et al., 2012) Furthermore, few studies have considered repeated play and communication simultaneously (for exceptions see Hackett et al. (1994), Wilson and Sell (1997), and Blume and Ortmann (2007), who all study finitely repeated play with communication). Departing from the prisoner's dilemma and the standard public goods games paradigm, the CR game studied in this paper allows for interesting endogenous role asymmetries among the players, and how these roles can be determined as a result of history-dependent strategies by others. Adopting the first complete factorial design that includes various forms of repetition and the presence and absence of communication allows us to compare and identify the marginal impacts and interactions of repetition and communication as mechanisms for coordinating resistance against divide-and-conquer. Our findings that repetition is a two-edged sword and has limited effectiveness in deterring divide-and-conquer, and that communication can be informative in the repeated CR game, are both novel empirical results in the literature on indefinitely repeated games.

The rest of this paper is organized as follows. Section 2 introduces the Coordinated Resistance game and derives implications of how repetition and communication affect behavior in the CR game that will be tested in the experiment. Section 3 discusses the experimental design. Results are presented in Section 4. Section 5 concludes by discussing implications of our findings for the study of DAC and describes directions of future research.

2. Divide-and-Conquer, Social Preferences, Repeated Interaction and Communication

Consider the Coordinated Resistance (CR) game illustrated in Figure 1, which is based on Weingast (1995, 1997) and captures the following ideas. First, successful transgression allows the leader to extract surplus from others and increases his *private* payoff, even though it reduces *total* surplus in society because some surplus is destroyed in the process. In the Figure 1 payoffs, successful transgression against an individual reduces her payoff by 6 and increases the leader's payoff by 3, since a transgression destroys half of the confiscated surplus. Second, challenging a transgression is costly regardless of whether it succeeds, and the "responders" face a coordination problem in deciding whether to challenge. The transgression will fail if and only if *both* responders incur the cost to challenge. Third, the leader can either transgress against both responders, or can practices DAC. When the leader practices DAC he shares 1 of the 3 units of the surplus expropriated from the "victim" with the "beneficiary" to gain her support.

When the leader practices DAC in the one-shot CR game, a beneficiary with standard preferences will always acquiesce, so the victim will also acquiesce. Therefore, DAC can eliminate the threat of joint resistance by the responders. The one-shot CR game thus has three (pure strategy) equilibria, and the total surplus-maximizing outcome No Transgression is not among them.[1] In one equilibrium, the leader transgresses against both responders, with the expectation that this will not be met by coordinated resistance. (Multiple equilibria exist in the top subgame when the leader transgresses against both, so this subgame is a "stag hunt" game.) In the other two equilibria, the leader transgresses against only one of the responders, with the expectation that neither will challenge. Furthermore, since a beneficiary with standard preferences will always prefer to acquiesce and any promise by him that he will challenge DAC is not credible, allowing the responders to engage in non-binding communication should not affect the incidence of transgression in the one-shot CR game.

The recent literature on social preferences (e.g., Camerer, 2003), however, suggests that *some* beneficiaries may be willing to act against their material interest to challenge DAC even in the one-shot version of this game. For example, some may be altruistic punishers (Fehr and Gächter, 2002, Gintis et al., 2005), who are willing to incur the cost to punish what they regard to be socially undesirable behavior, even with no scope for repeated interactions. In an earlier study that focuses exclusively on the one-shot CR game, Cason and Mui (2007) found that non-binding (cheap talk) communication modestly reduces the incidence of transgression. This is not predicted in a model with standard preferences, providing initial evidence that social preferences

[1] Allowing for mixed-strategy equilibrium does not change the key implications of the CR game with or without social preferences, so we shall focus on pure-strategy equilibria in the text.

may affect outcomes in this game. Rigdon and Smith (2010) replicate Cason and Mui's (2007) finding that communication reduces transgression, and present results from new treatments providing further evidence that social preferences are important in this new social dilemma.

When some responders are motivated by social preferences, joint resistance against DAC can be supported as an equilibrium, even in the one-shot game. In the appendix we briefly describe a model of the CR game with social preferences, and show how incomplete information and repeated play can affect behavior in the indefinitely repeated game. Here, we just sketch the main results intuitively.

Consider a model of the one-shot CR game in which agents are of two types: the standard preferences type (*S*-type) who only cares about her own payoffs and the social preferences type (*SP*-type). An agent's type is her private information. An *SP*-type responder disapproves of the leader's transgression, and her utility is declining in the leader's payoff. This implies that an *SP*-type beneficiary may be willing to act against her own material interest to challenge DAC against the other responder, provided that she expects with a sufficiently high probability that the victim will also challenge. If there is a high enough probability that a responder is an *SP*-type, the DAC subgame played by the victim and the beneficiary has two pure strategy equilibria: (i) Both the *S*-type victim and the *SP*-type victim acquiesce, and both the *S*-type beneficiary and the *SP*-type beneficiary acquiesce; and (ii) Both the *S*-type victim and the *SP*-type victim challenge, the *S*-type beneficiary always acquiesces, and the *SP*-type beneficiary challenges.

While social preferences can transform the DAC subgame into a stag-hunt game in utilities, coordinating on resistance involves two challenges. First, even if it is common knowledge that the beneficiary is an *SP*-type, the fact that "both acquiesce" and "both challenge" are equilibria implies that coordination failure can prevent successful joint resistance.[2] Second, since agents' types are private information, the possibility that a beneficiary is an *S*-type and will not challenge further weakens the prospect of joint resistance.

Repeated interaction further complicates this coordination problem. In particular, consider an indefinitely repeated CR game, in which the leader practices DAC against responder A in the first period and adopts the following strategy: If responder B (who is the beneficiary in period one) does not challenge in period one, the leader will continue to practice DAC against A. If B challenges the DAC against A in period one, however, the leader will then switch to DAC against B in period two. If A (who is now the beneficiary) does not challenge in period two, the leader will continue to practice DAC against B in the future. If A also challenges (as a beneficiary) in period two and the leader has met successful joint resistance in both periods one and two, then he will subsequently refrain from any transgression.

This leader strategy of punishing the challenging beneficiary affects incentives to challenge.[3] If the beneficiary B is a *S*-type, she will not challenge. If the beneficiary B is an *SP*-type, she prefers the No Transgression outcome to DAC with her as the beneficiary. By challenging the leader as the beneficiary, she may avoid being trapped in her less-preferred outcome of persistent DAC against the other responder, A. But challenging is costly and risky: if the other responder is an *S*-type who will not challenge the leader when a beneficiary, the initial beneficiary B will suffer as a victim of DAC in all subsequent periods. Thus, an *SP*-type B will only "separate herself out" from an *S*-type and challenge as a beneficiary if she is sufficiently

[2] This is similar to the coordination problem in the presence of multiple equilibria in earlier experimental studies such as Battalio et al. (2001), in which the games considered have multiple equilibria with standard preferences and complete information.
[3] The Supplementary Appendix available at http://users.monash.edu.au/~vlmui/CR_app.pdf provides a formal and complete description of the strategy of the leader and the responders and their belief updating rules, and. the proof of the theoretical result described here.

patient and believes that there is a high probability that A is also an *SP*-type.

This analysis highlights the novel insight that while repetition allows the victim and the beneficiary to use costly action to signal their intention for future cooperation, repetition also allows the leader to use history-dependent strategies to punish the challenging beneficiary and deter coordinated resistance. Because of the leader's threat to punish the challenging beneficiary, incomplete information about the types of others can create significant barriers to coordination.

In his pioneering analysis of the repeated CR game, Weingast (1995, 1997) does not consider social preferences or how the leader can use history-dependent strategies to punish the challenging beneficiary. He instead focuses on how repetition can facilitate cooperation between the victim and the beneficiary, and shows that if the CR game is repeated infinitely then sufficiently patient players can adopt the following trigger strategies to support the outcome of (No Transgression, Acquiesce, Acquiesce) as an equilibrium.[4] For the leader: if either A or B acquiesced to any transgression in an earlier period, transgress against both A and B thereafter; otherwise, do not transgress. For responder A (B): if responder B (A) challenges every previous transgression, then challenge any transgression in the current period and acquiesce otherwise; if responder B (A) acquiesces to any previous transgression, then acquiesce thereafter.[5]

In this equilibrium, the threat of a permanent switch to playing (Transgression Against Both, Acquiesce, Acquiesce) facilitates cooperation between A and B and deters transgression.

[4] Specifically, this requires that the discount factor be larger than 1/4 for the material payoffs shown in Figure 1.

[5] With standard preferences, the outcome in which the leader always practices DAC transgression is also an equilibrium in the indefinitely repeated game. For example, persistent DAC against A can be the equilibrium outcome if, regardless of the past history, the leader always chooses DAC against A, and A and B both always acquiesce except when the leader transgresses against both. This equilibrium also does not involve the leader switching to an alternate DAC when the beneficiary of a current DAC challenges, Note, however, in the presence of social preferences, it will not be in the interest of the leader to commit to always practicing DAC against a responder regardless of past histories. If the leader begins by practicing DAC against A, and B challenges as a beneficiary, this can suggest that B is an *SP*-type, and persistent DAC against A can be met with persistent joint resistance. In this case, the leader has the incentive to switch to DAC against B, and such switching can lead to persistent successful DAC if A turns out to be an *S*-type.

Transgression never occurs in equilibrium.[6] In contrast, in the signaling equilibrium described above, a leader will switch to practicing the "alternative DAC" if earlier attempts of DAC have been challenged by the beneficiary. Furthermore, successful coordinated challenge can induce the leader to play No Transgression if both responders have social preferences, and this successful coordination occurs only after the players undertake the risky and costly action to signal their types through resistance to some initial periods of DAC transgression. Even when repetition leads eventually to successful joint resistance and no transgression in equilibrium, transgression will still occur in the initial periods on the equilibrium path.

Besides repetition, another mechanism for coordinating resistance is communication between the responders. In particular, suppose that each period, after the leader makes his decision, the two responders can engage in non-binding and private communication to indicate their intentions whether to challenge. While a babbling equilibrium always exists in such cheap talk games, an informative equilibrium also exists in the repeated CR game with communication. In the informative cheap talk equilibrium, the beneficiary's indicated intention is crucial in determining whether coordinate resistance will occur. We proved this and other results regarding informative cheap talk in the Supplementary Appendix, but provide an intuitive discussion here.

Consider again the example in which the leader practices DAC against A in period one and switches to DAC against B in period two if B challenges as a beneficiary in period one. In the absence of communication, a signaling equilibrium exists in which both the *S*-type A and the *SP*-A challenge as the victim in period one, while the *S*-type B will acquiesce and the *SP*-type B will challenge in period one as the beneficiary. When communication is added to the repeated game, communication allows the beneficiary to use her message to directly signal her type and

[6] One can show that these strategies—with both *S*-type and *SP*-type responders adopting such trigger strategies—also constitute an equilibrium for the repeated CR game with social preferences and incomplete information about preferences. Hence, these properties of the equilibrium proposed by Weingast also hold with social preferences.

intended action in the signaling equilibrium, and strengthens the incentive for the *SP*-type B to separate herself out from an *S*-type and challenge as a beneficiary. In the informative cheap talk equilibrium, in period one, both the *S*-type A and the *SP*-type A indicate an intention to challenge as the victim. As the beneficiary, the *S*-type B indicates acquiesce, and the *SP*-type B indicates challenge. Furthermore, while the *S*-type B will always acquiesce as the beneficiary, both types of victim and the *SP*-type beneficiary will challenge only when the beneficiary indicates an intention to challenge. That is, communication facilitates coordinated resistance, and the beneficiary's indicated intention is the key in determining the rate of successful joint resistance. Communication is not risky because it is not observable by the leader, so the leader cannot condition his choice on the responders' messages.

Furthermore, communication can help reduced mis-coordinated resistance. In the absence of communication, the victim must decide whether to challenge without knowing the beneficiary's type in early periods. Mis-coordinated resistance happens, for example, in period one when the victim challenges but the *S*-type beneficiary acquiesces. With communication, however, the victim will not challenge after observing a beneficiary's intention to acquiesce.

In the absence of communication, when the leader practices DAC against A in the first period, an *SP*-type beneficiary B knows that if she challenges in the first period, she may become the victim in the second period and will then need to decide whether to challenge the leader without knowing A's type. With communication, however, in deciding whether to challenge as the beneficiary in the first period, B knows that communication can reduce the type uncertainty she faces when making decisions in the future and reduce mis-coordinated resistance. Thus, when she challenges in the first period as a beneficiary in the repeated game with communication, although she may still become the victim in the second period the *SP*-type B will get a higher continuation payoff compared to the repeated game without communication. Communication therefore strengthens the *SP*-type beneficiary's incentive to challenge (and weakens the conditions required to guarantee separation by the *SB*-type B) in the first period and should lead to a higher rate of coordinated resistance compared to the same form of repetition without communication.

3. Experimental Design

To study the effect of repetition and communication on DAC, we employ the CR game developed by Weingast (1995, 1997).[7] We conduct 42 independent sessions across six different repeated game treatments, as summarized in Table 1, involving 378 human subjects. To compare the effect of communication in one-shot game to the effect of repetition, our data analysis also includes two treatments (144 additional subjects) featuring random matching (with and without communication) previously reported in Cason and Mui (2007). The three forms of repetition allow the design to investigate whether differences in subjects' behavior when adding repetition and only adding communication to the one-shot CR game are robust. Furthermore, because the one-shot CR game has multiple equilibria, even with finite repetition and with standard preferences, the No Transgression outcome can be supported as an equilibrium up to the second to the last period (Benoit and Krishna, 1987). Although the theoretical insight by Benoit and Krishna (1987) regarding the lack of sharp difference between finite repetition and infinite repetition for games with multiple equilibria is well-recognized, as a reflection of our earlier observation that empirical evidence lags behind theories in the study of repeated games, there is

[7] Cason and Mui (2007) and Rigdon and Smith (2010) study the effect of binary restrictive communication in the one-shot CR game, while Cason and Mui (2010) study the effect of free-from communication in the one-shot CR game. Boone et al. (2009) and Landeo and Spier (2010) study experimentally how incumbent monopolist can use divide-and-conquer to achieve "naked exclusion" using the model developed by Rasmusen et al. (1993). None of these studies, however, consider repetition.

little empirical evidence regarding this proposition and our design allows for a direct test.

Subjects were recruited by e-mail and through web page and classroom announcements from the general student population at two large universities, and all were inexperienced in the sense that they participated in only one session of this study. Sessions lasted for at least 48 decision periods. As noted in the introduction, this is one of the first experimental studies to examine the interaction of type of repeated play and communication using a full factorial design.

The experiment instructions employed neutral terminology. For example, “Person 1” chose “earnings square” A, B, C or D—which was the transgression decision—and then “Persons 2 and 3” simultaneously selected either X or Y—which was the challenge decision. At the end of every period, subjects learned all actions and monetary payoffs for the three individuals in their group, and they recorded these choices and their own earnings on a hardcopy record sheet. Each session had nine participants, but two sessions were conducted simultaneously so 18 subjects were present for each data collection period. Subject roles remained fixed: leaders always remained leaders, and responders always remained responders throughout the session.

The Random Matching treatments were conducted for 50 periods and serve as the baseline that corresponds most closely to the one-shot game. In these treatments the instructions emphasized that subjects were randomly re-grouped each period. Subjects in the Long Horizon (hereafter LH) Finite Repetition treatment were randomly grouped to form a three-person group in period 1, and these groupings remained fixed for all 50 periods.

In the Indefinite Repetition treatment, groupings lasted for a random number of periods. Subject labels (“Persons” 1, 2 and 3) remained unchanged for all periods of each supergame grouping. At the end of each period in this treatment, the experimenter threw an eight-sided die, and for die rolls of 1, 2, 3, 4, 5, 6 or 7 the groupings remained unchanged for another period.

When the die roll was 8 the current grouping was immediately terminated. At that point each participant was randomly re-grouped with two other participants to form a new three-person group. All groupings terminated probabilistically using the die rolls, and no groupings were artificially ended due to time limits.[8] An average of 6 repeated games (max=10, min=3) were conducted per session in this treatment.

In the Equivalent Horizon (hereafter EH) Finite Repetition treatment, subjects were randomly regrouped at the end of every 8th period. The experimenter also made a verbal announcement that regrouping was taking place at these periods. These sessions lasted for 48 total periods (6 repeated games). Since repeated games end with a probability of 1/8 in each period in the Indefinite Repetition treatment, the repeated game has an expected horizon of 8 periods. Dal Bó (2005) argues that to compare the difference between finite and indefinite repetition of a particular game, one should consider a finitely repeated game with a horizon the same as the *expected* horizon of the indefinitely repeated game. In half of the sessions for the EH treatment without communication the subject labels ("Persons" 1, 2 and 3) remained unchanged for all periods of each repeated game grouping, as in the other repeated game treatments. We have shown theoretically that the leader's threat of punishing the challenging beneficiary can deter coordinated resistance. One advantage of the laboratory approach is that it allows the introduction of counter-factual environments to directly test key theoretical insights. In the other half of the sessions of this treatment we added a new information condition in which the responder labels ("Persons" 2 and 3) were randomly re-assigned each period to obscure the individual responder identities from the leader. This removes some of the risk of challenging

[8] We avoided hitting the time constraint through a session termination rule that was explained in the instructions at the beginning of the session: If the total number of periods conducted in the session at the conclusion of a grouping exceeded 49, or if less than 30 minutes remained in the two and a half hour time period reserved for the session, then a new re-grouping was not initiated and the session was terminated.

DAC as a beneficiary and should increase coordinated resistance.

In the communication treatments, after learning the leader's decision, the responders simultaneously sent a binary message to the other responder in their group in each period: a nonbinding "intended" choice (either X or Y), prior to making the actual challenge or acquiesce decision. The leader knew that responders communicate with each other prior to making decisions, but did not observe the messages.

Subjects' earnings were designated in "experimental francs." They were paid for all periods, and their cumulative francs balance was converted to either Australian or U.S. dollars at exchange rates that resulted in earnings that considerably exceeded their opportunity costs. The per-person earnings typically ranged between US$25 and US$40 for the Purdue sessions and between A$30 and A$60 for the Monash sessions.[9] Exchange rates were chosen before beginning data collection based on the time required to complete pilot sessions. Sessions without communication ran more quickly—some as short at 75 minutes including instructions—while those with communication typically required 1.5 to 2.5 hours. We employed more generous conversion rates for the longer sessions to compensate subjects for the longer time in the lab.

4. Results

Figure 2 presents the time series of the rate the leaders transgress, separately for all eight treatments. Leader transgressions are overwhelmingly the divide-and-conquer type, and transgression against both responders is uncommon. Nearly half of the attempts to transgress against both responders occur in periods 1 through 10, but these transgressions are met with successful coordinated resistance 69 percent of the time. This discourages leaders from pursuing

[9] The exchange rate between U.S. and Australian dollars was approximately 1 AUD = 0.75 USD when the experiment was conducted.

this most aggressive type of transgression, and after these initial 10 periods 95.5 percent of the transgressions are the DAC type. In our analysis below, we shall focus on DAC. We begin by documenting that, consistent with the theoretical discussion in Section 2, leaders target beneficiaries who previously challenge DAC and successful joint resistance reduces transgression. Section 4.2 reports how repetition and communication affects resistance behavior. Section 4.3 compares leader transgression rates across treatments.

4.1 Leader Responses to Histories in the Repeated Games

Finding 1: *Leaders target beneficiaries who previously challenge DAC, and a history of past resistance within a repeated game increases the likelihood of converging to the outcome with No Transgression.*

Support: As discussed above, repetition allows the leader to employ a "punishing the challenging beneficiary" strategy to deter resistance. The evidence indicates that leaders target beneficiaries who resist earlier DAC. Consider first the EH Finite Repetition treatment, since it provides a large number of repeated games of a fixed length. Define a repeated game that converges to transgression in this treatment as one with leader transgression in 6 or more out of its 8 periods. In 9 of these repeated games the leader chose DAC in the first period and experienced resistance by only the beneficiary, and he switched to target that beneficiary with the alternative DAC in 8 of these 9 cases (89 percent). Similarly, in 13 of these repeated games the leader chose DAC in the first period and experienced joint resistance by the beneficiary and victim, and he switched to target the beneficiary with the alternative DAC in 10 of these 13 cases (77 percent). The leader responses in the other repeated game treatments are similar, and the first column of Table 2 provides evidence using a logit regression employing data from all of these treatments. It shows that the leader is significantly more likely to switch to the alternative DAC rather than remain with the same DAC following beneficiary resistance.

To address the second part of Finding 1, again first consider the eight-period repeated games of the EH Finite Repetition treatment. We can define a No Transgression repeated game as one without any transgression in at least half the periods, including the final (eighth) period. The leader tried DAC in at least one earlier period in 30 of these repeated games, and she encountered beneficiary resistance in 26 of these cases (87 percent). Early beneficiary resistance is therefore strongly associated with eliminating transgression in the repeated game. The definition of a No Transgression repeated game is less straightforward in the Indefinite Horizon treatment because of its differing period lengths, and the LH Finite Repetition treatment provides few repeated games. Those repeated game treatments nevertheless provide qualitatively similar results. For example, the second column of Table 2 reports a logit regression that pools across repeated game treatments and indicates that leaders are significantly more likely to switch to No Transgression following beneficiary resistance.

4.2 Resistance in the Divide-and-Conquer Subgames

Having established that leaders target the challenging beneficiaries in the repeated games, we next turn to evaluate empirically whether joint resistance rates differ in the repeated game from the one-shot game baseline. The signaling equilibrium discussed in Section 2 suggests that joint resistance should occur more often in early rounds of a given repeated game since responders have the incentive to signal their types to try to achieve coordination. In later rounds of a repeated game, responders have either succeeded and the leader will no longer be practicing DAC, or they have failed, in which case the leader will be successfully transgressing and the responders will have given up resisting. The analysis thus identifies a selection bias, in that DAC that are observed in the later rounds of a repeated game should be significantly less likely to be successfully resisted. Therefore, a simple comparison of the overall resistance rates in later periods of each session fails to account for this endogenous selection bias and will be misleading. Note that this endogenous selection bias implied by the signaling equilibrium is not predicted by the trigger strategies equilibrium in Weingast (1995, 1997) discussed in Section 2.

Finding 2: *Successful resistance to DAC transgression occurs more frequently in the early rounds of the repeated games than the later rounds, both with and without communication. Repetition also increases joint resistance for the early rounds compared to the random matching baseline with communication.*

Support: Figure 3 illustrates the decline in the successful joint resistance rate in each of the first 8 rounds of the repeated games, separately for the Communication and the No Communication treatments. This figure includes the EH Finite and Indefinite Repetition conditions (pooled), and excludes the initial periods 1-16 of each session to eliminate the initial repeated games that are strongly influenced by subject learning. The joint resistance rate declines across periods in all cases, and is substantially greater in the Communication condition (the solid line labeled with triangles), as well as in the EH Finite Repetition condition with responder labels reassigned. In this latter follow-up repeated game treatment responders could not communicate, but the label reassignment obscured the beneficiary's identity from the leader. This latter result provides the first evidence that resistance is more common in the early periods of a repeated game when the leader is unable to target challenging beneficiaries.

For statistical support for Finding 2, define the first 3 rounds as the early repeated game rounds, and after round 3 as later repeated game rounds. The joint resistance rate is higher in the early rounds than the late rounds in all 6 individual sessions for Indefinite Repetition/Communication, and in 5 of the 6 individual sessions for EH Finite Repetition/

Communication (pairwise Mann-Whitney n=6 one-tailed p-value<0.05 for both). In the No Communication treatment the joint resistance rate is higher in the early rounds than the late rounds in 5 of the 6 individual sessions for EH Finite Repetition (pairwise Mann-Whitney n=6 one-tailed p-value<0.05).[10] For the EH Finite Repetition with responder labels randomly reassigned, the joint resistance rate is higher in the early rounds than the late rounds in all 6 individual sessions, also leading to a significant difference (p-value<0.05).

Repetition also increases successful joint resistance in the Communication treatments during the early rounds of the repeated game, but not in the later rounds, relative to the Random Matching/Communication treatment. The overall joint resistance rate in the early rounds of a specific repeated game (after dropping the first 16 periods to exclude the initial repeated games, as above) is 33.0 percent in Indefinite Repetition/Communication and 26.4 percent in EH Finite Repetition/Communication. Both of these are significantly higher than the joint resistance rate of 12.6 percent for the Random Matching/Communication treatment (U=6.5 and U=11; n=8, m=6, one-tailed p-value<0.05 for both). The joint resistance rate during the later rounds of a specific repeated game is 16.3 percent in Indefinite Repetition and 11.3 percent in EH Finite Repetition. Neither of these are different from the 12.6 percent rate in the Random Matching/ Communication treatment (U=18 and U=21; n=8, m=6, one-tailed p-value<0.05 for both).

Our next result establishes a link between earlier and later period resistance, consistent with the signaling equilibrium described in Section 2.

Finding 3: *In all repeated games treatments without communication, earlier period resistance to DAC transgression significantly increases resistance to later DAC transgression.*

Support: Table 3 presents fixed effects logit models of DAC resistance for the three

[10] Only two of the six sessions in the Indefinite Repetition No Communication treatment have early round DAC transgressions to resist, so a statistical test is not possible in that treatment.

repeated game treatments without communication to evaluate whether repetition enables responders to use their action to coordinate future resistance in the absence of communication. Only DAC that are immediately preceded by a DAC are included for these model estimates.[11] The table shows that resistance to DAC transgression in the previous period of that same repeated game strongly influences later resistance. Note, however, the previous challenge by a beneficiary is more important in affecting future resistance, and in several columns of Table 3 the victim-only resistance indicators appear weaker than the other types of previous resistance.

We have shown that leaders target challenging beneficiaries in repeated game treatments, and that resistance behavior is consistent with the signaling equilibrium discussed earlier. Our follow-up treatment with random reassignment of responder identity provides additional direct evidence that the leaders' threat of punishing the challenging beneficiaries deters resistance.

Finding 4: *Beneficiary resistance and joint, coordinated challenge is greater in the follow-up treatment that randomly re-assigns responder labels, relative to the comparable EH Finite Repetition with responder identities fixed throughout each repeated game.*

Support: Random reassignment of responder identity prevents the leader from targeting challenging beneficiaries. This nearly triples the DAC joint resistance rate during later periods 21-48 of the sessions, from 8.4 percent to 24.8 percent in the EH Finite/No Communication treatment. This difference is statistically significant based on a Mann-Whitney test that employs independent sessions as the unit of observation (one-tailed p-value<0.05). This higher joint resistance rate arises from a large increase in the frequency of beneficiary resistance when the beneficiary's identity is hidden from the leader, from 12.8 percent to 30.2 percent. This difference is highly significant (Mann-Whitney one-tailed p-value<0.01).

[11] We include a dummy variable for the first three rounds of each repeated game since (as just documented) the resistance rate varies within the repeated game, as well as a time trend 1/period to control for overall learning patterns within a session.

As discussed in section 2, private communication that is not observed by the leader, however, provides another coordinating device for an *SP*-type beneficiary to signal her type to the victim before undertaking the risky action of challenging the leader. Even in the presence of repeated interaction, this non-binding communication facilitates joint resistance. Table 4 displays the joint resistance rates for each session for the later periods, and a comparison of the two columns indicates that communication improves coordination in the repeated game, and these differences are highly significant in the EH Finite and Indefinite Repetition treatments (Mann-Whitney p-values<0.05). Furthermore, consistent with the informative equilibrium discussed in section 2, the "intended choice" communicated by the beneficiary is critical. Communication also reduces the incidence of mis-coordinated resistance, and increases joint resistance in the first period of a repeated game.

Finding 5: *The "intended choice" communicated by the beneficiary is most important for increasing resistance to DAC transgression.*

<u>Support:</u> Table 5 displays the different combinations of intended resistance to DAC transgression communicated in the four treatments that featured communication, as well as the resulting frequencies of actual coordinated resistance. Figure 4 indicates that victims of DAC transgressions challenge about 30 to 60 percent of the time, and beneficiaries challenge about 10 to 30 percent of the time. Table 5 indicates that communication helps coordinate successful resistance. Rows 1 and 2 show that successful joint resistance never occurs more than 4 percent of the time when the beneficiary does not signal intended resistance. By contrast, row 4 shows that successful joint resistance occurs 48 to 70 percent of the time when both responders indicate intended resistance. Even when only the beneficiary indicates an intention to resist, the successful joint resistance rate reaches about 30 percent in the finite horizon treatments.

Table 6 presents statistical support for the conclusion that both victims and beneficiaries choose to resist a DAC transgression when the beneficiary or (especially) when both responders indicate that they intend to resist. These fixed effects logit models indicate that the likelihood of actual resistance for both victims and beneficiaries is always significantly higher when only the beneficiary or when both responders indicate an intention to resist, compared to the omitted case of no intended resistance. The beneficiary's intention apparently plays a more important role to facilitate coordinated resistance, since the impact of the victims' intention is always smaller and sometimes insignificant.

Finding 6: *Communication reduces mis-coordinated resistance rate, and increases joint resistance in the first period of a repeated game.*

Support: As discussed in section 2, when communication is informative, it reduces the uncertainty a responder faces regarding the type of the other responder, and hence should reduce mis-coordinated resistance. The data provide clear evidence that mis-coordinated resistance to DAC is less common in the communication treatments, falling from a range of 28 to 42 percent in treatments without communication to 22 to 29 percent in treatments with communication. A random effects logit model that controls for the different matching protocols and an overall time trend indicates that this reduction in miscoordination is highly significant (p-value<0.001). Considering only the first period of the match (to remove repeated interactions that can also convey information), this reduction in miscoordination due to communication is statistically significant for each matching protocol individually even based on very conservative nonparametric Mann-Whitney tests (one-tailed p-values are 0.018 for EH Finite Repetition, 0.027 for Indefinite Repetition, 0.033 for LH Finite Repetition, and 0.037 for the Random Matching baseline).

Furthermore, as discussed in section 2, when communication is informative it reduces the uncertainty that responders will face in future periods. This strengthens the *SP*-type beneficiary's incentive to challenge in the first period and should lead to a higher rate of coordinated resistance in the first period compared to the same form of repetition without communication. The data provide some evidence for this implication of the informative cheap talk equilibrium. A random effects logit model that controls for the different matching protocols and an overall time trend indicates that this increase in coordinated on this first period of the match is statistically significant (one-tailed *p*-value=0.02). Considering the random matching treatments individually, Mann-Whitney tests indicate that an increase in coordinated resistance in the first period from 22.5 percent without communication to 32.8 percent with communication in the EH Finite repetition treatment is marginally significant (one-tailed *p*-value=0.054). A much larger increase in coordinated resistance in the first period from 25.0 percent without communication to 80.6 percent with communication in the LH Finite repetition treatment is significant (one-tailed *p*-value=0.033).

These findings show that communication can be informative even in the presence of repetition. The following result confirms that even in the presence of repetition, by being less risky and informative, communication further increases joint resistance.

Finding 7: *Even in the presence of repetition,* a*dding communication increases responders' resistance substantially. Furthermore, communication is more effective than the history of past resistance to coordinate responders' current resistance.*

Support: The top three rows of Table 7 report that previous period resistance has a weaker influence on current resistance in the Communication treatments. The logit models in this table include both the previous resistance as well as the current period communications, essentially combining the explanatory variables used in Tables 3 and 6. Current period resistance is systematically more likely only when both responders resisted in the previous period. By contrast, the variables representing different intention messages shown in the middle of the table indicate that both responders always strongly increase actual resistance when the beneficiary alone, or both responders, indicate an intention to resist. Likelihood ratio tests shown toward the bottom of this table indicate that the communications are always jointly highly significant determinants of both victim and beneficiary resistance, but previous period resistance sometimes has an insignificant influence on current resistance. Our findings suggest that earlier action of resistance help coordinate resistance in the current period. However, the result here also suggests that while earlier action of resistance helps coordinate future behavior, the presence of multiple equilibria in repeated game makes them imperfect indicators for future intentions, and non-binding communication provides a clearer signal about intentions in the current period and is extremely helpful in facilitating coordination.

4.3 Overall Transgression Rate

We conclude with a summary of the implications of the resistance and DAC rates on overall performance, as summarized by the transgression rate.

Finding 8: *Repetition alone reduces the rate that leaders transgress, but no significant differences exist in overall DAC rates between the different repeated game treatments.*

Support: Table 8 presents the DAC rates for each individual session for the later periods. Considerable variation exists across sessions within all treatment conditions. In the repeated game treatments without communication, averaged across sessions, transgression occurs 92.5 percent of the time in the Random Matching/No Communication baseline shown on the upper left. Adding repetition decreases transgression, with a highly significant decrease to 67.4 percent for LH Finite Repetition (Mann-Whitney U=7.5; for sample sizes n=8, m=6, one-tailed p-value<0.05) and a marginally significant decrease to 79.8 percent for EH Finite Repetition (U=13; one-tailed p-value<0.10), but no significant change for Indefinite Repetition (U=25; *ns*). We employ one-tailed tests because the research hypothesis is that communication and repetition will increase resistance and reduce transgression.

As discussed in section 3, although the theoretical insight by Benoit and Krishna (1987) regarding the lack of sharp difference between finite repetition and infinite repetition for games with multiple equilibria is well-recognized, there is not much direct empirical evidence regarding this proposition. Although not a main focus of our study, our experiment provides direct evidence for this theoretical insight. In particular, although transgression rates are higher in the Indefinite Repetition treatment (87.9 percent) than both of the Finite Repetition treatments, these differences are not statistically significant (Mann-Whitney two-tailed p-values=0.15).

We have reported a rich set of behavioral evidence supporting the theoretical insight that the leader's threat of punishing the challenging beneficiaries limits the effectiveness of repetition alone in facilitating coordinated resistance against DAC. We also find empirically that communication is informative, and can increase coordinated resistance even in the presence of repetition. We conclude by reporting that these properties of repetition and communication as mechanisms for coordinating resistance are reflected in their effects on transgression rates.

Finding 9: *Repetition alone is no more effective than communication in reducing transgression. Holding the matching protocol constant, adding communication always reduces the transgression rate.*

Support: Adding communication, even in the Random Matching environment, results in a highly significant decrease in transgression (U=10; n=m=8, one-tailed p-value<0.05).

Importantly, the transgression rate in the Random Matching/Communication treatment (75.3 percent overall) is not significantly different from the best repeated play no communication treatment (LH Finite Repetition, at 67.4 percent), indicating that communication alone is at least as effective as repetition in reducing transgression (*U*=20; *ns*).

The interaction of communication and repetition decreases transgression even further, and in these late periods the transgression rate falls below 45 percent in the LH Finite Repetition/Communication treatment. This is significantly less than the Random Matching/ Communication level (*U*=10; one-tailed *p*-value<0.05). The other two repetition and communication treatments result in marginally significant decreases in transgression relative to the Random Matching/Communication level (*U*=12 and *U*=12.5; both one-tailed *p*-value<0.10), but all communication/repetition treatments have significantly less transgression than the Random Matching/No Communication baseline.

Adding communication, holding the matching protocol constant, also usually reduces the transgression rate significantly. In particular, the decrease in transgression from adding communication is highly significant for Random Matching (*U*=10; *n*=*m*=8, one-tailed *p*-value<0.05), Indefinite Repetition (*U*=3; *n*=*m*=6, one-tailed *p*-value<0.01) and LH Finite Repetition (Mann-Whitney approximation *z*=1.78; *n*=*m*=18, one-tailed *p*-value<0.05).[12] The decrease is marginally significant for EH Finite Repetition (*U*=8; *n*=*m*=6, one-tailed *p*-value<0.10).

5. Conclusions

Since the seminal work of North and Weingast (1989), an important economic literature

[12] Each grouping of three subjects is statistically independent in the LH Finite Repetition treatment because subjects are never regrouped. This leads to 18 independent observations per treatment for this matching protocol.

has argued that the successful deterrence of leader expropriation is necessary for economic development. Deterring leader transgression, however, is difficult, especially when the leader can practice divide-and-conquer. In his influential work on divide-and-conquer, Weingast (1995, 1997) focuses on how repetition may enable victims and beneficiaries of DAC to use history-dependent strategies to facilitate cooperation to defeat DAC, but he does not consider how repetition can also enable the leader to use history-dependent strategies to punish beneficiaries who refuse to cooperate with him. Besides this neglect on how the threat of punishing the challenging beneficiary may deter coordinated resistance, the literature on leader expropriation also does not consider social preferences.

Using a CR game modeled with incomplete information about preferences, this paper derives theoretically the implications of the observation that repetition is a two-edged sword in affecting cooperation in this setting, and tests these implications in an experiment. This study is the first to provide empirical support to the novel observation that even in the presence of social preferences, repetition alone can be of limited effectiveness in deterring divide-and-conquer. This result, together with our other findings showing that communication can be informative and significantly reduce DAC even in the presence of repetition, strongly suggests that research seeking to identify mechanisms that can deter divide-and-conquer should avoid focusing on repetition alone. Instead, we should consider repetition in conjunction with communication, or repetition in conjunction with other mechanisms that may enable potential challengers to DAC to reveal whether they have standard or social preferences to others.

This study also contributes to the emerging experimental literature on indefinitely repeated games. As discussed in the introduction, our empirical knowledge about indefinitely repeated games lags significantly behind the theoretical literature, and the small number of experimental studies on indefinitely repeated games focus on the prisoner's dilemma and public good games where there is no asymmetry between the roles of players. Most existing work also does not consider the interaction between communication and repetition. Our findings regarding this DAC social dilemma that has interesting endogenous role asymmetry constitute novel empirical results in the literature on indefinitely repeated games. We hope that these results will stimulate interest in studying additional rich and under-explored classes of repeated games with endogenous roles.

Our results also provide a natural explanation of why political leaders who use divide-and-conquer to extract surplus from their subordinates have a strong desire to suppress on-going social interactions, including social interactions that may not be political. Diamond et al. (1995) observe how the absence of a vigorous sector of voluntary associations and the control of such organizations can reinforce authoritarian rule, and Robison and Ritchie (2010, p.228) discuss how in autocratic societies, "cafe, newspapers, the Internet, religious meetings, and so forth must all be managed to ensure that collective action is limited." Our results suggest that even though they may not be political in nature, social interactions, in particular on-going social interactions, can facilitate type identification for different groups in society. This fact, together with the prospect of enhancing repeated interaction, makes even apolitical social interactions dangerous because they can help facilitate coordinated resistance against divide-and-conquer leader transgression when it occurs. More generally, a political leader may even want to discourage the development of other-regarding preferences in a community, since divide-and-conquer is more likely to be successful if most members of the community are self-regarding.

Our results also reveal that non-binding communication can be informative and effective in facilitating coordinated challenge even in the presence of repeated interaction. Compared to coordination through costly actions, communication provides victims and beneficiaries with a less costly means to coordinate their actions, and when it is not observed by the leader, is also safer than costly observable actions that can be used by the leader to target the challenging beneficiary. Our results naturally imply that political and organizational leaders have the incentive to make communication between their subordinates observable, so that they can use the information to implement the punishing the challenging beneficiary strategy to deter resistance.

For example, the Chinese government has recently mandated that users of the Twitter-like microblog websites must authenticate their identity with official documents bearing their real names before they can send any messages, and there is serious concern that such regulation will significantly deter communication through microblogs (Phys. Org, 2012). As discussed in the introduction, organizational leaders, similar to political leaders, also frequently employ divide-and-conquer strategies. For example, the management of a firm may use divide-and-conquer to prevent coordinated resistance by unions. Interestingly, the issue of whether employees can use company emails to promote union activities has been the subject of a recent high profile lawsuit (*Guard Publishing Company v. NLRB,* see, for example, the report by the US Chamber of Commerce, 2010). The policy and legal implications for employers who observe employees' personal information about trade union membership or their discussions about union activities by monitoring personal communication through the company network are the subject of debates by scholars and practitioners in the UK (Oliver, 2002) and the US (DelPo and Guerin, 2011). In future work, we plan to study what happens in the repeated CR game if the leader can invest resources to observe stochastically the communication between responders, and also investigate to what extent that victims and beneficiaries can solve the "higher order" coordinated resistance problem of coordinating to resist such attempts by the leader.

Appendix

This appendix sketches a model that formalizes the ideas that incomplete information about whether other responders are social preferences types, and the leader's threat of using history-dependent strategies to punish beneficiaries who refuse to cooperate with him, constitute barriers to coordinated resistance against DAC by its victims and beneficiaries even in the presence of repeated interactions. Detailed discussion of the model and proofs of results are reported in Supplementary Appendix available at http://users.monash.edu.au/~vlmui/CR_app.pdf.

Consider a model in which all agents are of two types. With probability *p* an agent has standard preferences, and with probability *(1-p)* the agent has social preferences. An agent's type is her private information. Cox et al. (2007) assume that in a (two-player) sequential move game, when a second-mover with social preferences makes her decision after observing the action chosen by the first-mover, the second-mover's marginal rate of substitution between her income and the income of the first-mover depends on her emotional state toward the first-mover. Following this approach, and for simplicity we assume that the only emotional reaction that can be triggered in the CR game is the negative reaction toward a transgressing leader by the responders. Qualitatively, our main results hold for any social preferences models in which a social preference type beneficiary prefers that DAC be defeated.

If agent *i* is a Social Preferences type (hereafter the *SP*-type) and a responder, she regards a DAC transgression by the leader as undesirable, modeled with the utility function

$$U_i\left(y_L, y_i, y_j\right) = \begin{cases} \dfrac{1}{\alpha}\left[y_i^{\alpha} + \theta y_L^{\alpha})\right], & \theta \in (-1,0) \text{ if } a_L \in \{TAB, TA, TB\} \\ & \theta = 0 \text{ if } a_L = NT \end{cases} \qquad (1)$$

Here, y_i is agent *i*'s income, y_L is the leader's income, y_j is the income of the other responder, θ is the (conditional) emotional state variable, and $\alpha \le 1$ (and $\alpha \ne 0$) is an elasticity of substitution parameter. TAB denotes transgression against both responders, NT denotes No Transgression, and TA and TB denote divide-and-conquer transgression against A and B, respectively. If an agent is a Standard type (hereafter the *S*-type), then regardless of whether she is a leader or a responder, she has a utility function

$$U_i\left(y_i\right) = \frac{1}{\alpha} y_i^{\alpha}. \qquad (2)$$

Because the only emotional reaction we focus on is the negative reaction by a responder towards a transgressing leader, an *SP*-type leader will also have a utility function of $U_i\left(y_i\right)=\frac{1}{\alpha}y_i^{\alpha}$.

Result 1: If $|\theta|>\left(9^{\alpha}-7^{\alpha}\right)/8^{\alpha}$ and $p<\left(7^{\alpha}-2^{\alpha}\right)/\left(7^{\alpha}-1\right)$, then each of the three following strategy profiles constitutes a Bayesian Nash Equilibrium in the DAC subgame with social preferences:

(i) Both the *S*-type victim and the *SP*-type victim acquiesce, and both the *S*-type beneficiary and the *SP*-type beneficiary acquiesce.

(ii) Both the *S*-type victim and the *SP*-type victim challenge. The *S*-type beneficiary always acquiesces, and the *SP*-type beneficiary challenges.

(iii) The *S*-type victim challenges with a probability $\beta=\frac{\left(1-p\right)(9^{\alpha}+\theta 8^{\alpha}-7^{\alpha})+p(9^{\alpha}-8^{\alpha})}{p(7^{\alpha}-8^{\alpha}-\theta 8^{\alpha})}\in\left(0,1\right)$, and the *SP*-type victim always challenges. The *S*-type beneficiary always acquiesces, and the *SP*-type beneficiary challenges with a probability $\gamma=\frac{2^{\alpha}-1}{\left(1-p\right)\left(7^{\alpha}-1\right)}\in\left(0,1\right)$.

Result 1 shows that when social preferences are sufficiently strong and that there is a sufficiently high probability that a beneficiary is an *SP*-type, then social preferences transform the DAC subgame into a stag-hunt game for the responders, with multiple (and Pareto-ranked) equilibria. The model also implies that victims will challenge more than beneficiaries, which is consistent with the empirical findings in Cason and Mui (2007). Although joint resistance can be supported as an equilibrium, incomplete information about the types of other responders and multiple equilibria can prevent joint resistance from occurring.

Now consider the effect of non-binding communication between the responders in the one-shot CR game. As common in cheap talk games, a babbling equilibrium always exists, but it is straightforward to show that an informative equilibrium also exists. In this equilibrium, both types of victim will indicate Challenge and will challenge if and only if both the victim and the beneficiary have indicated Challenge in the communication stage. An *SP*-type beneficiary will indicate Challenge, and will challenge if and only if both the victim and the beneficiary have indicated Challenge in their messages. An *S*-type beneficiary will indicate Acquiesce, and will acquiesce regardless of the messages sent by the victim and beneficiary. These strategies constitute an equilibrium because an *SP*-type beneficiary prefers that a DAC transgression be defeated and has the incentive to send a message of CH to indicate that she is an *SP*-type so as to induce coordinated resistance with the victim. On the other hand, an *S*-type beneficiary prefers that a DAC transgression succeeds, and has no incentive to deviate to send a message of Challenge. Communication can help coordinate resistance against DAC in this environment.

Result 2 shows when the leader uses history-dependent strategies to punish beneficiaries who refuse to cooperate, an *SP*-type beneficiary will challenge only when she believes that there is a sufficiently small probability that the other responder is an *S*-type (this is given by the condition $p < \frac{(1-\delta)(1+\delta)7^{\alpha} + \delta^{2}8^{\alpha} - 9^{\alpha} - \theta 8^{\alpha}}{\delta\left[(1-\delta)7^{\alpha} + \delta 8^{\alpha} - (1-\delta)(1+\theta 8^{\alpha}) - \delta(2^{\alpha} + \theta 8^{\alpha})\right]}$ in Result 2 below). The Supplementary Appendix provides a formal and complete description of the strategy of the leader and the responders and their belief updating rules, and provides interpretations of the conditions ensuring this result. It also shows how communication can be informative and help coordinate resistance in the repeated CR game.

Result 2: If $\frac{9^\alpha - 7^\alpha}{8^\alpha} < -\theta < \frac{\left(9^\alpha - 7^\alpha\right) + \delta\left(9^\alpha - 1\right) + \delta^2\left(9^\alpha - 2^\alpha\right)}{8^\alpha}$ and $\frac{6^\alpha(1-\delta)}{8^\alpha - \delta 6^\alpha} < p < \min\left(\frac{7^\alpha - 2^\alpha}{7^\alpha - 1}, \frac{(1-\delta)(1+\delta)7^\alpha + \delta^2 8^\alpha - 9^\alpha - \theta 8^\alpha}{\delta\left[(1-\delta)7^\alpha + \delta 8^\alpha - (1-\delta)\left(1+\theta 8^\alpha\right) - \delta\left(2^\alpha + \theta 8^\alpha\right)\right]}\right)$, then the following strategies constitute a Perfect Bayesian equilibrium in the infinitely repeated CR game with social preferences:

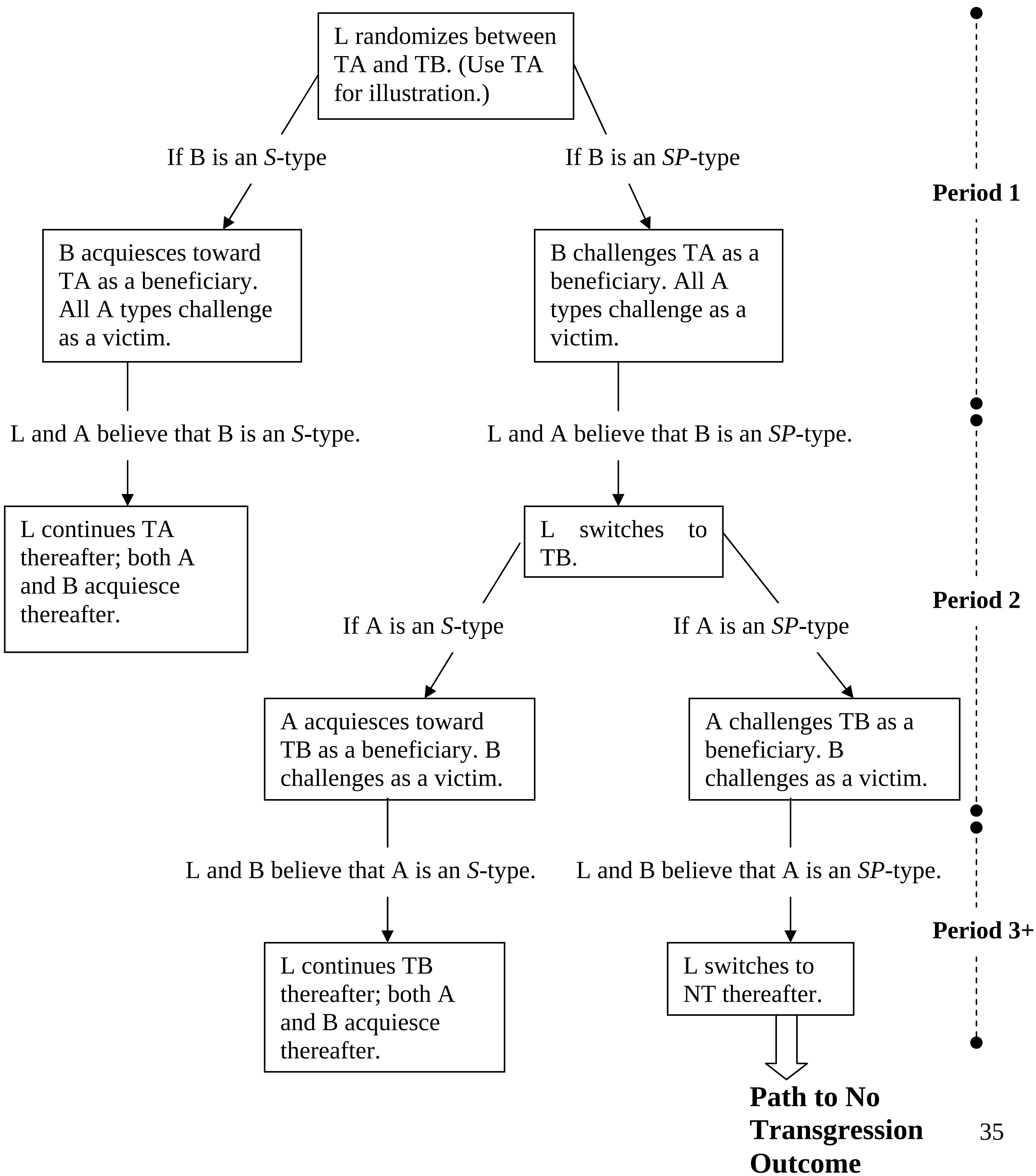


Table 1: Experimental Design (522 Total Subjects)

	No Communication	Communication
Long Horizon Finite Repetition (50 Periods)	6 Sessions (54 Subjects) 2 at Monash Univ., 4 at Purdue Univ.	6 Sessions (54 Subjects) 2 at Monash Univ., 4 at Purdue Univ.
Equivalent Horizon Finite Repetition (8 Periods)	12 Sessions[a] (108 Subjects) 6 at Monash Univ., 6 at Purdue Univ.	6 Sessions (54 Subjects) 2 at Monash Univ., 4 at Purdue Univ.
Indefinite Repetition (7/8 probability of continuation)	6 Sessions (54 Subjects) 2 at Monash Univ., 4 at Purdue Univ.	6 Sessions (54 Subjects) 2 at Monash Univ., 4 at Purdue Univ.
Random Matching[b] (50 Total Periods)	8 Sessions (72 Subjects) 6 at Monash Univ., 2 at Purdue Univ.	8 Sessions (72 Subjects) 6 at Monash Univ., 2 at Purdue Univ.

[a] Six of the 12 sessions in this No Communication, Equivalent Horizon Finite Repetition treatment were conducted with responder labels randomly re-assigned each period to obscure responder identity from the leader, as discussed in the text.

[b] Data from the two Random Matching treatments were previously reported in Cason and Mui (2007).

Table 2: Fixed Effects Logit Models of Leader Transgression Decisions: Repeated Game Treatments

Resistance in Previous DAC Transgression of this Match:	Dependent Variable: Leader switches to DAC against other responder	Dependent Variable: Leader switches to No Transgression
Victim Resisted	0.099 (0.160)	0.139 (0.198)
Beneficiary Resisted	0.845** (0.221)	0.803** (0.231)
Log likelihood	-513.1	-333.0
Observations	1195	1027

Notes: All models are estimated with subject fixed effects. Some subjects were dropped due to zero variation in transgression decision. Standard errors are shown in parentheses. ** denotes significance at the one-percent level (all two-tailed tests).

Table 3: Fixed Effects Logit Models of DAC Challenge Decision Based on Previous DAC Challenges within Current Repeated game: No Communication Treatments

Dependent Variable = 1 if Responder Challenges a DAC Transgression

	Indefinite Repetition		Equiv. Horizon Finite		Long Horizon Finite		Resp. Labels Reassigned	
Resistance in Previous DAC Transgression of this Match:	Victim Challenge	Beneficiary Challenge	Victim Challenge	Beneficiary Challenge	Victim Challenge	Beneficiary Challenge	Victim Challenge	Beneficiary Challenge
Only Victim Resisted	1.31**	0.58	1.02**	1.16*	0.81**	1.54**	0.58*	-0.05
	(0.25)	(0.45)	(0.26)	(0.56)	(0.31)	(0.56)	(0.029)	(0.40)
Only Beneficiary Resisted	1.08*	-0.12	1.88**	1.63*	1.96**	1.82*	1.35**	0.48
	(0.53)	(0.82)	(0.63)	(0.78)	(0.65)	(0.81)	(0.45)	(0.52)
Both Responders Resisted	1.87**	-1.17	2.63**	3.43**	2.05**	1.90**	4.47**	2.32**
	(0.55)	(1.15)	(0.57)	(0.71)	(0.66)	(0.70)	(1.11)	(0.55)
1/period	5.05*	5.32†	3.37†	2.27	7.05*	2.97	1.64	-1.94
	(2.19)	(2.86)	(1.90)	(2.01)	(3.21)	(3.78)	(1.89)	(1.85)
Early 3 rounds dummy var.	0.12	-0.36	0.25	-0.14	-2.09†	-2.87†	0.25	0.39
	(0.36)	(0.56)	(0.26)	(0.42)	(1.23)	(1.73)	(0.30)	(0.37)
Log likelihood	-212.0	-83.6	-177.7	-62.5	-140.0	-67.3	-134.4	-86.1
Observations	533	272	431	266	404	215	336	247

Notes: All models are estimated with subject fixed effects. Some subjects were dropped due to zero variation in challenge decision. Standard errors are shown in parentheses. ** denotes significance at the one-percent level; * denotes significance at the five-percent level; † denotes significance at the ten-percent level (all two-tailed tests).

Table 4: Rates for Independent Sessions that Responders Successfully Jointly Resist a Divide-and-Conquer Transgression (Sessions ordered highest to lowest)

	No Communication	Communication
	23.7%	43.1%
Random	15.0%	24.3%
Matching	8.9%	21.2%
(one-shot)	4.4%	12.7%
	3.4%	8.5%
	1.2%	4.8%
	0.0%	2.6%
	0.0%	1.2%
Treatment Average	**7.1%**	**14.8%**
	34.8%	88.9%
Long Horizon	25.8%	15.0%
Finite Repetition	11.7%	14.0%
(50 periods)	8.1%	10.8%
	3.6%	5.7%
	0.0%	0.0%
Treatment Average	**14.0%**	**22.4%**
	18.5%	26.5%
Equivalent Horizon	11.5%	21.6%
Finite Repetition	9.5%	17.3%
(8 periods)	6.2%	12.5%
	3.2%	9.9%
	1.3%	8.1%
Treatment Average	**8.4%**	**16.0%**
Indefinite	28.9%	57.1%
Repetition	12.6%	36.0%
(7/8 probability	6.3%	25.0%
of continuation,	5.3%	17.5%
8 periods in	1.9%	17.1%
expectation)	1.7%	8.9%
Treatment Average	**9.5%**	**26.9%**

Note: The early periods 1-20 are excluded from these calculations.

Table 5: Challenge and Successful Resistance Rates for Different Combinations of Messages, Divide-and Conquer Transgressions

	Message Combination:	Random Matching	Indefinite Repetition	Equivalent Horizon Finite	Long Horizon Finite
(1)	Neither Responder	0/141	0/73	0/105	0/142
	Indicates Resistance	0.0%	0.0%	0.0%	0.0%
(2)	Only Victim	5/443	7/263	9/246	4/155
	Indicates Resistance	1.1%	2.7%	3.7%	2.6%
(3)	Only Beneficiary	9/78	5/33	11/38	8/24
	Indicates Resistance	11.5%	15.2%	28.9%	33.3%
(4)	Both Responders	110/228	91/140	80/115	56/88
	Indicate Resistance	48.2%	65.0%	69.6%	63.6%

Table 6: Fixed Effects Logit Models of DAC Challenge Decision Based on Communicated Messages

Dependent Variable = 1 if Responder Challenges a DAC Transgression

	Random Matching		Indefinite Repetition		Equiv. Horizon Finite		Long Horizon Finite	
Message Combinations:	Victim Challenge	Beneficiary Challenge	Victim Challenge	Beneficiary Challenge	Victim Challenge	Beneficiary Challenge	Victim Challenge	Beneficiary Challenge
Only Victim	0.12	0.07	1.84**	0.23	2.33**	1.18	1.88**	0.73
Indicates Resistance	(0.35)	(0.59)	(0.56)	(0.83)	(0.51)	(1.07)	(0.46)	(1.17)
Only Beneficiary	1.45**	1.74**	3.01**	2.44**	2.56**	4.71**	2.25**	4.49**
Indicates Resistance	(0.39)	(0.61)	(0.69)	(0.94)	(0.63)	(1.18)	(0.63)	(1.29)
Both Responders	4.01**	3.23**	5.74**	4.46**	6.35**	4.83**	6.80**	4.78**
Indicate Resistance	(0.42)	(0.59)	(0.68)	(0.85)	(0.75)	(1.11)	(1.13)	(1.15)
1/period	4.19**	2.21*	0.43	-0.82	0.49	0.55	4.68*	3.36
	(0.83)	(0.98)	(0.89)	(1.02)	(0.91)	(0.91)	(2.20)	(2.67)
Early 3 rounds			0.51†	0.79*	0.18	0.59	-1.00	0.22
dummy var.			(0.30)	(0.38)	(0.29)	(0.39)	(1.37)	(1.80)
Log likelihood	-250.8	-127.7	-142.6	-84.7	-127.7	-68.6	-97.9	-46.4
Observations	855	464	500	458	479	331	376	235

Notes: All models are estimated with subject fixed effects. Some subjects were dropped due to zero variation in challenge decision. Standard errors are shown in parentheses. ** denotes significance at the one-percent level; * denotes significance at the five-percent level; † denotes significance at the ten-percent level (all two-tailed tests).

Table 7: Fixed Effects Logit Models of DAC Challenge Decision Based on Previous DAC Challenges within Current Repeated game and Current Period Messages Communicated
Dependent Variable = 1 if Responder Challenges a DAC Transgression

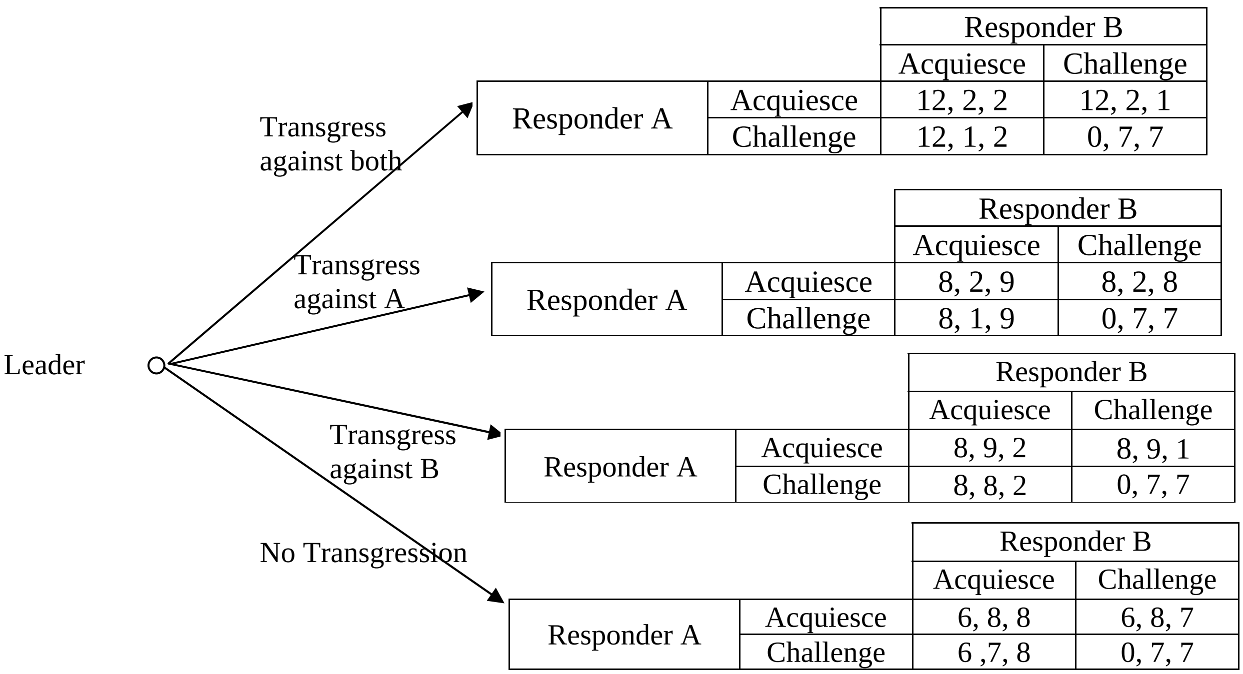
	Indefinite Repetition				Equiv. Horizon Finite				Long Horizon Finite			
Resistance to Previous DAC Transgression:	Victim Challenge	Beneficiary Challenge	Victim Challenge	Beneficiary Challenge	Victim Challenge	Beneficiary Challenge	Victim Challenge	Beneficiary Challenge	Victim Challenge	Beneficiary Challenge	Victim Challenge	Beneficiary Challenge
Only Victim	0.32	0.29	-0.02	0.19	0.85*	0.06	0.97*	-0.75	-0.48	-1.06	-0.44	-1.44
Resisted	(0.30)	(0.47)	(0.39)	(0.65)	(0.35)	(0.48)	(0.48)	(0.61)	(0.43)	(0.67)	(0.50)	(0.87)
Only Beneficiary	2.89*	1.60†	2.36*	0.72	2.18†	0.46	1.97	0.00	1.14	-0.22	0.90	-1.44
Resisted	(1.17)	(0.91)	(1.20)	(1.30)	(1.26)	(0.96)	(1.39)	(1.06)	(1.40)	(1.21)	(1.53)	(3.15)
Both Responders	2.33**	1.89**	1.60**	0.86	3.39**	0.43	2.64**	-0.89	2.92**	2.03**	2.05*	2.19*
Resisted	(0.45)	(0.46)	(0.56)	(0.74)	(0.81)	(0.62)	(0.93)	(0.86)	(0.76)	(0.69)	(0.87)	(1.09)
Messages:												
Only Victim			1.52*	0.04			2.36**	1.38			0.72	-1.03
Indicates Resistance			(0.60)	(1.23)			(0.65)	(1.15)			(0.54)	(1.25)
Only Beneficiary			2.29**	3.08*			2.90**	4.83**			1.56*	7.55*
Indicates Resistance			(0.82)	(1.51)			(0.75)	(1.37)			(0.73)	(3.13)
Both Responders			5.15**	6.02**			6.14**	4.32**			4.82**	7.01*
Indicate Resistance			(0.75)	(1.60)			(1.02)	(1.23)			(0.94)	(2.87)
1/period	0.11	0.86	1.35	2.52	1.48	1.49	-0.31	3.04	7.25†	7.24	9.28*	22.1*
	(1.73)	(1.83)	(2.74)	(3.27)	(1.96)	(2.18)	(2.96)	(2.23)	(4.12)	(4.75)	(4.41)	(9.46)
Early 3 rounds	0.64†	0.69†	0.30	0.78	0.65*	0.50	0.35	0.69	-1.92	-0.13	-2.59	-2.17
dummy var.	(0.33)	(0.40)	(0.42)	(0.55)	(0.33)	(0.40)	(0.42)	(0.54)	(1.76)	(1.66)	(1.94)	(2.19)
LR test: Previous DAC resist terms jointly insignificant			12.8*	1.4			12.0*	2.0			8.6†	9.2†
LR test: Current cheap talk terms jointly insignificant			108.6**	81.6**			70.8**	43.0**			49.4**	52.4**
Log likelihood	-146.9	-76.9	-92.6	-36.1	-95.9	-60.8	-60.5	-39.3	-89.8	-47.1	-65.1	-20.9
Observations	368	308	368	308	305	182	305	182	277	158	277	158

Notes: All models are estimated with subject fixed effects. Some subjects were dropped due to zero variation in challenge decision. Standard errors are shown in parentheses. ** denotes significance at the one-percent level; * denotes significance at the five-percent level; † denotes significance at the ten-percent level (all two-tailed tests). The likelihood ratio (LR) test statistics are distributed χ^2(3 d.f.).

Table 8: Rates for Independent Sessions that Leaders Transgressed (Sessions ordered lowest to highest)

	No Communication	Communication
	66.7%	37.8%
Random	90.0%	56.7%
Matching	91.1%	65.6%
(one-shot)	94.4%	77.8%
	97.8%	86.7%
	100.0%	87.8%
	100.0%	93.3%
	100.0%	96.7%
Treatment Average	**92.5%**	**75.3%**
	41.1%	10.0%
Long Horizon	43.3%	22.2%
Finite Repetition	66.7%	38.9%
(50 periods)	68.9%	47.8%
	85.6%	52.2%
	98.9%	94.4%
Treatment Average	**67.4%**	**44.3%**
	34.5%	44.0%
Equivalent Horizon	77.4%	51.2%
Finite Repetition	78.6%	58.3%
(8 periods)	92.9%	60.7%
	97.6%	61.9%
	97.6%	84.5%
Treatment Average	**79.8%**	**60.1%**
Indefinite	40.4%	15.1%
Repetition	93.3%	28.0%
(7/8 probability	95.7%	38.9%
of continuation,	98.2%	77.8%
8 periods in	100.0%	78.4%
expectation)	100.0%	81.4%
Treatment Average	**87.9%**	**53.2%**

Note: The early periods 1-20 are excluded from these calculations.



Transgress against both:

		Responder B: Acquiesce	Responder B: Challenge
Responder A	Acquiesce	12, 2, 2	12, 2, 1
	Challenge	12, 1, 2	0, 7, 7

Transgress against A:

		Responder B: Acquiesce	Responder B: Challenge
Responder A	Acquiesce	8, 2, 9	8, 2, 8
	Challenge	8, 1, 9	0, 7, 7

Transgress against B:

		Responder B: Acquiesce	Responder B: Challenge
Responder A	Acquiesce	8, 9, 2	8, 9, 1
	Challenge	8, 8, 2	0, 7, 7

No Transgression:

		Responder B: Acquiesce	Responder B: Challenge
Responder A	Acquiesce	6, 8, 8	6, 8, 7
	Challenge	6 ,7, 8	0, 7, 7

Figure 1: The Divide-and-Conquer Coordinated Resistance Game (payoffs are for (Leader, Responder A, Responder B))

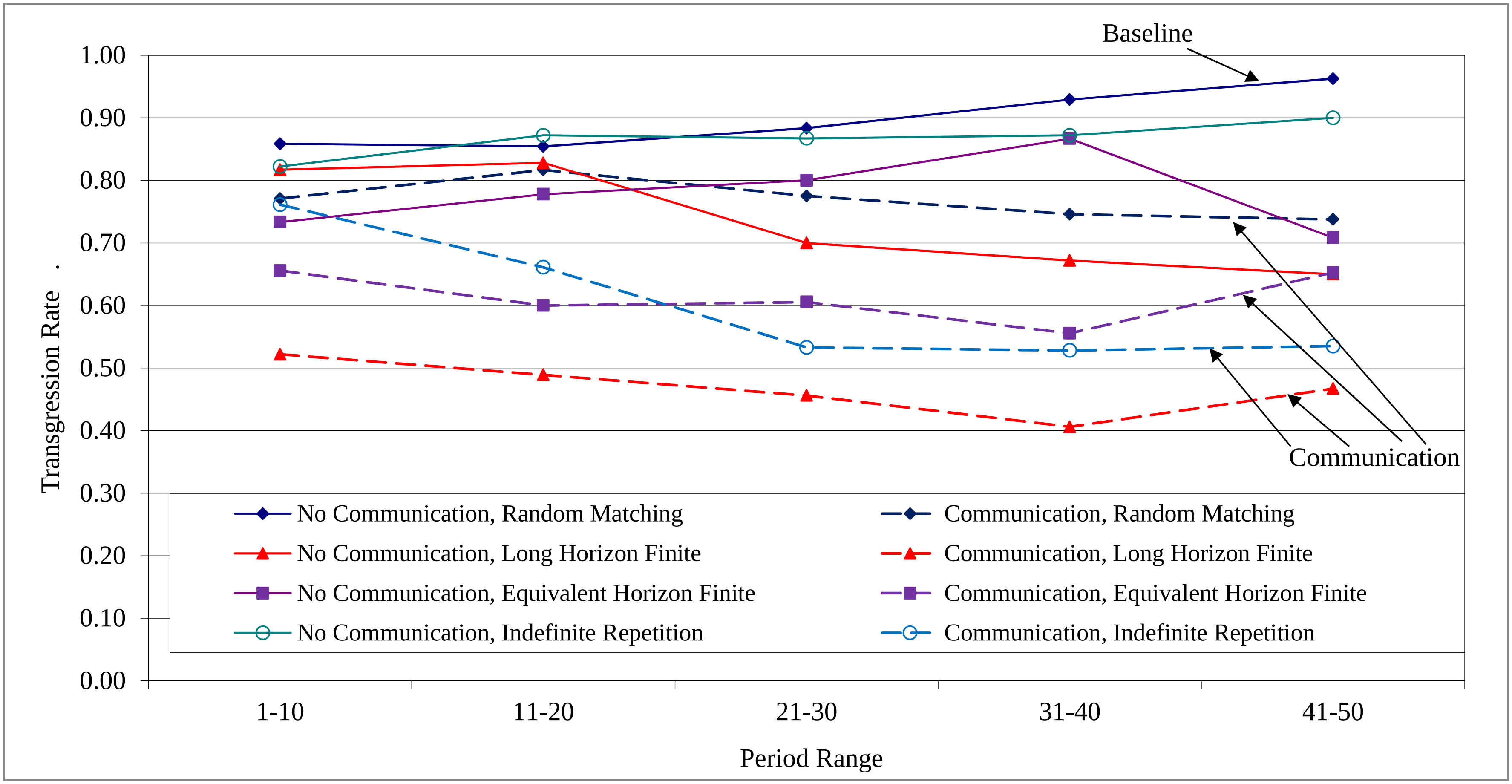


Figure 2: Transgression Rates for All Treatments

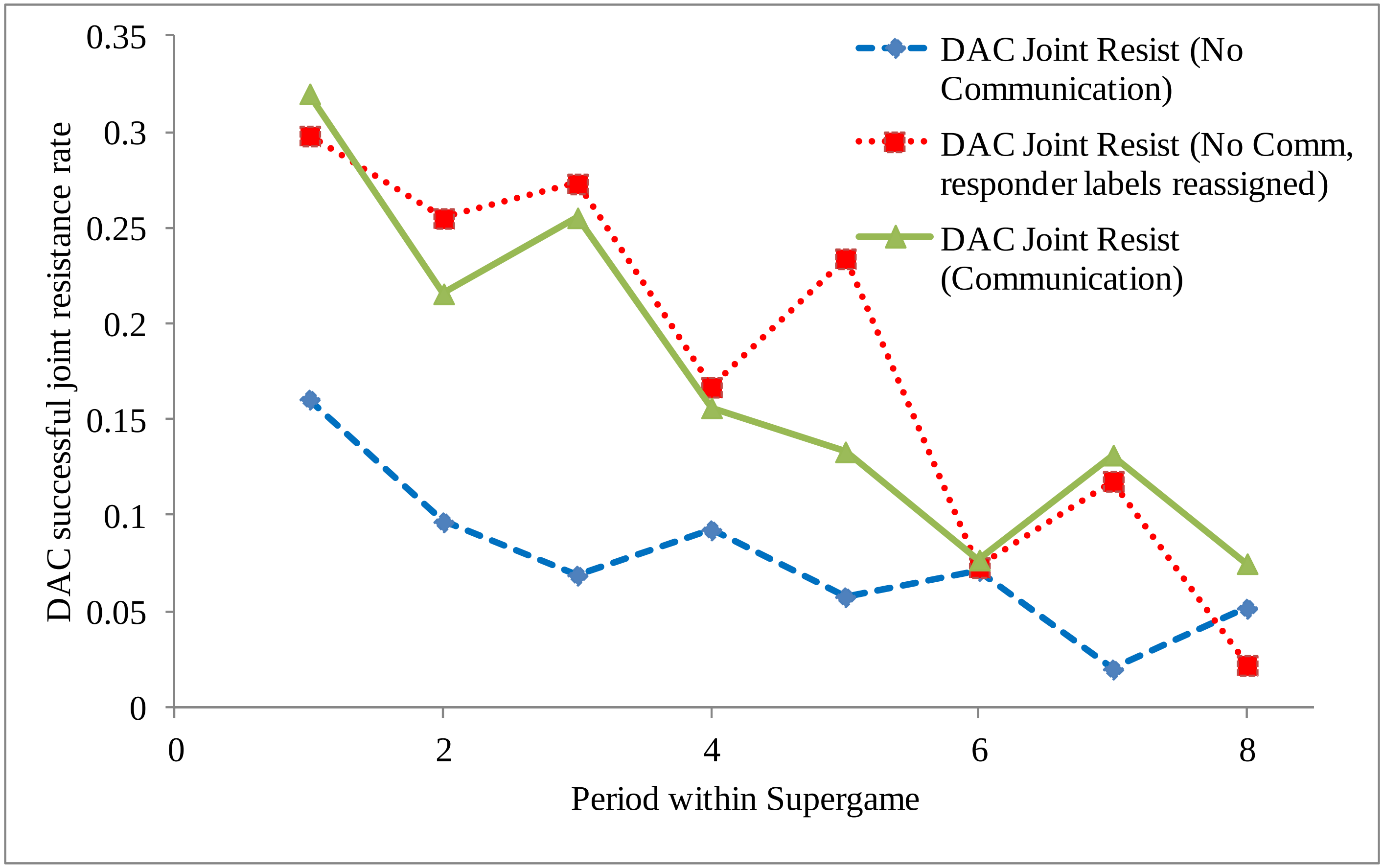


Figure 3: Successful Joint Resistance Rates within Repeated games for EH Finite Repetition and Indefinite Repetition Treatments (after session period 16)

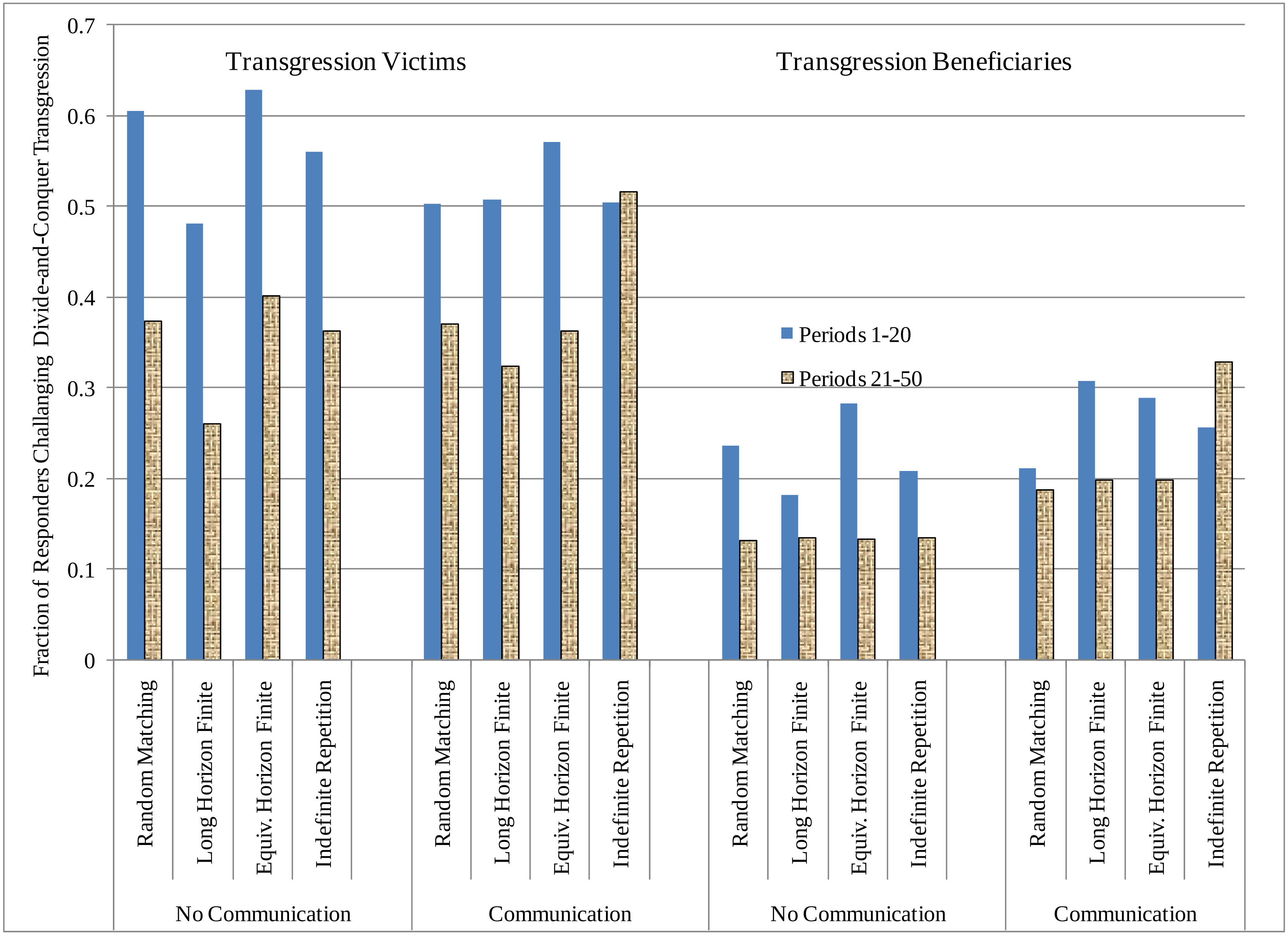


Figure 4: Resistance Rates for Divide-and-Conquer Transgressions

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Appendix I: *Instructions for Indefinite Repetition/Communication* Treatment

This is an experiment in the economics of multi-person strategic decision making. The National Science Foundation has provided funds for this research. If you follow the instructions and make appropriate decisions, you can earn an appreciable amount of money. The currency used in the experiment is francs. Your francs will be converted to U.S. Dollars at a rate of 10 francs to one dollar. At the end of today's session, you will be paid in private and in cash.

It is important that you remain silent and do not look at other people's work. If you have any questions, or need assistance of any kind, please raise your hand and an experimenter will come to you. If you talk, laugh, exclaim out loud, etc., you will be asked to leave and you will not be paid. We expect and appreciate your cooperation.

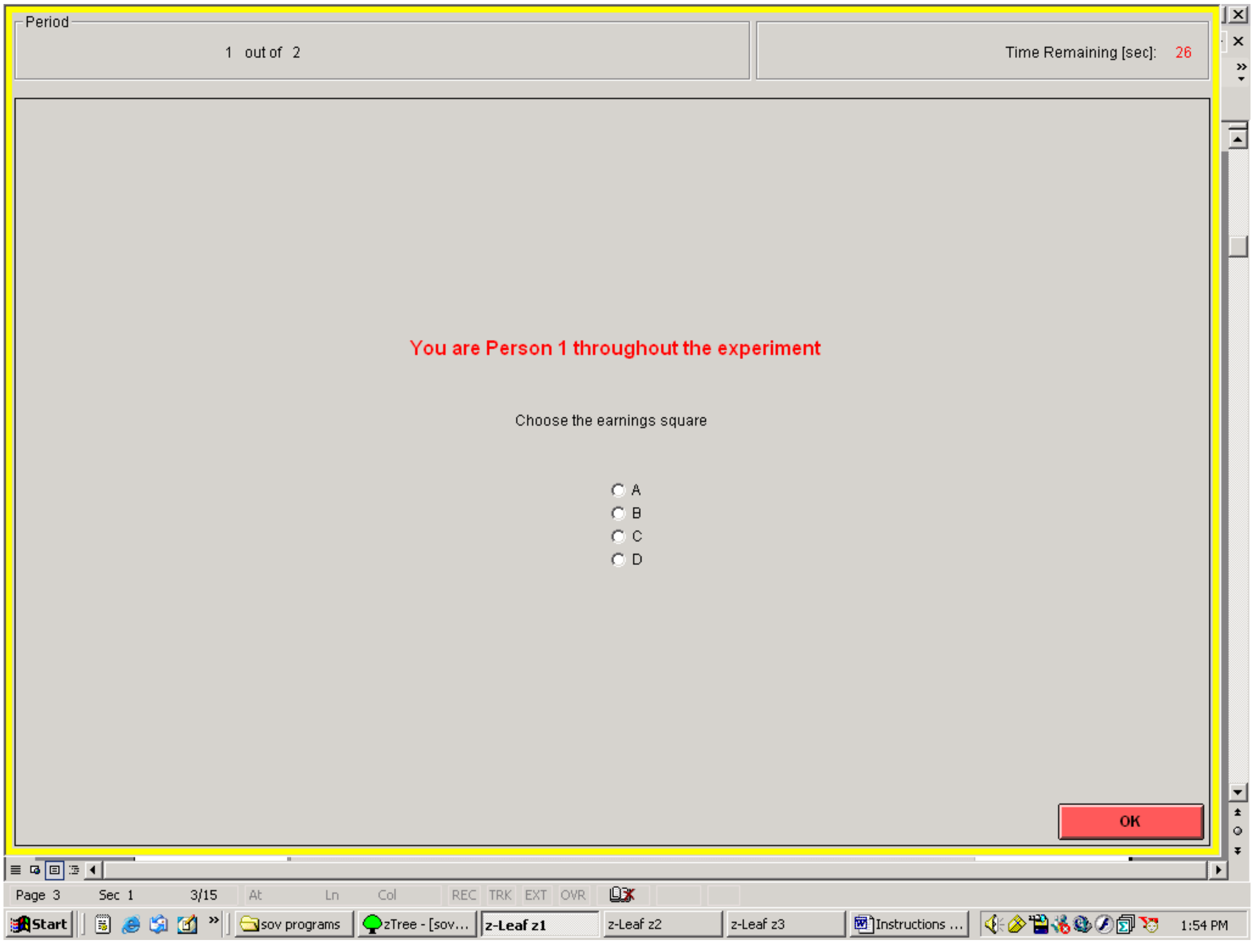
The experiment consists of many separate decision making periods. The 18 participants in today's experiment will be randomly split each period between three equal-sized groups, designated as **Person 1**, **Person 2** and **Person 3** groups. If you are designated as a Person 1, then you remain in this same role throughout the experiment. Participants who are not designated as a Person 1 switch randomly between the Person 2 and Person 3 roles at specific points in the experiment when individuals may be re-grouped, as explained later.

At the beginning of the experiment you will be randomly re-grouped with two other participants to form a three-person group, with one person of each type in each group. You will be grouped with these same two participants for a random number of periods, as explained later.

<u>Your Choice</u>

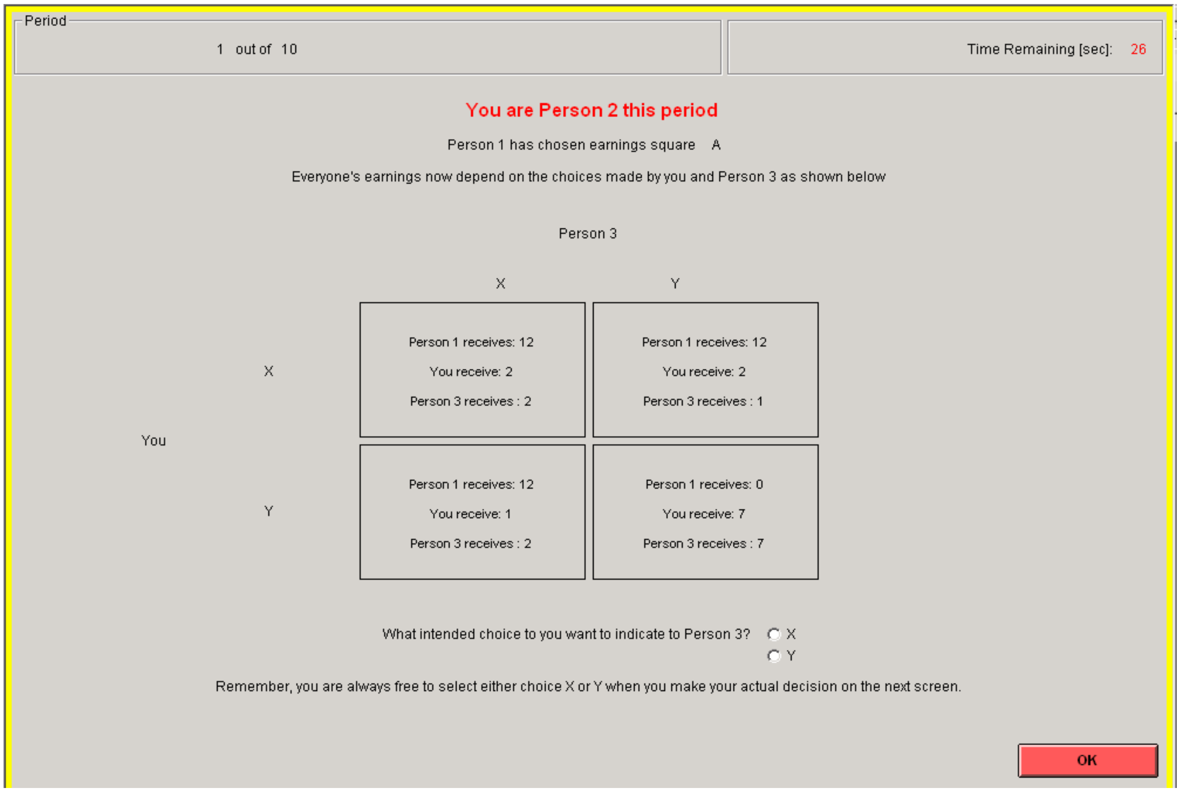
During each period, you and all other participants will make one choice. Earnings tables are provided on separate papers, which tell you the earnings you receive given the choices that you and others in your group make. If you are **Person 1** then you choose the earnings square, either **A**, **B**, **C** or **D**. You make this choice before the other two people in your group make their choice, on a decision screen as shown in Figure 1 on the next page.

After learning which earnings square the Person 1 chose, then **Persons 2 and 3** make their choices. However, after learning Person 1's earnings square choice but before making their actual choice, Persons 2 and 3 have an opportunity to privately communicate to each other an "intended" choice. As noted on the example Intention Screen for Person 2 (see page 3), Persons 2 and 3 are not required to make the same actual choice as the intended choice they share with the other person, and they are always free to select either choice X or Y when they make their actual decision. Persons 2 and 3 indicate their intended choices simultaneously; for example, if you are Person 3 then you do not learn the intended choice of Person 2 until after you indicate your intended choice.

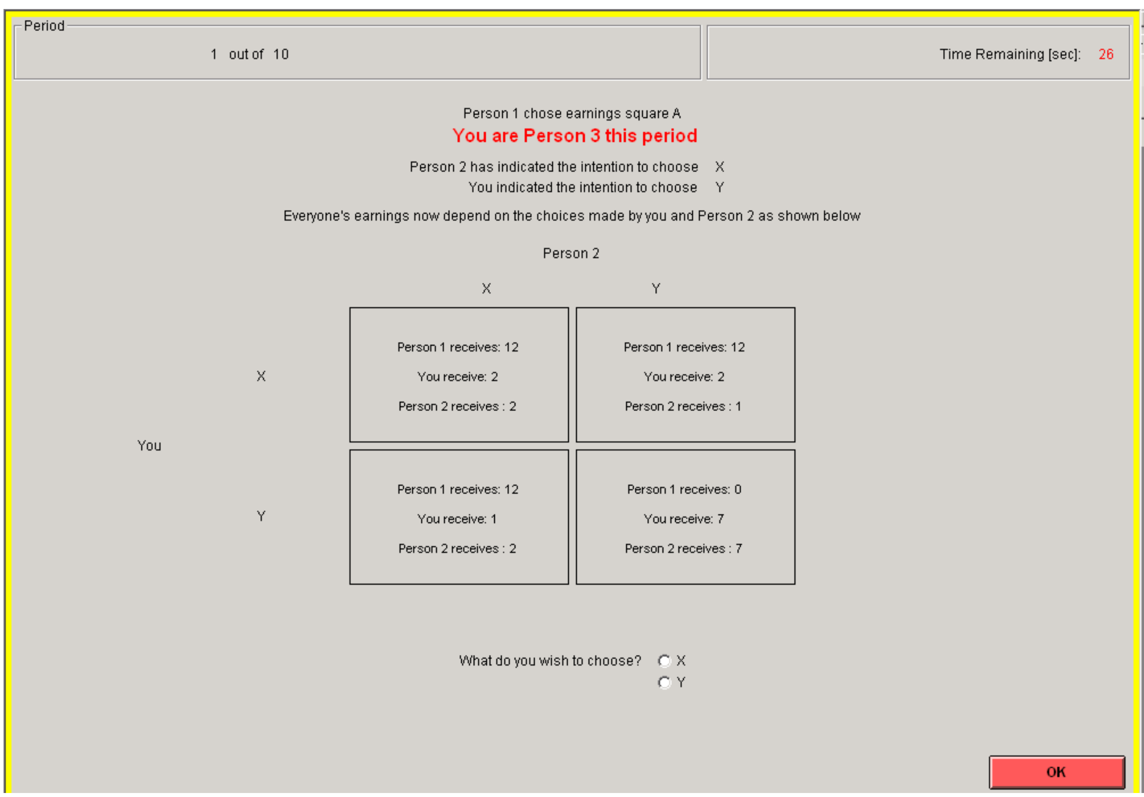


Decision Screen for Person 1

The computer program displays Person 2's intended choice to Person 3, and it displays Person 3's intended choice to Person 2. Only these two people observe these intended choices, and they are displayed on the top of the Decision Screen as shown on page 4. These intended choices should be recorded on the Personal Record Sheet. Persons 2 and 3 then make their actual choice simultaneously; for example, if you are Person 2 then you do not learn the actual choice of Person 3 until after you make your choice. Both Persons 2 and 3 may choose either **X** or **Y.**



Intention Screen for Person 2 (Person 3's is very similar)

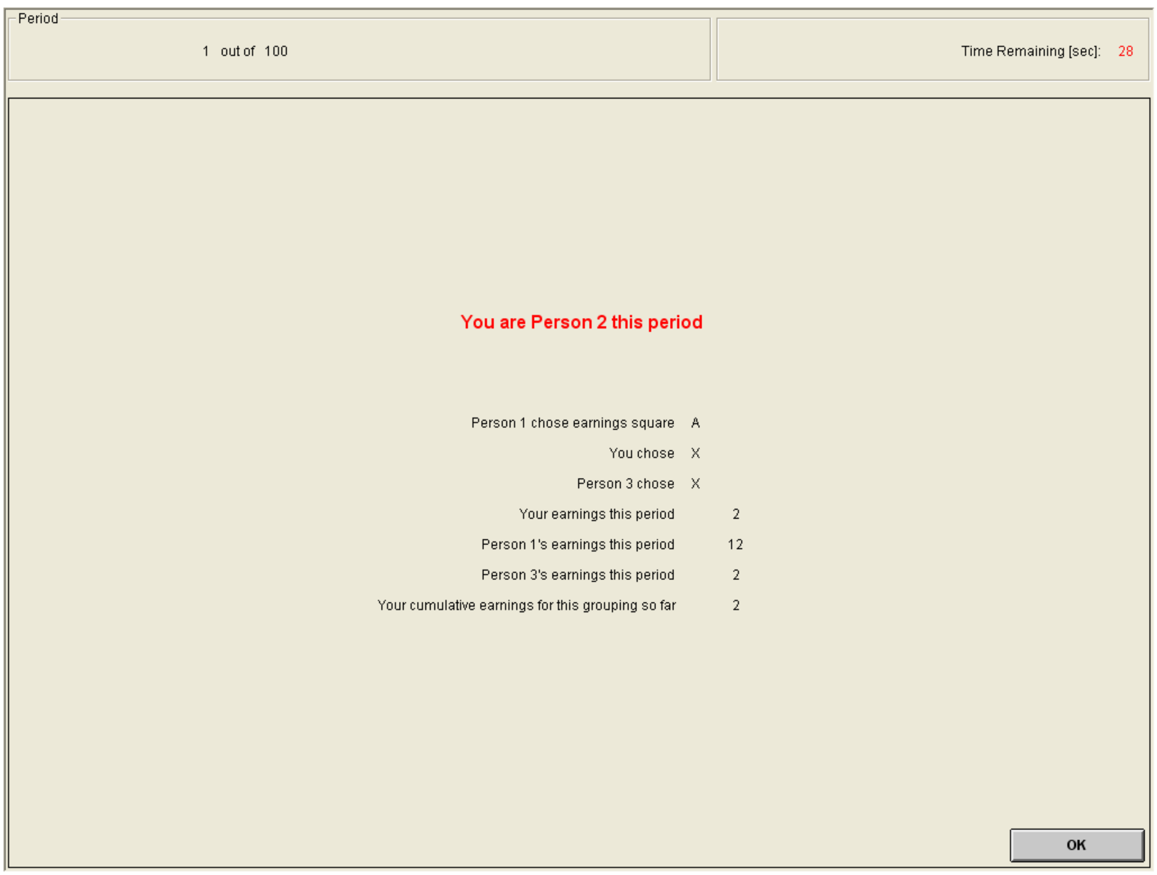


Decision Screen for Person 3 (Person 2's is very similar)

Your earnings from the choices each period are found in the box determined by you and the other two people in your group. If both Persons 2 and 3 choose **X**, then earnings are paid as shown in the box in the upper left on the screen. If both Persons 2 and 3 choose **Y**, then earnings are paid as shown in the box in the lower right on the screen. The other two boxes indicate earnings when one chooses **X** and the other chooses **Y**. To illustrate with a random example: if Person 1 chooses earnings square **A**, Person 2 chooses **X** and Person 3 chooses **Y**, then Person 1 earns 12, Person 2 earns 2, and Person 3 earns 1. You can find these amounts by looking at the appropriate square and box in your page of earnings tables.

<u>The End of the Period</u>

After everyone has made choices for the current period you will be automatically switched to the outcome screen, as shown below. This screen displays your choice as well as the choices of the people in your group. It also shows your earnings for this period and your earnings for the experiment so far.



Example Outcome Screen (Shown for Person 2)

Once the outcome screen is displayed you should record your choice and the choice of the others in your group on your Personal Record Sheet. Also record your current and cumulative earnings for this grouping. Click on the *OK* button on the lower right of your screen when the experimenter instructs you.

<u>The Random Ending to Each Grouping</u>

You will remain grouped with the same two other people in your group for some random number of periods. At the end of each decision period, we will throw an eight-sided die on the floor in front of some of the participants. The outcome of the roll will be announced verbally to everyone. If the die comes up 1, 2, 3, 4, 5, 6 or 7, then you will remain grouped with these same two people for another period; at the end of the next period, the die will be thrown again, and again the grouping will continue for at least another round if a 1, 2, 3, 4, 5, 6 or 7 is thrown.

If the die comes up an 8 on any throw, then the current grouping is immediately terminated. If the total number of periods conducted in the experiment at that point exceeds 49, or if less than 30 minutes remain in the two-hour block of time reserved for this lab session, then the experiment will also be terminated at that time. Otherwise, you will be randomly re-grouped with two other participants to form a new three-person group, with one person of each type in each group. You will remain grouped with these same two people for some random number of periods, with the same die-throwing rule to determine the termination of each random re-grouping of participants. At these re-grouping points, participants who are not designated as a Person 1 switch randomly between the Person 2 and Person 3 roles. The participants who may switch roles is determined randomly, and some may switch while others may not switch.

We will now pass out a questionnaire to make sure that all participants understand how to read the earnings tables and understand other important features of these instructions. Please fill it out now. Raise your hand when you are finished and we will collect it. If there are any mistakes on any questionnaire, I will summarize the relevant part of the instructions again. Do not put your name on the questionnaire.