Center for Economic Institutions Working Paper Series

No. 2014-2

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May 2014

Center for Economic Institutions
Working Paper Series

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Other-regarding behavior under collective action*

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Abstract

In many collective action settings, such as decisions on public education or climate change mitigation, actions of a group have welfare consequences for themselves as well as their followers. We conduct laboratory experiments with two-stage predecessor-follower prisoners' dilemma and coordination games with dynamic externalities to study whether concerns for the followers' welfare affect the predecessors' behavior. We find that predecessors often give up own payoffs to avoid imposing negative externalities on the followers, but not to generate positive externalities for the followers. A concern for the followers aligned with own group payoff maximization motive helps to resolve social dilemma and coordination problems; yet, a conflict in motives greatly exacerbates both free-riding and coordination on the payoff-inferior equilibrium. We also find strong evidence of social learning: the followers tend to blindly mimic their own predecessor, but act opposite to their match's predecessor, no matter whether these actions are welfare-improving or not.

JEL Codes: C90, C73
Key words: economic experiments; other-regarding behavior; collective action

*This research was supported by the University of Hawaii College of Social Sciences research grant and the Grant-in-Aid for Scientific Research on Priority Areas from the Ministry of Education, Science and Culture of Japan. We would like to thank Yan Chen, Tim Halliday, participants of the Economic Science Association Meetings and the World Congress of Environmental and Resource Economists, as well as seminar participants at the University of Michigan, Osaka University, and Kanto Environmental Economics Workshop for their valuable comments. Tarui thanks the Center for Economic Institutions at Hitotsubashi University's Institute of Economic Research for its hospitality while this manuscript was completed.

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1 Introduction

Exploring ways to achieve efficient outcomes in collective action involving social dilemma, and to coordinate on efficient equilibria in coordination games, have been at the forefront of investigation by economists and game theorists for many years (Olson, 1971; Ledyard, 1995; Camerer, 2003). These strategic settings often have an added dynamic inter-generational feature, in that similar collective action problems persist across generations of economic agents. Real-world examples include decisions on social security (Diamond, 1977), public education (Glomm and Ravikumar, 1992), climate-change mitigation (Karp and Tsur, 2011; Harstad, 2012), and efforts to preserve an international monetary union (De Grauwe, 2012). In these situations, actions of a group of decision makers (people or governments) may have welfare consequences for themselves as well as for their followers. A natural question is whether, and under what circumstances, the inter-generational feature of these problems may help resolve them, or whether it is likely to make the problems worse. This is the central question we investigate in this paper. Addressing this issue is important both for deeper understanding of collective-action problems, and for finding ways to resolve them.

There are at least two channels through which the presence of multiple generations may change the outcome in a collective-action problem. First, a welfare-improving outcome may be supported as an equilibrium through a social contract between generations (Hammond, 1975; Kotlikoff et al., 1988; Van der Heijden et al., 1998; Offerman et al., 2001). Second, even in the absence of a social contract, the agents may exhibit other-regarding preferences, and change their behavior because of the effect they may have on the future. This latter channel is the main subject of our investigation. A large and growing literature in experimental and behavioral economics documents that people do not always act in a purely selfish manner and often exhibit social preferences (Fehr and Schmidt, 1999; Bolton and Ockenfels, 2000; Charness and Rabin, 2002). However, most studies that investigate social preferences use simple sequential game settings, such as dictator, ultimatum or trust games, that do not involve collective action (see Camerer, 2003). Other studies consider collective-action problems, such as prisoners' dilemma or public good games, but in settings where a cooperative other-regarding action has welfare consequences for own group of players, but not for the others (Andreoni, 1995; Ledyard, 1995; Fischbacher and Gächter, 2010).

There are, however, many situations where collective action of the current generation of players has welfare consequences for the next generation of players, who themselves face their collective action issue. In this paper we report on a simple laboratory experiment that is designed to study other-regarding behavior in such settings. We investigate simple two-stage games where the actions of players in the first stage affect payoff opportunities for players in the second stage. In the first stage, two players (predecessors) play variations of prisoners' dilemma (PD), uniform dominance, or stag-hunt coordination games.[1] In the second stage, two other players (followers) play a similar game. The predecessors' and the followers' games are identical, except the actions taken by predecessors may shift (either up or down) the payoffs of the followers' game; thus, the predecessors' actions impose a dynamic externality on the followers. This models a dynamic setting, such as a long-term environmental or public education issue, where groups of players sequentially face a series of interlinked collective action problems, with the outcomes of earlier games affecting the potential payoffs in later games. This design allows us to examine whether predecessors exhibit other-regarding behavior towards the followers by choosing costly and/or risky cooperative actions that may help the followers by improving their potential payoffs. At the same time, the simple two-stage design eliminates the possibility of implicit social contract emerging between generations, and isolates the role of future-regarding preferences in predecessor behavior.

We contribute to the studies of collective action games and social preferences by investigating other-regarding behavior in a novel but simple dynamic collective action environment. Our design is simple, but rich: predecessors' actions determine followers' payoff opportunities, and not payoffs per se. Moreover, the followers' opportunities are determined not only by an individual predecessor's action (as in dictator games) but through collective action of the predecessors. This feature creates strategic uncertainty regarding the effect of the predecessor actions on the followers. The simple design further allows us to vary many factors that may affect behavior, including payoff asymmetry between the predecessors; whether the predecessor actions may impose positive or negative dynamic externality on the followers; and whether the predecessors' own group welfare maximization motives are aligned or in conflict with the other-regarding motive towards the followers. Finally, we document whether and how the predecessors' actions affect the followers' behavior.

We present strong evidence that a concern for the followers has a significant effect on the predecessor behavior, although this effect varies across games and treatments. The frequency of Pareto-dominant actions increases among the predecessors in the symmetric

[1] Prisoners' dilemma is chosen as the most widely studied collective action game that illustrates the conflict between social welfare (joint payoff) maximization and individual incentives. PD has been used to represent many real world settings, including arms races (Majeski, 1984), international relations (Conybeare, 1984), and climate-change mitigation (Pittel and Rubbelke, 2008). Stag-hunt coordination game is considered as an alternative which is equally relevant in many applications (e.g., Cooper et al., 1990, Cooper et al., 1992); Camerer (2003) argues that "many games thought to be prisoners' dilemmas are actually coordination games such as stag hunt" (p. 376). Uniform dominance games (Huck and Sarin, 2004) are used to disentangle other-regarding motives in behavior from own group welfare maximization motives, as will be discussed in Section 2 below.

prisoners' dilemma and stag-hunt coordination games if such actions help to prevent the followers potential payoffs from *decreasing*. Some predecessors are willing to help the followers even in uniform dominance games where the helping action is Pareto-dominated and is a pure sacrifice for themselves. However, the frequency of Pareto-dominant actions in prisoners' dilemma games does not increase if these actions help the followers by *increasing* (rather than keeping from decreasing) their potential payoffs. This indicates that predecessor-follower equity concern may often outweigh the global welfare maximization motive among the participants. Further, the evidence of other-regarding behavior disappears in asymmetric prisoners' dilemma games or if the cooperative action of only one (not both) predecessors is needed to help the followers, creating a sort of volunteers' dilemma (Diekmann, 1985, 1993) towards the followers.

The follower-regarding motive may also exacerbate collective action problems among the predecessors if this motive is misaligned with own group welfare maximization objective. In settings where free-riding (in prisoners' dilemma games) or actions leading to a payoff-inferior equilibrium (in coordination games) help the followers, the frequency of such actions among the predecessors increases significantly.

We also find that predecessors' actions have a strong effect on their followers' behavior in all settings that we study. The followers tend to blindly follow their own predecessor, but blindly act opposite to their match's predecessor, irrespective of whether such behavior improves their payoffs or not. Thus the predecessor actions have a significant effect on the followers not only by affecting the followers' welfare opportunities, but also through social learning channels. This indicates that people learn differently from in-group and out-group member behaviors—a result distinct from in-group versus out-group biases documented in the literature (e.g., Chen and Li, 2009). These findings also indicate that, depending on the setting and on the emerged social dynamics, the inter-generational aspect of a collective action problem, when present, may help to resolve this problem, but it may also make the problem worse.

Our study is related to several strands of experimental literature. In addition to the social dilemma and social preferences studies discussed above, a closely related paper is by Engel and Rockenbach (2011) who evaluate the impact of bystanders on public good provision.[2] They find that both positive and negative externalities imposed on bystanders reduce provision levels of public goods whenever active contributors risk falling back behind bystanders. In agreement with this result, we also find that players in our setting do not

[2] Delaney and Jacobson (2014) investigate a local public good setting where there is a negative externality on the outsiders, making this a global public bad setting. They find limited restraint in the provision of the "bad."

exhibit other-regarding behavior whenever it may lead to disadvantageous, relative to the followers, inequality in predecessor's payoffs. However, unlike Engel and Rockenbach (2011), we consider a dynamic setting. This allows us to not only investigate how the predecessors are affected by the presence of the followers, but also to consider how the followers' actions are influenced by the actions of the predecessors.

In its dynamic nature, our design is similar to dynamic intergenerational games, where one generation's decisions affect the environment "inherited" by the next generation. The experimental evidence from such games is mixed. Fischer et al. (2004) conclude that financial incentives override altruistic motives in a common pool resource setting even if there is a concern for intergenerational equity in principle. Van der Heijden et al. (1998) find a substantial degree of voluntary transfers across generations of players in a finite-horizon pension game experiment. Offerman et al. (2001) report that subjects in their overlapping generations game seldom supported cooperative actions even when they were recommended to play grim-trigger strategies. In contrast to the above studies, we use a much simpler two-stage game design that still combines a collective action and a dynamic externality aspect. This allows us to explore, in a unified study, a number of games and a number of environmental factors, including the direction of externalities, symmetry or asymmetry of payoffs, and alignment or misalignment of own and others' welfare maximization motives.

In regards to connection between predecessor and follower behavior, this paper is closely related to Schotter and Sopher (2003) and Chaudhuri et al. (2006), who investigate social learning in recurring inter-generational games with advice. Unlike these studies, the stage games in our setting are not identical, but evolve due to the presence of dynamic externalities; further, the predecessors do not leave advice to the followers. It is still possible, however, that the predecessors' action affect the followers' choices, an issue that we address below.

The rest of the paper is organized as follows. Section 2 presents experimental design. Key findings on predecessor and follower behavior are discussed in Sections 3.1–3.2. In Section 3.3, we analyze individual decision rules and their changes across parts of the experiment, and uncover underlying behavioral principles that persist across games. Effects of personal opinions and goals are discussed in Section 3.4. Section 4 concludes with a summary.

2 Experimental design

2.1 Basic structure of the experiment and choice of games

To study various aspects of other-regarding behavior under dynamic collective action, we employ five different baseline games, as presented in Figure 1: Prisoners' Dilemma (PD) and Asymmetric Prisoners' Dilemma (PDA) games; two uniform-dominance games, which

1. Symmetric Prisoners' Dilemma game (PD)

	A	B
A	12,12	8,14
B	14,8	10,10

2. Asymmetric Prisoners' Dilemma game (PDA)

	A	B
A	12,12	7,13
B	15,9	10,10

3. No Static Externality game (NS)

	A	B
A	10,10	10,12
B	12,10	12,12

4. Static externality game (SE)

	A	B
A	10,10	8,14
B	14,8	12,12

5. Coordination game (CO)

	A	B
A	12,12	6,9
B	9,6	10,10

Figure 1: Basic games

we call No Static Externality Game (NS) and Static Externality game (SE); and a stag-hunt Coordination game (CO).

These games were played three times by each subject. First, the subjects played the one-shot games given in Figure 1, to establish a baseline to compare with behavior in other parts of the experiment. Afterwards, the subjects played two-stage predecessor-follower games generated from the above one-shot games, as illustrated in Figures 2– 3. In the predecessor stage, the subjects were given their own payoff tables (identical to those given in Figure 1), but were also shown the potential payoff tables for the followers, as illustrated in Figure 8 (top panel) in the Supplementary Materials. It was emphasized in the predecessor games that the subjects will never receive payoff tables in the follower game that result from their own decisions. In the follower stage, the participants were given the follower payoff tables which resulted from some other subjects' (their predecessors') actions. Predecessor payoff tables and their decisions were shown to the followers along with their own payoff table. Except for the possible payoff shift, the follower payoff tables were identical to those of the predecessors. An example of the follower decision screen is given in Figure 8 (bottom panel) in the Supplementary Materials.

There are a total of six two-stage predecessor-follower games, based on the five one-shot games described above: Prisoners' Dilemma (PD), Prisoners' Dilemma Unilateral (PDU), Prisoners' Dilemma Asymmetric (PDA), No Static Externality Game (NS), Static Externality game (SE), and Coordination game (CO). Note that the Prisoners' Dilemma Unilateral (PDU) game had the same predecessor payoff matrix as the PD, but a different set of the follower payoff matrices.

Negative externality, A helps games

game	predecessor stage			follower stage								
				if AA			if AB or if BA			if BB		
		A	B		A	B		A	B		A	B
PD	A	12,12	8,14	A	12,12	8,14	A	8,8	4,10	A	4,4	0,6
	B	14,8	10,10	B	14,8	10,10	B	10,4	6,6	B	6,0	2,2
				if not BB			if BB					
		A	B		A	B		A	B			
PDU	A	12,12	8,14	A	12,12	8,14	A	4,4	0,6			
	B	14,8	10,10	B	14,8	10,10	B	6,0	2,2			
				if not BB			if BB					
		A	B		A	B		A	B			
PDA	A	12,12	7,13	A	12,12	8,14	A	4,4	0,6			
	B	15,9	10,10	B	14,8	10,10	B	6,0	2,2			
				if AA			if AB or if BA			if BB		
		A	B		A	B		A	B		A	B
NS	A	10,10	10,12	A	10,10	10,12	A	6,6	6,8	A	2,2	2,4
	B	12,10	12,12	B	12,10	12,12	B	8,6	8,8	B	4,2	4,4
				if AA			if AB or if BA			if BB		
		A	B		A	B		A	B		A	B
SE	A	10,10	8,14	A	10,10	8,14	A	6,6	8,10	A	2,2	0,6
	B	14,8	12,12	B	14,8	12,12	B	10,8	8,8	B	6,0	4,4
				if AA			if AB or if BA			if BB		
		A	B		A	B		A	B		A	B
CO	A	12,12	6,9	A	12,12	6,9	A	8,8	2,5	A	4,4	0,1
	B	9,6	10,10	B	9,6	10,10	B	5,2	6,6	B	1,0	2,2

Positive externality, A helps games

game	predecessor stage			follower stage								
				if AA			if AB or if BA			if BB		
		A	B		A	B		A	B		A	B
PD	A	12,12	8,14	A	20,20	16, 22	A	16,16	12,18	A	12,12	8,14
	B	14,8	10,10	B	22,16	18,18	B	18, 12	14,14	B	14,8	10,10
				if not BB			if BB					
		A	B		A	B		A	B			
PDU	A	12,12	8,14	A	20,20	16, 22	A	12,12	8,14			
	B	14,8	10,10	B	22,16	18,18	B	14,8	10,10			
				if not BB			if BB					
		A	B		A	B		A	B			
PDA	A	12,12	7,13	A	20,20	16,22	A	12,12	8,14			
	B	15,9	10,10	B	22,16	18,18	B	14,8	10,10			
				if AA			if AB or if BA			if BB		
		A	B		A	B		A	B		A	B
NS	A	10,10	10,12	A	18,18	18,20	A	14,14	14,16	A	10,10	10,12
	B	12,10	12,12	B	20,18	20,20	B	16,14	16,16	B	12,10	12,12
				if AA			if AB or if BA			if BB		
		A	B		A	B		A	B		A	B
SE	A	10,10	8,14	A	18,18	16, 22	A	14,14	12,18	A	10,10	8,14
	B	14,8	12,12	B	22,16	20,20	B	18, 12	16,16	B	14,8	12,12
				if AA			if AB or if BA			if BB		
		A	B		A	B		A	B		A	B
CO	A	12,12	6,9	A	20,20	14,17	A	16,16	10,13	A	12,12	6,9
	B	9,6	10,10	B	17,14	18,18	B	13,10	14,14	B	9,6	10,10

Figure 2: Two-stage games, A-helps treatment

Negative externality, B helps games

game	predecessor stage			follower stage								
				if AA			if AB or if BA			if BB		
		A	B		A	B		A	B		A	B
PD	A	12,12	8,14	A	4,4	0,6	A	8,8	4,10	A	12,12	8,14
	B	14,8	10,10	B	6,0	2,2	B	10,4	6,6	B	14,8	10,10
				if not BB			if BB					
		A	B		A	B		A	B			
PDU	A	12,12	8,14	A	4,4	0,6	A	12,12	8,14			
	B	14,8	10,10	B	6,0	2,2	B	14,8	10,10			
				if not BB			if BB					
		A	B		A	B		A	B			
PDA	A	12,12	7,13	A	4,4	0,6	A	12,12	7,13			
	B	15,9	10,10	B	6,0	2,2	B	15,9	10,10			
				if AA			if AB or if BA			if BB		
		A	B		A	B		A	B		A	B
NS	A	10,10	10,12	A	2,2	2,4	A	6,6	6,8	A	10,10	10,12
	B	12,10	12,12	B	4,2	4,4	B	8,6	8,8	B	12,10	12,12
				if AA			if AB or if BA			if BB		
		A	B		A	B		A	B		A	B
SE	A	10,10	8,14	A	2,2	0,6	A	6,6	8,10	A	10,10	8,14
	B	14,8	12,12	B	6,0	4,4	B	10,8	8,8	B	14,8	12,12
				if AA			if AB or if BA			if BB		
		A	B		A	B		A	B		A	B
CO	A	12,12	6,9	A	4,4	0,1	A	8,8	2,5	A	12,12	6,9
	B	9,6	10,10	B	1,0	2,2	B	5,2	6,6	B	9,6	10,10

Positive externality, B helps games

game	predecessor stage			follower stage								
				if AA			if AB or if BA			if BB		
		A	B		A	B		A	B		A	B
PD	A	12,12	8,14	A	12,12	8,14	A	16,16	12,18	A	20,20	16, 22
	B	14,8	10,10	B	14,8	10,10	B	18, 12	14,14	B	22,16	18,18
				if not BB			if BB					
		A	B		A	B		A	B			
PDU	A	12,12	8,14	A	12,12	8,14	A	20,20	16, 22			
	B	14,8	10,10	B	14,8	10,10	B	22,16	18,18			
				if not BB			if BB					
		A	B		A	B		A	B			
PDA	A	12,12	7,13	A	12,12	8,14	A	20,20	16, 22			
	B	15,9	10,10	B	14,8	10,10	B	22,16	18,18			
				if AA			if AB or if BA			if BB		
		A	B		A	B		A	B		A	B
NS	A	10,10	10,12	A	10,10	10,12	A	14,14	14,16	A	18,18	18,20
	B	12,10	12,12	B	12,10	12,12	B	16,14	16,16	B	20,18	20,20
				if AA			if AB or if BA			if BB		
		A	B		A	B		A	B		A	B
SE	A	10,10	8,14	A	10,10	8,14	A	14,14	12,18	A	18,18	16, 22
	B	14,8	12,12	B	14,8	12,12	B	18, 12	16,16	B	22,16	20,20
				if AA			if AB or if BA			if BB		
		A	B		A	B		A	B		A	B
CO	A	12,12	6,9	A	12,12	6,9	A	16,16	10,13	A	20,20	14,17
	B	9,6	10,10	B	9,6	10,10	B	13,10	14,14	B	17,14	18,18

Figure 3: Two-stage games, B-helps treatment

The payoffs are designed so that it is always efficient, in terms of global two-stage welfare (payoff) maximization,[3] for the predecessor to choose the action that "helps" the followers. In all games, the highest possible cost of the helping action to the predecessor was no higher than the lowest possible benefit it could yield to the followers, making the helping action globally welfare-improving. In most games, a helping action cost a predecessor 2 or 3 experimental dollars, but yielded a payoff benefit of 4 experimental dollars to each player in the follower game.

The motivation behind the choice of each game is explained next. For this purpose, we use the main treatment variation, where the action "A" by the predecessors, corresponding to the cooperative action in PD and stag-hunt coordination games, benefits the followers; see Figures 2 and 3. The treatments where action "B" helps the followers, designed to better disentangle various determinants of subject behavior, are discussed in Section 2.2 below.

Prisoners' Dilemma game (PD) is used to investigate whether the presence of follower-regarding motive may help resolve the social dilemma between the Pareto Optimal (PO) outcome and the dominant strategy equilibrium outcome. However, PD does not allow us to differentiate between cooperation out of a predecessor's concern for own joint payoff maximization, or cooperation out of concern for the followers. Further, a predecessor who chooses a cooperative action faces strategic uncertainty about the benefit of this action to the followers, as the magnitude of the benefit also depends on the other predecessor's action. We use several modifications of prisoners' dilemma games along with uniform dominance games to disentangle the effects of each of these aspects on predecessor behavior.

The unilateral PD game (PDU) requires only one predecessor's cooperative action to benefit the followers to the maximum, regardless of what the other predecessor does (Figure 2, PDU), thus eliminating uncertainty about the effectiveness of the helping action as compared to PD. There are two possible effects: predecessors may be more likely to choose the helping action knowing that this action will guarantee to help their followers, or predecessors may be less likely to choose this action, hoping that the other player will help instead.

The asymmetric PD game (PDA) is used to examine the effect of payoff asymmetry on choosing the helping action. This game has a payoff structure that makes it more costly for the row player to choose action "A" than for the column player: the row player has to forgo 3 experimental dollars to cooperate, whereas the column player only needs to forgo 1 experimental dollar. Also, as in PDU game, only one predecessor's cooperative action is needed to fully benefit the followers. Given this, one may expect the predecessors in this

[3] We will refer to joint payoff maximization as welfare maximization, as in Charness and Rabin (2002). For the stage games, we may also refer to the joint payoff maximizing outcomes as Pareto Optimal.

game to coordinate on the column player taking the cooperative action. On the other hand, cooperation may be destroyed by payoff asymmetry (see Ledyard, 1995).

No Static Externality game (NS). Unlike the prisoners' dilemma games described above, the next two games, NS and SE, are uniform dominance games (Huck and Sarin, 2004). Choosing "B" is both the dominant strategy equilibrium and the Pareto Optimal outcome in each stage game, so the only reason to choose "A" for the predecessors is to benefit the followers. These games help to isolate follower-regarding motive from Pareto Optimality in the predecessor game. In the NS game, there is no static externality, i.e., each predecessor's action has no impact on the other predecessor's payoff. Hence the cost of the helping action is certain and does not vary with the action of the other predecessor. The one-shot NS game is also used as a minimum test of rationality for the subjects. As there are no compelling reasons to choose "A" in the one-shot NS game, we can see how many subjects understand dominant strategies.

Static Externality game (SE). Similarly to the NS game, predecessors in the SE game do not themselves benefit from choosing action "A," either individually or jointly. In addition, the payoff from choosing a helping action is lower if the other predecessor does not choose the helping action as well (this aspect is similar to PD). Thus strategic uncertainty exists regarding the magnitude of sacrifice that each predecessor needs to make to benefit the followers. This game is used to see if other-regarding motives are powerful enough to override playing a dominant strategy when there are both no own monetary benefits and there is strategic uncertainty about the costs of doing so.

Coordination game (CO). In the stag-hunt coordination game, both players cooperating is the Pareto dominant equilibrium, while not cooperating is the risk-dominant equilibrium. This game is well-known to produce coordination failure (e.g., Cooper et al., 1992). We use it to study whether follower-regarding motives may help the predecessors to coordinate on a Pareto-dominant outcome, given that this outcome is also an equilibrium.

Potential real-world applications of each game are discussed in the Supplementary Materials.

2.2 Treatments

Experimental treatments vary in the effects the predecessor actions have on the follower payoffs along two dimensions: (i) whether the predecessor actions could result in upward or downward shift of the follower payoffs (positive or negative dynamic externality); and (ii) whether action "A" or action "B" of the predecessors helps the followers to reach their best payoff. In the A-helps variation, action "A" by predecessors benefits the followers, while the opposite is true in B-helps variation. This results in four different treatments: **(1) Negative**

externality, A-helps; (2) Positive externality, A-helps; (3) Negative externality, B-helps; (4) Positive externality, B-helps.

The positive/negative externality treatment variation is introduced to study if people's willingness to help the followers varies depending on whether helping involves increasing the follower payoff opportunities as compared to preventing them from falling. In the positive externality treatment, if both predecessors do not choose the helping action, then the follower payoff table is the same as the predecessors;' if the predecessors choose the helping actions, then the follower payoffs increase. In the negative externality treatment, if both predecessors choose the helping actions, then the follower payoff table is the same as the predecessors;' otherwise, the follower payoffs decrease.

The positive/negative externality variation allows us to observe whether the participants' behavior may be influenced by the predecessor-follower equity considerations. Whereas the absolute magnitudes of the payoff shifts are the same under positive and negative externality treatments, these treatments differ in the direction of the payoff shifts between the predecessors and the followers. In the positive externality treatments, the follower payoffs are never lower, and become higher than the predecessors' if they choose the helping actions. Under the negative externality, the follower payoffs are never higher, and may only be made equal to the predecessors' if the predecessors choose the helping action. These variations in the treatments have direct real-world implications, for example, for the debates over the effectiveness of long-term environmental policies.[4]

We further vary the treatments according to which action of the predecessors helps the followers. The A-helps/B-helps variation investigates the strength of the follower-regarding motives. By using this variation, we observe how the motives of dominant strategy play, equilibrium play, Pareto Optimality in own game, and global social welfare maximization interact to determine predecessor actions. Note that in most games (PD, PDU, PDA, NS, SE), the dominant strategies conflict with the helping actions in the A-helps treatments while they coincide in the B-helps treatments. In some games (such as PD, PDU, PDA, CO), achieving Pareto-optimality in the predecessor game benefits the followers in the A-helps treatment while, in other games (NS and SE), this happens in the B-helps treatment.

[4]The debate on whether real-world long-term environmental problems should be viewed as those with positive or negative dynamic externalities is wide open. Economists do not agree on how much and how fast green-house gas emissions should be reduced; this is partly because their economic models assume different parameter values on the discount rate and the elasticity of intertemporal substitution (Stern, 2006; Nordhaus, 2013). Likewise, the general public do not agree on whether in the future people will invent new technologies that would solve most problems we have today, or whether they will experience more problems; see, e.g., the responses to Question 16 in our exit questinnaire (Figure 9 in the Supplementary Materials).

2.3 Additional design elements and procedures

Real-life economic relationships often occur in social settings where interactions are not completely anonymous. Long-term collective action may involve interactions among political parties, countries or other localities, where predecessors and followers share a common group identity. To make our experimental results more applicable to such settings, we reduce social distance between the predecessors and the followers by dividing the subjects into two groups and having them share some basic information about themselves within the group.[5] At the beginning of each experimental session, the subjects were divided into two groups, "Green" and "Blue." The group assignment stayed the same throughout the session. Before the instructions started, the subjects had 5 minutes to introduce themselves to their own group in a controlled manner (their name, major, favorite food, and favorite activity). In each part of the experiment, a member of the Blue group interacted with a member of the Green group. This design allowed for some basic identification between a predecessor and a follower in a two-stage game, but less identification between a Green and a Blue player with any part (in either one-shot games, the predecessor games, or the follower games). We believe that this type of group interaction parallels many real-life situations (such as interactions between generations of country governments or families) that we are interested in modeling.

As explained above, each session consisted of three parts: Part 1 (five one-shot games); Part 2 (six predecessor games); and Part 3 (six follower games). To control for possible order effects, the order of games was randomized in each part. To control for the order in which strategies were displayed, some experimental sessions used the inverted game presentations, where the payoffs corresponding to strategies A and B were switched.[6] To minimize the effect of learning across games, subjects were not informed about the outcomes of their own one-shot and predecessor games (although they were given the results of their predecessors' game at the follower stage) until the end of the experiment, when they were informed of the game outcomes. Throughout the experiment, subjects were asked to make a prediction about their match's choice by using a sliding scale for probabilistic assessments. To elicit true beliefs, subjects earned extra experimental dollars depending on the accuracy of their prediction. Players were matched using a "strangers design," where no matchings were repeated.

At the end of Part 3 in each session, one of the games and one of the parts was randomly chosen for payment. If Part 2 or 3 were chosen (these parts constituted the predecessor-

[5]Previous research shows that reducing social distance using naturally occurring groups or through identification increases other-regarding behavior (Bohnet, 1999; Leider et al., 2008; Charness and Gneezy, 2008). Group identity may be also induced using the minimum group paradigm (Chen and Li, 2009; Charness et al., 2007).

[6]In all analyses reported below, we convert the data labels to correspond to those in Figure 1, so that "A" always stands for the cooperative choice in the PD game.

Table 1: Summary of experimental sessions

Session	No of subjects	Dynamic Externality	Predecessor action that helps the followers
1	12	Negative	A-helps
2	12	Negative	B-helps
3	12	Negative	B-helps
4	12	Negative	A-helps
5	12	Positive	B-helps
6	12	Positive	A-helps
7	12	Positive	A-helps
8	12	Positive	A-helps
9	12	Negative	A-helps
10	12	Negative	A-helps
11	12	Negative	A-helps
12	12	Positive	A-helps
13	12	Positive	A-helps
14	12	Positive	B-helps

follower game), then half of the participants were randomly assigned to be paid based on their predecessor game outcomes, and the other half were paid based on the linked follower game results. This was done to increase the credibility of "helping" actions, so that a predecessors' decision, when chosen for payment, was guaranteed to affect their followers' realized payoffs.

Procedures 14 sessions were conducted at the the University of Hawaii using z-Tree (Fischbacher (2007)). The summary of experimental sessions is included in Table 1.

Each session involved 12 subjects; all subjects were students. Experimental instructions were provided in print at the beginning of each part, and were read aloud by an experimenter. Neutral language was used so that subjects were not aware of the purpose of the experiment. Prior to starting each part, participants completed a basic tutorial to ensure that they understood how to navigate the information on their computer screen. Following Part 3 decisions, participants completed a questionnaire that included basic demographic questions along with questions on the motives for their decisions in the experiment. Experimental instructions, sample screen-shots from the predecessor and the follower games, and a complete list of the questions from the exit questionnaire are provided in the Supplementary Materials.

3 Results

A total of 168 subjects participated in the experiment,[7] 52 percent male and 48 percent female. The average age of participants was 27 (minimum 18, maximum 65), 15 percent had one or two children, and 30 percent had studied game theory as part of a college class. The subjects earned an average of US $24.3 for about 1.5 hours of their time, including the $5 show-up fee. Payments ranged from $5 to $42, with a median of $24.

In Part 1 (one-shot games), in PD 43.1 percent of subjects choose the cooperative action A, which is within normal bounds reported in the data elsewhere (Davis and Holt, 1993). In the NS one-shot game that we use as a minimal test of rationality for our subjects, 18.0 percent of the subjects choose the strictly dominated strategy"A" despite having no reason to do so, which is also within the normal bounds.[8] We conclude that our subject pool is quite standard as measured by the one-shot PD play and the percentage of people who understand dominance.

3.1 Predecessor behavior

The discussion of predecessor behavior is organized around several research questions of interest. We consider whether there is evidence of other-regarding behavior towards the followers; whether this evidence differs between the positive and negative externality treatments; and whether and how the motives of dominant strategy play, equilibrium play, Pareto Optimality in own game, predecessor-follower equity, and pure altruism towards the followers interact to determine the predecessor actions.

We start with investigating the main research question: Do predecessors exhibit follower-regarding behavior?

One way to address this question is to compare, within each treatment, the frequencies of A-choices in Part 1 (one-shot games) and Part 2 (predecessor games) of the experiment. For example, if in the A-helps treatment, participants choose "A" more frequently in the predecessor games than in the one-shot games, this could be considered as evidence of other-regarding behavior. However, such within-treatment evidence may be convoluted by factors other than other-regarding preferences; e.g., the subjects may be learning, even without feedback, from own experiences in Part 1, and thus act differently in Part 2. For this reason, we apply the difference-in-differences approach to our between-treatment data and consider whether the changes between Part 1 (one-shot) and Part 2 (predecessor) decisions

[7]The data for one subject was corrupted and excluded from the analysis.

[8]Camerer (2003) notes that most people obey dominance, but percentages can vary widely depending on the game played. In beauty-contest games, for example, the ratio of subjects not obeying first-level dominance varied between 16 and 28 percent (Camerer, 2003).

are significantly different between the A-helps and B-helps treatments. Both non-parametric and parametric methods are used in the analysis.

Figure 4 shows the dynamics of mean frequency of A-choices across the three parts of the experiment, by treatment. Table 2 displays descriptive statistics of individual changes in decisions between Parts 1 and 2, as well as the Wilcoxon Mann-Whitney (WMW hereafter) and t-tests results of differences in individual changes between A-helps and B-helps variations, by treatments. The table shows overall statistics by treatment, as well as statistics by game.[9] Table 3 presents the results of the probit regression of individual decisions on treatment variables of interest and basic demographic characteristics (basic regression), along with selected survey responses (full regression). Table 4 displays the results of analogous probit regressions by game.

Result 1 (Evidence of other-regarding behavior) *Overall, there is strong evidence of other-regarding behavior. Subjects switch from "B" in Part 1 (the one-shot game) to "A" in Part 2 (the predecessor game) significantly more often when "A" helps the followers than when "B" helps. In PD and NS games under A-helps, the frequencies of follower-regarding actions in predecessor games increase in spite of dominance and uniform dominance, respectively.*

Support: Figure 4, Tables 2–4. The dynamics of average subject choices displayed in Figure 4 suggest that subjects change their choices from Part 1 (one-shot-games) to Part 2 (predecessor games) more often in the direction that helps the followers; this is especially evident from comparing the A-helps and B-helps treatments in PD, NS and CO games. From Table 2, overall, the frequency of A-choices increases from Part 1 to Part 2 by 4.20 percent when A-helps, but decreases by 8.7 percent when B-helps; these differences are statistically significant ($p = 0.0008$ for both WMW and t-test). The differences between A-helps and B-helps are also significant (at 10 percent level or higher) for three out of six individual games: PD ($p = 0.051$), NS ($p = 0.086$), and CO ($p = 0.002$).

Table 3 shows probit estimation results for subject decisions for all games pooled, using the data from Parts 1 and 2. Whereas the differences between Part 1 and Part 2 choices are insignificant overall, as indicated by the "Part 2" dummy, "A-helps" in Part 2 increases the probability of choosing A by 25 percent, which is significant at 1 percent level ("Part 2*A-helps" interaction dummy, basic regression). Results by game (Table 4) indicate that A-helps in Part 2 significantly (at 5 percent level) increases the probability of choosing "A" in PD, NS and CO games. Although not statistically significant, the coefficient of "Part 2 * A helps" is positive for all other games as well. □

[9] In addition, Table 8 in the Supplementary Materials displays the increase in the helping action ("A" in A-helps, "B" in B-helps treatments) from Part 1 to Part 2, in percentage points.

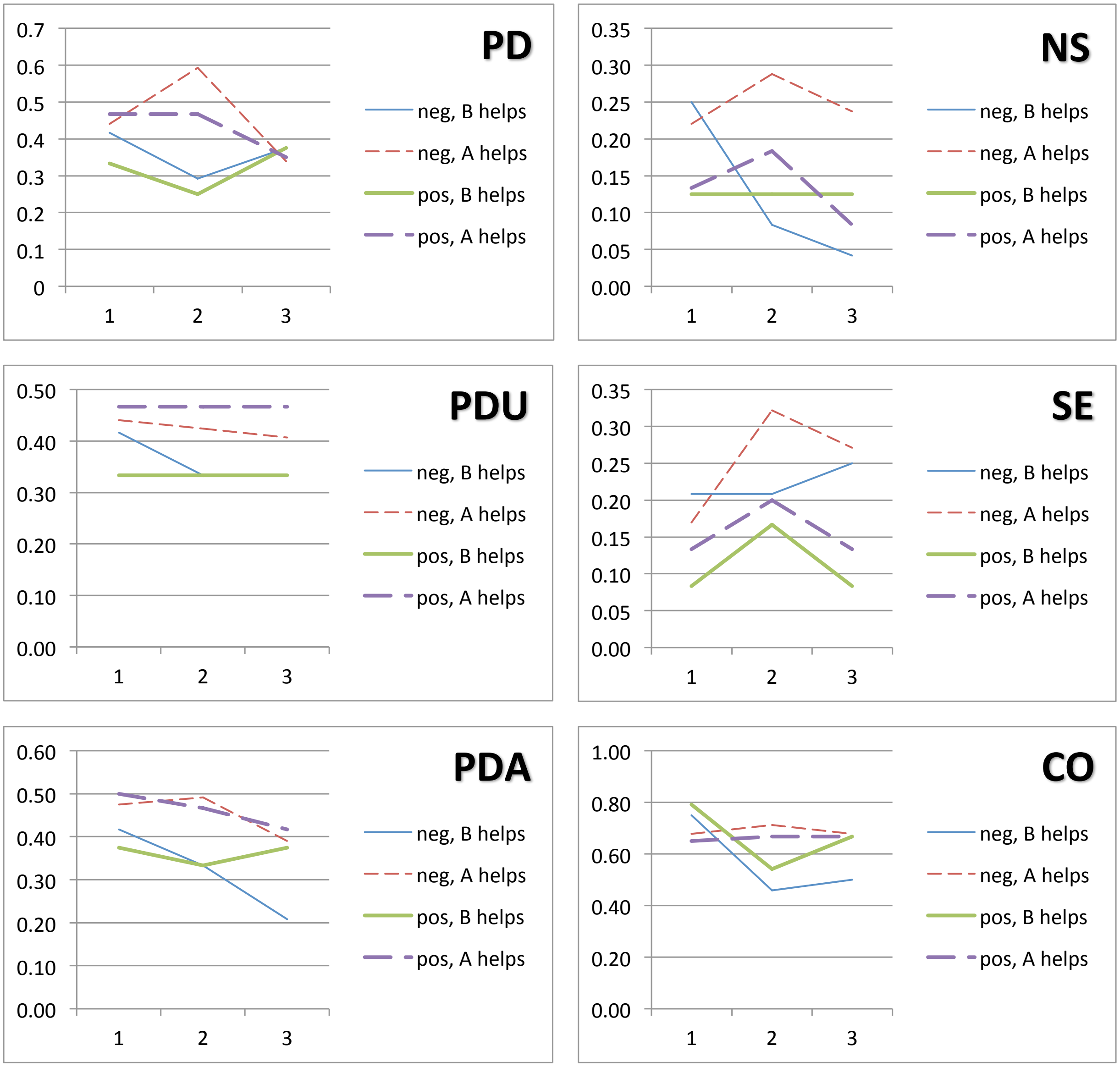


Figure 4: Average frequency of A-choices in three parts of the experiment, by game and treatment

Table 2: Decision changes between one-shot games and predecessor games

(0 is no change, -1 is switching from A to B, 1 is switching from B to A)

All Games pooled	Pooled		Positive Externality		Negative Externality	
	A-helps	B-helps	A-helps	B-helps	A-helps	B-helps
number of observations	714	288	360	144	354	144
mean of change	**0.042**	**-0.087**	**0.017**	**-0.049**	**0.068**	**-0.125**
standard deviation	*0.554*	*0.032*	*0.568*	*0.044*	*0.539*	*0.045*
p-value: "A-helps" = "B-helps"						
Wilcoxon-Mann-Whitney test	0.0008		0.2363		0.0004	
t-test	0.0008		0.2364		0.0003	

PD game	Pooled		Positive externality		Negative externality	
	A-helps	B-helps	A-helps	B-helps	A-helps	B-helps
Number of Obseravtions	119	48	60	24	59	24
change: mean	**0.076**	**-0.104**	**0.000**	**-0.083**	**0.153**	**-0.125**
stddv	*0.523*	*0.555*	*0.521*	*0.584*	*0.519*	*0.537*
p-value: "A-helps" = "B-helps"						
Wilcoxon-Mann-Whitney test	0.05		0.5164		0.034	
t-test	0.0511		0.524		0.0316	

PDU game	Pooled		Positive externality		Negative externality	
	A-helps	B-helps	A-helps	B-helps	A-helps	B-helps
Number of Obseravtions	119	48	60	24	59	24
change: mean	**-0.008**	**-0.042**	**0.000**	**0.000**	**-0.017**	**-0.083**
stddv	*0.589*	*0.582*	*0.611*	*0.590*	*0.572*	*0.584*
p-value: "A-helps" = "B-helps"						
Wilcoxon-Mann-Whitney test	0.7408		1.0000		0.6314	
t-test	0.7409		1.0000		0.635	

PDA game	Pooled		Positive externality		Negative externality	
	A-helps	B-helps	A-helps	B-helps	A-helps	B-helps
Number of Obseravtions	119	48	60	24	59	24
change: mean	**-0.008**	**-0.063**	**-0.033**	**-0.042**	**0.017**	**-0.083**
stddv	*0.589*	*0.598*	*0.637*	*0.550*	*0.541*	*0.654*
p-value: "A-helps" = "B-helps"						
Wilcoxon-Mann-Whitney test	0.5915		0.9678		0.4663	
t-test	0.5937		0.9553		0.4737	

NS game	Pooled		Positive externality		Negative externality	
	A-helps	B-helps	A-helps	B-helps	A-helps	B-helps
Number of Obseravtions	119	48	60	24	59	24
change: mean	**0.059**	**-0.083**	**0.050**	**0**	**0.068**	**-0.167**
stddv	*0.492*	*0.454*	*0.467*	*0.417*	*0.521*	*0.482*
p-value: "A-helps" = "B-helps"						
Wilcoxon-Mann-Whitney test	0.0855		0.6408		0.0615	
t-test	0.0861		0.6491		0.0611	

SE game	Pooled		Positive externality		Negative externality	
	A-helps	B-helps	A-helps	B-helps	A-helps	B-helps
Number of Obseravtions	119	48	60	24	59	24
change: mean	**0.109**	**0.042**	**0.067**	**0.083**	**0.153**	**0.000**
stddv	*0.579*	*0.355*	*0.578*	*0.408*	*0.582*	*0.295*
p-value: "A-helps" = "B-helps"						
Wilcoxon-Mann-Whitney test	0.3843		0.9403		0.1848	
t-test	0.4527		0.8979		0.2263	

CO game	Pooled		Positive externality		Negative externality	
	A-helps	B-helps	A-helps	B-helps	A-helps	B-helps
Number of Obseravtions	119	48	60	24	59	24
change: mean	**0.025**	**-0.271**	**0.017**	**-0.250**	**0.034**	**-0.292**
stddv	*0.544*	*0.610*	*0.596*	*0.608*	*0.490*	*0.624*
p-value: "A-helps" = "B-helps"						
Wilcoxon-Mann-Whitney test	0.0024		0.0681		0.0126	
t-test	0.0025		0.0692		0.0134	

Table 3: Probit estimation of predecessor behavior reporting marginal effects, games pooled

Parts 1 and 2, games pooled	All games pooled, basic		All games pooled, full		PD, PDU, PDA and CO, full	
Dependent variable: Decision (1 if choose A)	**dF/dx**	*R.SE*	**dF/dx**	*R.SE*	**dF/dx**	*R.SE*
part 2 * A helps	**0.25*** **	*0.068*	**0.29*** **	*0.074*	**0.34*** **	*0.102*
part 2 * externality * A helps	**-0.14**	*0.096*	**-0.20** **	*0.090*	**-0.19**	*0.136*
part 2 dummy	**-0.05**	*0.074*	**-0.08**	*0.078*	**-0.19***	*0.098*
A helps	**-0.11**	*0.089*	**-0.09**	*0.101*	**0.02**	*0.093*
externality	**-0.07**	*0.085*	**-0.09**	*0.095*	**-0.04**	*0.113*
inversion	**0.00**	*0.046*	**0.02**	*0.047*	**0.00**	*0.056*
part 2 * externality	**0.09**	*0.097*	**0.14**	*0.097*	**0.11**	*0.127*
externality * A helps	**0.09**	*0.101*	**0.13**	*0.116*	**0.09**	*0.136*
green group dummy	**0.04**	*0.041*	**0.03**	*0.042*	**0.04**	*0.051*
A is PO	**0.26*** **	*0.069*	**0.25*** **	*0.071*		
A is PO * part 2	**-0.10**	*0.072*	**-0.07**	*0.079*		
unilateral action in part 2 is enough to help	**0.04**	*0.055*	**0.04**	*0.060*	**0.09**	*0.068*
asymmetric payoffs in PD	**0.03**	*0.049*	**0.05**	*0.056*	**0.05**	*0.059*
asymmetric payoffs in PD * part 2	**0.01**	*0.08*	**-0.01**	*0.086*	**0.03**	*0.100*
no static externality	**0.04**	*0.059*	**0.04**	*0.061*		
no static externality * part 2	**-0.14**	*0.096*	**-0.14**	*0.098*		
A is Nash equilibrium	**0.27*** **	*0.051*	**0.28*** **	*0.056*	**0.29*** **	*0.055*
A is Nash equilibrium * part 2	**-0.06**	*0.083*	**-0.05**	*0.088*	**-0.02**	*0.109*
A is PO * A helps	**0.08**	*0.077*	**0.10**	*0.081*		
asymmetric payoffs in PD * A helps	**-0.08**	*0.076*	**-0.07**	*0.083*	**-0.13**	*0.102*
unilateral action is enough * A helps	**-0.10**	*0.062*	**-0.09**	*0.069*	**-0.15***	*0.088*
A is Nash equilibrium * A helps	**-0.03**	*0.09*	**-0.05**	*0.095*	**-0.11**	*0.116*
no static externality * A helps	**0.06**	*0.101*	**0.10**	*0.108*		
age	**0.01*** **	*0.003*	**0.01** **	*0.003*	**0.01***	*0.004*
has any children	**0.02**	*0.065*	**0.08**	*0.073*	**0.06**	*0.082*
number of siblings	**0.00**	*0.011*	**-0.00**	*0.012*	**0.00**	*0.014*
male	**-0.09** **	*0.041*	**-0.11** **	*0.043*	**-0.14*** **	*0.052*
studied game theory as part of college class			**0.05**	*0.051*	**0.09**	*0.062*
studied environmental issues as part of college class			**0.01**	*0.045*	**-0.03**	*0.054*
number of people subject knows in own group			**0.02**	*0.017*	**0.03**	*0.024*
number of people subject knows in other group			**-0.02**	*0.017*	**-0.03**	*0.021*
willing to take significant risks in life			**0.07**	*0.051*	**0.08**	*0.058*
does not like to take risks in life			**-0.02**	*0.080*	**0.00**	*0.101*
"if I have a comfortable income, I save much of it for the future"			**0.01**	*0.080*	**0.03**	*0.088*
"if I have a comfortable income, I save little for the future"			**-0.13***	*0.079*	**-0.14***	*0.087*
"generally most people are trustworthy"			**0.01**	*0.047*	**0.03**	*0.056*
believes people's lives are influenced by a higher being (such as God)			**-0.01**	*0.058*	**-0.06**	*0.073*
believes people's actions are judged by a higher being (such as God)			**-0.03**	*0.059*	**-0.01**	*0.072*
participates in religious activities once a month or more			**-0.03**	*0.081*	**0.02**	*0.106*
participates in religious activities once a month or less			**0.11**	*0.082*	**0.11**	*0.094*
participates in religious activities less than 5 times a year			**-0.10**	*0.072*	**-0.07**	*0.091*
never participates in organized religious activities			**0.03**	*0.081*	**0.00**	*0.096*
prefers high taxes, with high government support and services			**-0.04** **	*0.020*	**-0.08*** **	*0.027*
believes "society should regulate scarce resources"			**0.01**	*0.063*	**-0.04**	*0.075*
believes "it is up to each person to conserve scarce resources"			**-0.05**	*0.070*	**-0.13**	*0.087*
does not believe we should conserve scarce resources			**-0.27*** **	*0.085*	**-0.38*** **	*0.098*
believes "technology will improve but future won't be different"			**-0.06**	*0.061*	**-0.05**	*0.075*
believes "people will not be able to solve many of the problems we have today"			**-0.03**	*0.065*	**-0.02**	*0.080*
believes "people will experience more problems than we have today"			**0.00**	*0.058*	**-0.03**	*0.070*
believes "If we don't change, the world will be much worse in future..."			**0.03**	*0.114*	**0.12**	*0.136*
believes "If we don't change, the world will be worse in the future..."			**0.08**	*0.126*	**0.16**	*0.150*
believes "We do not need to make changes, future will not be worse"			**-0.03**	*0.124*	**-0.03**	*0.163*
believes "Whether we make changes or not, it will not affect the future..."			**-0.01**	*0.130*	**0.06**	*0.159*
"My goal was to get the highest payoff for myself"			**-0.05**	*0.089*	**0.06**	*0.102*
"My goal to get the highest payoff, considering what others will do"			**0.04**	*0.072*	**0.20*** **	*0.077*
"My goal was to get the highest payoff table for the followers"			**0.16**	*0.150*	**0.23**	*0.140*
"My goal was to keep a balance between a payoff for me, and for the followers"			**0.08**	*0.077*	**0.24*** **	*0.082*
"My goal was to avoid getting the lowest payoff"			**-0.21** **	*0.083*	**-0.20***	*0.110*
N	2,004		1,847		1231	
Pseudo R2	0.123		0.174		0.1409	

Robust standard errors (R.se.) are reported in parentheses. Clustered on person ID.
Significance levels are *** 1%, ** 5%, and * 10%.
N in second specification is reduced due to some unanswered survey questions.

Table 4: Probit estimation of predecessor behavior by game, reporting marginal effects

Parts 1 and 2	PD		PDU		PDA	
Dependent variable: Decision (1 if choose A)	**dF/dx**	*R.SE*	**dF/dx**	*R.SE*	**dF/dx**	*R.SE*
part 2 * A helps	**0.30****	*0.132*	**0.07**	*0.147*	**0.11**	*0.156*
part 2 * externality * A helps	**-0.20**	*0.183*	**-0.07**	*0.205*	**-0.10**	*0.207*
part 2 dummy	**-0.14**	*0.118*	**-0.09**	*0.124*	**-0.09**	*0.137*
A helps	**-0.01**	*0.130*	**0.01**	*0.127*	**0.00**	*0.129*
externality	**-0.07**	*0.149*	**-0.08**	*0.148*	**-0.03**	*0.151*
inversion	**0.00**	*0.079*	**0.07**	*0.073*	**-0.03**	*0.075*
part 2 * externality	**0.05**	*0.184*	**0.09**	*0.182*	**0.04**	*0.183*
externality * A helps	**0.12**	*0.178*	**0.13**	*0.177*	**0.09**	*0.177*
green group dummy	**0.12***	*0.067*	**0.14****	*0.062*	**-0.02**	*0.064*
age	**0.01****	*0.004*	**0.01***	*0.005*	**0.02*****	*0.005*
has any children	**0.04**	*0.096*	**0.04**	*0.095*	**-0.15***	*0.082*
number of siblings	**-0.02**	*0.021*	**0.01**	*0.016*	**0.02**	*0.018*
male	**-0.13***	*0.069*	**-0.10**	*0.064*	**-0.07**	*0.064*
Pseudo R2	0.064		0.043		0.056	

Parts 1 and 2	NS		SE		CO	
Dependent variable: Decision (1 if choose A)	**dF/dx**	*R.SE*	**dF/dx**	*R.SE*	**dF/dx**	*R.SE*
part 2 * A helps	**0.28****	*0.148*	**0.14**	*0.098*	**0.30****	*0.119*
part 2 * externality * A helps	**-0.15**	*0.100*	**-0.14**	*0.101*	**-0.05**	*0.218*
part 2 dummy	**-0.19***	*0.108*	**0.00**	*0.055*	**-0.28****	*0.121*
A helps	**-0.04**	*0.095*	**-0.07**	*0.106*	**-0.15**	*0.111*
externality	**-0.11**	*0.109*	**-0.15**	*0.125*	**0.04**	*0.146*
inversion	**0.05**	*0.050*	**0.00**	*0.049*	**-0.10**	*0.067*
part 2 * externality	**0.23**	*0.195*	**0.12**	*0.144*	**0.03**	*0.181*
externality * A helps	**0.05**	*0.138*	**0.14**	*0.163*	**-0.05**	*0.173*
green group dummy	**0.05**	*0.046*	**-0.05**	*0.043*	**-0.03**	*0.059*
age	**0.01*****	*0.003*	**0.01**	*0.003*	**0.00**	*0.004*
has any children	**0.05**	*0.071*	**0.07**	*0.069*	**0.04**	*0.082*
number of siblings	**0.01**	*0.011*	**0.00**	*0.012*	**0.02**	*0.016*
male	**-0.06**	*0.046*	**-0.08***	*0.047*	**-0.08**	*0.060*
Pseudo R2	0.074		0.059		0.045	

N = 334

Robust standard errors (R.se.) are reported in parentheses. Clustered on person ID. Significance levels are *** 1%, ** 5%, and * 10%.

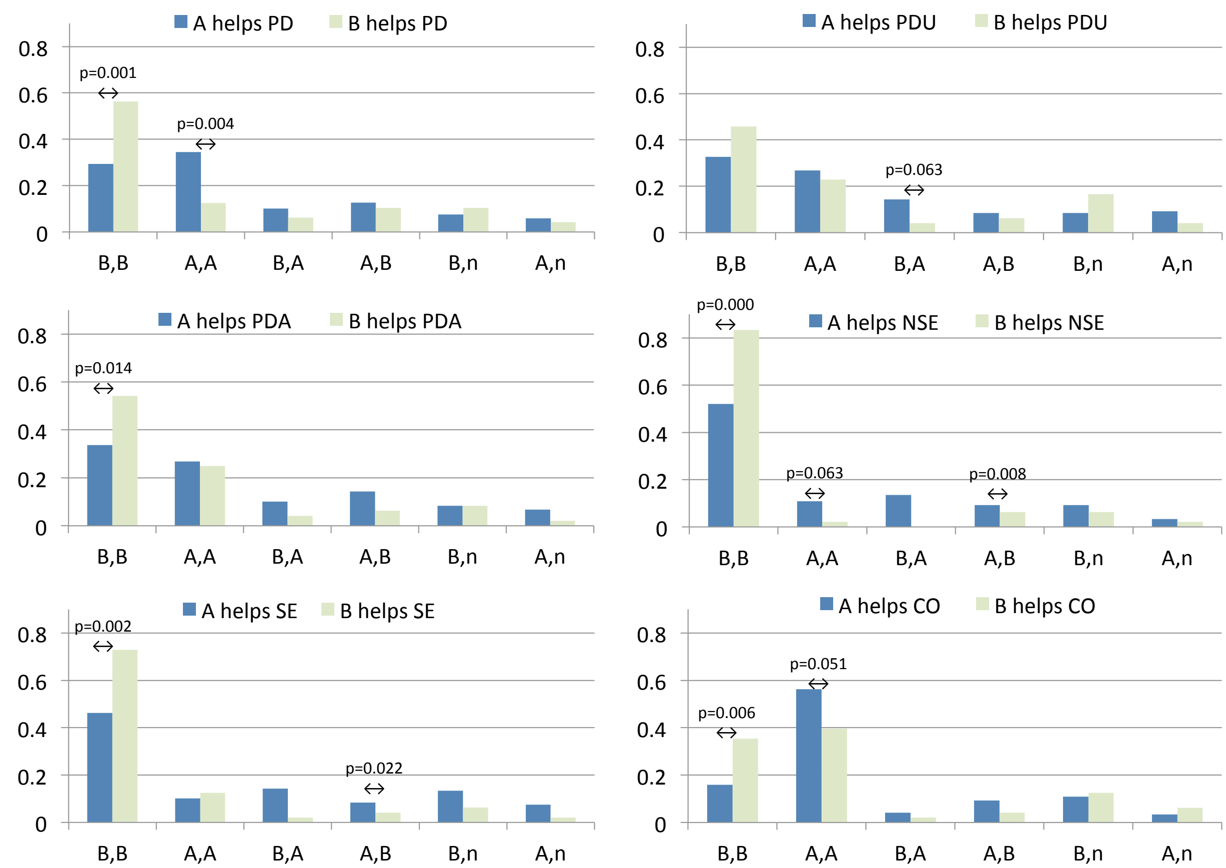
It is especially notable that the participants switch to follower-regarding actions in spite of dominance (in PD game) and even uniform dominance (in NS game). For example, in the NS game under the negative externality A-helps, 22 percent of participants choose the uniformly dominated action A in Part 1; in Part 2, this number increases to 28.8 percent. In comparison, under the negative externality B-helps, 25 percent of participants choose the uniformly dominated action A in Part 1; but in Part 2, this number decreases to 8.3 percent. As the difference between A-helps and B-helps is significant ($p = 0.0615$; see Table 2), the increase in A-choices in Part 2 under A-helps, as compared to decrease of those under B-helps, cannot be attributed entirely to persistent subject confusion, and should be attributed, to a significant degree, to the concern for the followers. We conclude that in some simple games, other-regarding preferences among subjects are strong enough to overcome dominance and even uniform dominance as guiding behavioral principles.

The evidence of other-regarding behavior is also strengthened by the analysis of predictions of the other player's choices in conjunction with own actual choices. Figure 5 displays the distribution action-prediction pairs by game and A-helps/B-helps treatment variation. Table 9 in the Supplementary materials presents similar information in tabular form.

Following Fischer et al. (2004), we call a subject's action *consensus-seeking* if the action is consistent with their prediction of the other player's action (with 60 percent confidence or higher).[10] Likewise, we may classify a subject as a consensus-seeker if their action is consistent with their prediction of the other's action most of the time (in 4 games or more out of 6 in Part 2). The plurality of participants (40 percent) under A-helps and the majority of the participants (68 percent) under B-helps are consensus-seekers. Yet, consensus seeking on A is higher in the A-helps treatment (18 percent of subjects overall) compared to the B-helps treatment (10 percent of subjects overall), and consensus seeking on B is higher in the B-helps treatment (58 percent of subjects overall) compared to the A-helps treatment (22 percent of subjects overall). For all individual games (Figure 5), the frequencies of consensus-seeking action-belief pairs shift between A-helps and B-helps treatments in the direction that helps the followers. The differences between the frequency of consensus-seeking actions between A-helps and B-helps treatment variations are significant at the 1 percent level for the PD game for both actions, and are significant at various levels for the PDA, NS, SE, and CO games as well.

In summary, analyzing expectations indicates that subjects shift their actions themselves,

[10]The threshold of 60 percent or higher prediction of an action is used to classify the subjects into those who predict that the other participant chooses A (probability of A-choice believed to be 60 percent or more); those who predict that the other participant chooses B (probability of A-choice believed to be less than 40 percent), or undecided (probability of A-choice by the other is believed to be between 40 and 60 percent). Using a threshold higher than 60 percent gives qualitatively similar results.



(A,A): chose A, predicted A; (A,B): chose A, predicted B; (B,A): chose B, predicted A; (A,A): chose A, predicted A; (B,B): chose B, predicted B; (A,n): chose A, no clear prediction; (B,n): chose B, no clear prediction

Note: p-values are shown for those significant at 10 percent or higher.

Figure 5: Frequency of choice-prediction pairs, by game and treatment

and believe that the others do too, in the direction that helps the followers. This finding gives additional evidence that people exhibit other-regarding behavior in predecessor games.

We next consider whether the subjects behave differently under positive and negative externalities.

Result 2 (Negative versus positive externality) *Subjects exhibit more follower-regarding behavior under negative externality than under positive externality treatments.*

Support: Figure 4, Tables 2–4. From Table 2, with negative externalities, overall, the frequency of A-choices between Part 1 and Part 2 of the experiment increases by 6.8 percent under A-helps, but decreases by 12.5 percent under B-helps; the difference is statistically significant ($p = 0.0004$). In contrast, with positive externalities, the frequency of A-choices between Parts 1 and 2 increases by 1.7 percent under A-helps, and decreases by 4.9 percent under B-helps; the difference between A-helps and B-helps is not statistically significant ($p = 0.2363$). The same is true for PD and NS games, where there is an overall evidence of the follower-regarding behavior: For PD, the null hypothesis of no differences between A-helps and B-helps treatments is rejected under the negative externality ($p = 0.034$, WMW test) but not under the positive externality ($p = 0.516$). For NS, the null hypothesis of no differences in changes between A-helps and B-helps treatments is marginally rejected under the negative externality ($p = 0.062$) but not under the positive externality ($p = 0.641$). The stag-hunt cooridnation game (CO) is the only game where there is evidence of follower-regarding behavior under both negative and positive externality treatments: the null hypothesis of no differences between the A-helps and B-helps treatment is rejected under the negative externality ($p = 0.013$) and, marginally, under the positive externality ($p = 0.068$).

The probit regressions in Table 3 also show that a positive externality term reduces the effect of A-helps variation in Part 2: whereas the coefficient on the interaction dummy "part2∗Ahelps" is positive and highly significant ($p < 0.001$), the coefficient on the interaction term "part2∗externality∗Ahelps" is negative, and is significant at 5 percent level (in the full regression).

□

This result suggests that incentives to avoid imposing negative externalities on others tend to be stronger than incentives to generate positive externalities for others. This finding is consistent with inequality-aversion social preferences where the participants are more averse to disadvantageous, than to advantageous, inequality (Fehr and Schmidt, 1999): the participants are willing to save the followers from falling behind, but not to help the followers to get ahead of their own payoffs.

We next consider the factors that are likely to hinder other-regarding behavior.

Result 3 (Unilateral helping action, payoff asymmetry and strategic uncertainty) *Evidence of other-regarding behavior found in symmetric games PD, NS and CO disappears in the presence of payoff asymmetry, if a helping action of only one predecessor is sufficient to help the followers, or in uniform dominance games with strategic uncertainty.*

Support Figure 4, Tables 2, 4. Table 2 indicates that while the differences between A-helps and B-helps treatments are significant for PD ($p = 0.0500$), NS ($p = 0.0855$), and CO ($p = 0.0024$) games, these differences are insignificant in the presence of unilateral helping action (PDU: $p = 0.7408$), payoff asymmetry (PDA: $p = 0.5915$), or uniform dominance combined with strategic uncertainty (SE: $p = 0.3834$). Similarly, in Table 4, while the coefficients for helping in Part 2 ('part2*A helps') are statistically significant in the PD, NS and CO games, they are not significant (even though positive in sign) in the PDU, PDA and SE games. □

Apparently, the incentive to "free-ride" on the opponent's (potential) other-regarding action toward followers is stronger under PDU and PDA than under PD. The finding on PDU is reminiscent of the experimental evidence from volunteer's dilemma games (Diekmann, 1985, 1993). Further, the result on PDA is consistent with the existing evidence that asymmetric PD games result in less cooperation than symmetric ones (Ledyard, 1995); we find that payoff asymmetry in the PDA game does not help the predecessors to coordinate on which player should help the followers, but instead eliminates caring for the followers altogether. Finally, we observe, by comparing NS and SE games, that while follower-regarding behavior which constitutes a pure sacrifice (and may therefore be attributed to pure altruism) is still observable under uniform dominance games with no strategic uncertainty (NS), it disappears with an added strategic uncertainly regarding the cost of the helping action (SE).

One of the primary motivations for this experiment was to explore whether concerns for the followers may help to resolve collective action and coordination problems in own (predecessor) games. We turn to this issue next.

Result 4 (Alignment of other-regarding and own game welfare maximization motives) *A concern for the followers aligned with own stage game welfare maximization motive helps predecessors to resolve social dilemma and coordination problems; yet, a conflict in motives greatly exacerbates free-riding in PD as well as coordination on the payoff-inferior equilibrium in the stag-hunt coordination game CO.*

Support: Figure 4, Table 3. Overall, from Table 3, when action "A" is Pareto optimal for the stage game (games PD, PDU, PDA and CO), subjects are up to 26 percent more likely to choose it; the coefficient on "A is Pareto optimal" dummy is significant at 1 percent level. As documented by Result 1, when A-helps, the frequencies of A-choices in these games further increase or do not drop in Part 2. However, as illustrated by Figure 4, the frequencies of Pareto-optimal actions drop in the predecessor games as compared to one-shot games if such actions contradict with the follower-regarding motive. In PD game, when B-helps, the frequency of A-choices decreases from 41.7 percent in Part 1 to 29.2 percent in Part 2 under negative externalities, and from 33.3 percent to 25.0 percent under positive externalities. In CO game, coordination on the Pareto-dominant A-equilibrium is generally high, but significantly decreases from Part 1 to Part 2 under B-helps: from 75 percent to 45.8 percent under negative externalities, and from 79.2 percent to 54.2 percent under positive externalities. This indicates that predecessors are willing to switch from a Pareto dominant equilibrium to another equilibrium if it helps the payoffs of the followers. □

To summarize, we document that the effect of the concern for the followers on the predecessor behavior is strong overall although it varies across treatments and games. In the next section, we analyze the followers' actions to consider whether the observed play of predecessors has any effect on the follower behavior.

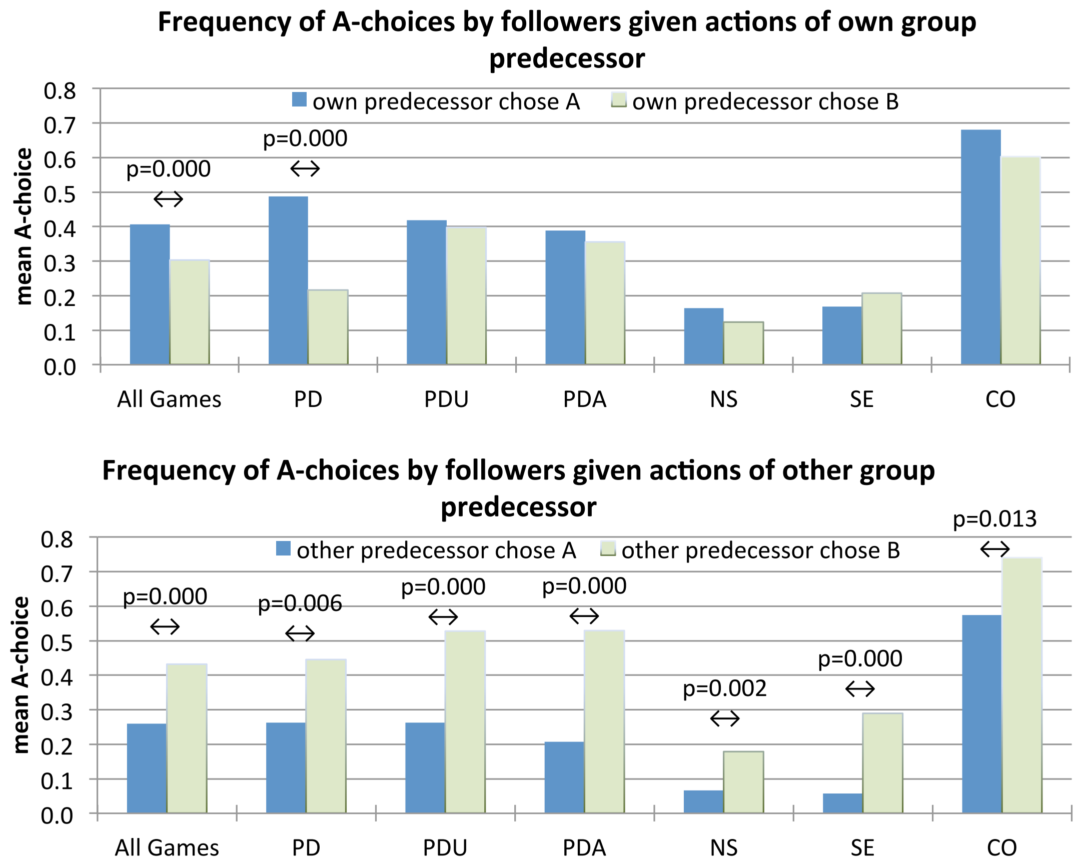
3.2 Follower behavior results

We now turn to Part 3 (follower games) and consider whether and how the followers were influenced by the predecessor choices. Did the followers learn from their predecessor behavior in any way? In particular, did the followers learn to take cooperative actions, or to free-ride, if their predecessors did so? We address these issues next.

In order to understand how predecessor choices affected the follower behavior, recall that the participants in each experimental session were divided into two groups, so that the predecessors and followers within a group could share a common group identity, but had to interact, on each stage, with a participant from a different ("other") group. When participants made decisions at the follower stage (Part 3 of the experiment), they were informed about the actions of both own group's and the other group's predecessor, and how these actions together determined their payoff matrix. Apparently, the followers were influenced by own and the other group's predecessors very differently, as the next result indicates.

Result 5 (Effect of predecessor behavior) *Overall, the followers are significantly more likely to act the same as own group predecessor, and to act opposite to the other group's predecessor.*

Support: Figure 6, Table 5. The top panel of Figure 6 displays the frequencies of follower decisions given own group predecessor decisions. When all games are pooled, and in the



Note: p-values, one-sided (identical results for WMW and t-tests), are shown for those significant at 10 percent or higher.

Figure 6: Follower decisions given predecessor actions

Table 5: Probit estimation of follower behavior reporting marginal effects

Part 3, games pooled	All games, basic regression		PD, PDU, PDA and CO, basic regression		PD, PDU, PDA and CO, extended regression	
Dependent variable: Decision (1 if choose A)	**dF/dx**	*R.SE*	**dF/dx**	*R.SE*	**dF/dx**	*R.SE*
own predecessor choice A	**0.18*** **	*0.042*	**0.20*** **	*0.050*	**0.17*** **	*0.052*
other predecessor choice A	**-0.29*** **	*0.041*	**-0.30*** **	*0.048*	**-0.32*** **	*0.052*
A helps	**0.05**	*0.096*	**0.07**	*0.090*	**0.11**	*0.098*
externality	**0.09**	*0.089*	**0.13**	*0.114*	**0.15**	*0.113*
inversion	**-0.10* **	*0.054*	**-0.05**	*0.064*	**-0.07**	*0.077*
externality * A helps	**-0.11**	*0.097*	**-0.09**	*0.128*	**-0.08**	*0.132*
green group dummy	**0.09* **	*0.045*	**0.12** **	*0.057*	**0.12* **	*0.062*
A is PO	**0.22*** **	*0.067*				
asymmetric payoffs in PD	**-0.01**	*0.033*	**-0.01**	*0.036*	**0.01**	*0.043*
no static externality	**-0.08* **	*0.047*				
A is Nash equilibrium	**0.30*** **	*0.045*	**0.30*** **	*0.043*	**0.32*** **	*0.051*
A is PO * A helps	**0.00**	*0.087*				
age	**0.01*** **	*0.003*	**0.01** **	*0.004*	**0.01** **	*0.005*
has any children	**-0.05**	*0.060*	**-0.08**	*0.075*	**-0.07**	*0.091*
number of siblings	**0.00**	*0.012*	**0.00**	*0.014*	**0.00**	*0.016*
male	**-0.05**	*0.047*	**-0.08**	*0.059*	**-0.12* **	*0.069*
studied game theory as part of college class					**0.06**	*0.075*
studied environmental issues as part of college class					**-0.03**	*0.068*
number of people subject knows in own group					**0.03**	*0.030*
number of people subject knows in other group					**-0.03**	*0.027*
willing to take significant risks in life					**0.05**	*0.080*
does not like to take risks in life					**0.18** **	*0.106*
"if I have a comfortable income, I save much of it for the future"					**-0.14**	*0.133*
"if I have a comfortable income, I save little for the future"					**-0.28** **	*0.129*
"generally most people are trustworthy"					**0.03**	*0.061*
believes people's lives are influenced by a higher being (such as God)					**0.03**	*0.097*
believes people's actions are judged by a higher being (such as God)					**0.00**	*0.088*
participates in religious activities once a month or more					**-0.12**	*0.125*
participates in religious activities once a month or less					**-0.18* **	*0.101*
participates in religious activities less than 5 times a year					**-0.07**	*0.114*
never participates in organized religious activities					**0.07**	*0.120*
prefers high taxes, with high government support and services					**-0.06* **	*0.035*
believes "society should regulate scarce resources"					**-0.11**	*0.109*
believes "it is up to each person to conserve scarce resources"					**-0.13**	*0.115*
does not believe we should conserve scarce resources					**-0.23**	*0.175*
believes "technology will improve but future won't be drastically different"					**-0.29*** **	*0.084*
believes "people will not be able to solve many of the problems we have today"					**-0.32*** **	*0.085*
believes "people will experience more problems than we have today"					**-0.23*** **	*0.080*
believes "If we don't change, the world will be much worse for future generations"					**0.31**	*0.233*
believes "If we don't change, the world will be worse in the future for future generations"					**0.34**	*0.230*
believes "We do not need to make changes, future will not be worse"					**-0.09**	*0.255*
believes "Whether we make changes or not, it will not affect future generations"					**0.31**	*0.233*
"My goal was to get the highest payoff for myself"					**-0.20**	*0.134*
"My goal to get the highest payoff, considering what others will do"					**0.00**	*0.132*
"My goal was to get the highest payoff table for the followers"					**-0.05**	*0.192*
"My goal was to keep a balance between a payoff for me, and for the followers"					**0.12**	*0.147*
"My goal was to avoid getting the lowest payoff"					**0.01**	*0.158*
N	1,002		668		616	
Pseudo R2	0.190		0.142		0.2531	

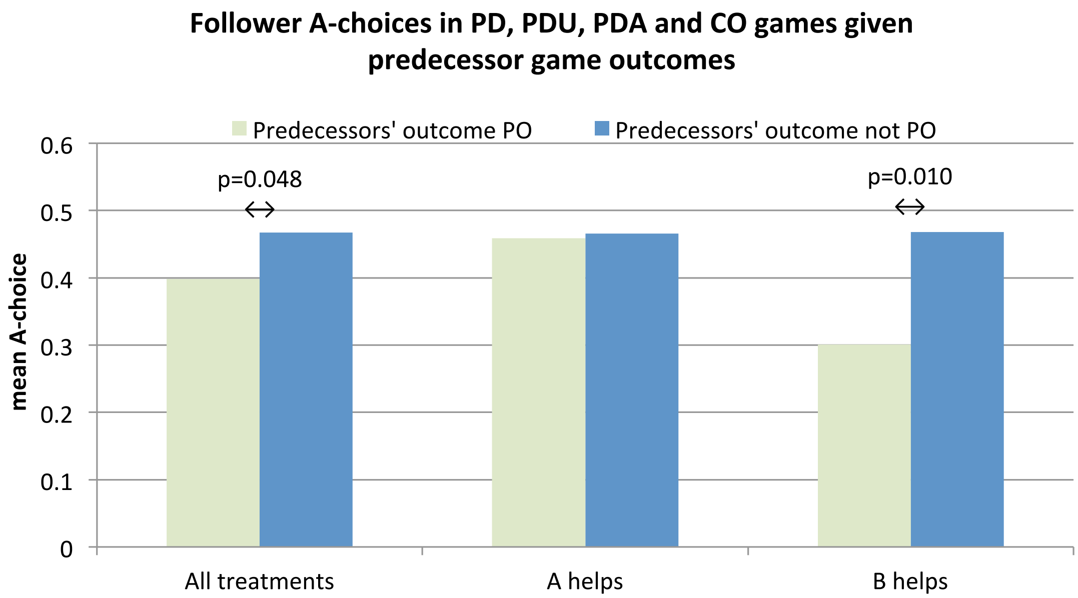
Robust standard errors (R.se.) are reported in parentheses. Clustered on person ID.
Significance levels are *** 1%, ** 5%, and * 10%.
N in second specification is reduced due to some unanswered survey questions.

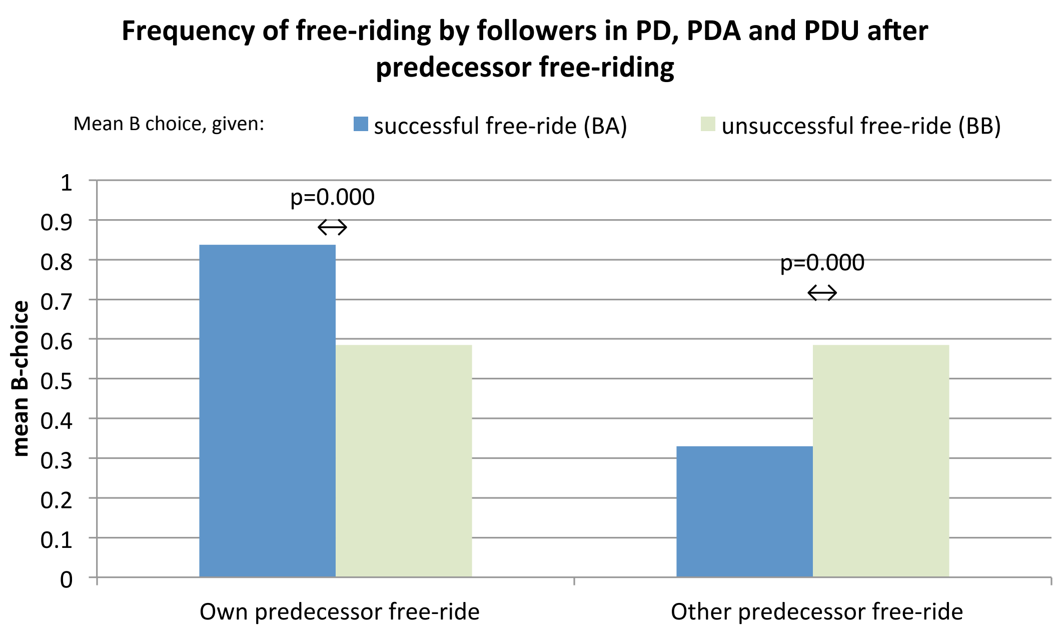
PD game pooled across treatments, the followers are more likely to choose A if their own predecessor chose A ($p < 0.001$, both WMW and t-test). There is some evidence that the followers followed the predecessors more often when the predecessor actions helped. Table 10 in the Supplementary Materials reports statistics separately for A-helps and B-helps treatments. In A-helps treatments, the differences in frequences of A-choices depending on predecessor decisions are significant at conventional levels for the pooled results, and for the PD, PDA, and NS games. For B-helps treatments, these differences are significant for PD and CO games only. Figure 6 (bottom panel) shows the distribution of follower decisions given the decisions of predecessors from the other group. In all games and overall, the subjects are significantly ($p < 0.05$) more likely to choose an action that is opposite to what the other-group predecessor did. The differences are significant for the pooled data and for all games in both A-helps and B-helps treatments (except for the NS game in the B-helps treatments; see Table 10 in the Supplementary Materials). These results are also confirmed by probit estimation of follower behavior reported in Table 5; on average, own predecessor choosing “A” increases follower probability of choosing “A” by 18 percent, whereas the other predecessor choosing “A” decreases this probability by 29 percent; both estimates are highly significant. □

The effects of acting opposite to the other group’s predecessor appeared so strong that it prevented Pareto Optimal outcomes from persisting to followers from predecessors, as we show next. A similar observation applies to free-riding. Let us consider free-riding in a Prisoners’ Dilemma game successful if the free-rider receives a higher payoff than they would under mutual cooperation (which is the case when the free-rider chooses “B,” and the other player chooses “A”). Consider free-riding unsuccessful if the free-riders receive a lower payoff than they would under mutual cooperation (which is the case when both players choose “B”). We observe that in our experiment, the followers tend to free-ride more when their own predecessor free-rode successfully, but they free-ride less when their own predecessor was taken advantage of (i.e., the other group’s predecessor free-rode successfully).

Result 6 (Effect of predecessor Pareto Optimal outcome and free-riding) *Successful coordination by predecessors on a Pareto Optimal outcome does not lead to more Pareto Optimal choices by the followers. Successful free-riding by a predecessor makes own follower more likely to free-ride, but makes the other follower less likely to free-ride.*

Support: Figure 7. The top panel displays frequencies of A-choices by the followers in PD, PDU and PDA and CO games, by Pareto Optimality of their predecessor game outcome (“AA” outcomes, when both players chose A, as compared to “non-AA” outcomes). Overall, there is evidence that in games where choosing “A” is Pareto Optimal, and predecessors





Note: p-values, one-sided (identical results for WMW and t-tests), are shown for those significant at 10 percent or higher.

Figure 7: Follower choices given predecessor game outcomes

successfully coordinated on “AA,” the followers are actually less likely to choose “A” ($p = 0.048$). This result is also significant for the B-helps treatment ($p = 0.01$), but not for the A-helps treatment ($p = 0.44$). Figure 7 (bottom panel) shows that successful free-riding by own predecessor in the three prisoners’ dilemma games (PD, PDU, and PDA) increases the follower attempts to free-ride ($p < 0.001$). On the other hand, successful free-riding by the other predecessor actually increases the likelihood of a cooperative action by the follower ($p < 0.001$). □

The above finding echoes Result 5 and suggests the followers may be blindly following their own predecessor, and blindly opposing the other group’s predecessor, rather than “wisely” following or opposing them.

We conclude that within-group basic information sharing conducted at the beginning of the sessions, along with group labeling (Green or Blue), were successful at inducing group identity and creating an in-group bias in learning from own predecessors. An unexpected and surprising side effect of inducing group identity was to create a bias against learning from the other group’s predecessors. While both in-group and out-group biases have been documented earlier (e.g., Chen and Li, 2009), these results concerned *treating* in-group and out-group members differently. In contrast, our results provide new and surprising evidence of *learning* differently from in-group and out-group member behaviors.

3.3 Analysis of individual decision rules

Until now, we focused on behavioral changes between parts of the experiment, considering each of the six games (PD, PDU, PDA, NS, SE and CO) separately. We now assume that each individual agent employs a certain decision rule that specifies playing “A” or “B” for each of the six games. By looking into the individual decision rules, and changes in the prevalent rules from Part 1 to Part 2 to Part 3, we are able to better understand whether and how other-regarding behavior manifests itself under different treatments, and, further, how predecessor actions affect follower choices.

To address this issue, we adopt the Strategy Frequency Estimation Method (SFEM), developed by Dal Bó and Fréchette (2011)[11]. There are potentially 2^6 different decision rules, but which decision rules would prevail among agents could differ across parts and across treatments. Using SFEM, we can estimate the prevalence of decision rules, within the set of rules considered, in each part and treatment by applying maximum likelihood estimation (MLE). Let s^k be decision rule k among the set of K decision rules under consideration. Let $y_{ig}(s^k) = I_{s_{ig}(s^k)+\gamma\varepsilon_{ig}\geq 0}$ be the indicator that subject i’s actual decision for game g follows

[11]See, for example, Fudenberg et al. (2012), for an adaptation of SFEM. We follow the terminology of Dal Bó and Fréchette (2013) here, as suggested by the method’s authors.

s^k, where $s_{ig}(s^k)$ is the choice in game g implied by the decision rule ($= 1$ if it follows, $= -1$ if it does not), ε the error term, and γ the variance in the error. The likelihood that subject i's observed choice is generated by decision rule k is then given by

$$\Pr_i(s^k) = \Pi_g \left(\frac{1}{1+\exp(-s_{ig}(s^k)/\gamma)}\right)^{y_{ig}} \left(\frac{1}{1+\exp(s_{ig}(s^k)/\gamma)}\right)^{1-y_{ig}}.$$

The likelihood function for the sample is

$$\sum_{i=1}^{n} \ln\left(\sum_{k=1}^{K} \phi^k \Pr_i(s^k)\right),$$

where ϕ is the proportion of the data attributed to decision rule s^k.

In estimating the above likelihood function, the standard errors are bootstrapped as in Dal Bó and Fréchette (2011).[12] In this context, $\beta \equiv \frac{1}{1+\exp(-1/\gamma)}$ measures the extent to which the decisions are random (subjects choose A or B completely randomly if $\beta = 1/2$). We test $H_0 : \beta = 0.5$ using the estimates of γ and its standard error.

Out of all potential decision rules, we picked 14 rules to include in the estimations for the A-helps treatments, and 12 rules for the B-helps treatments. The decision rules were picked by examining the raw data and by fine-tuning the sets of rules to improve the estimation results.

The results of MLE are presented in Table 6 (A-helps treatments) and Table 7 (B-helps treatments). The results are highly significant: for all treatments and parts except for part 2 under the positive-externality B-helps treatment, $H_0 : \beta = 0.5$ is rejected at the 1 percent significance level. The tables list the proportion of subjects estimated to use each decision rule, along with its standard errors, for each treatment and part. Decision rules are coded by the actions which they prescribe for each game; i.e., rule AAAAAA prescribes 'Play A in all six games,' and rule AAABBA prescribes 'Play A in all but uniform dominance games.' Under the negative externality-A helps treatment in part 1, for example, the rule BBBBBA, "Play A only in CO and play B otherwise," constitutes 22 percent of the decision rules adopted in the sample.

The estimation results help to uncover the participants' guiding decision principles, and highlight the changes between the parts of the experiment. We first consider prominent decision rules in one-shot games.

Result 7 (Decision rules in one-shot games) *In Part 1 (one-shot games), the most prominent decision rules are those where action A is played only in the coordination game, or in*

[12] We applied the Matlab toolbox for SFEM provided at `http://www.econ.brown.edu/fac/Pedro_Dal_Bo/`.

Table 6: Estimation of Decision Rules, A-helps treatments

Rule	Game						Negative ext-ty, A helps			Positive ext-ty, A helps		
No	PD	PDU	PDA	NS	SE	CO	Part 1	Part 2	Part 3	Part 1	Part 2	Part 3
1	A	A	A	A	A	A	0.012	0.210***	0.110*	0.011	0.049	0.000
							(0.000)	*(0.006)*	*(0.004)*	*(0.000)*	*(0.002)*	*(0.000)*
2	A	A	A	A	B	A	0.101*	0.027	0.000	0.086*	0.000	0.000
							(0.056)	*(0.033)*	*(0.010)*	*(0.051)*	*(0.018)*	*(0.014)*
3	A	A	A	B	A	A	0.000	0.070	0.082	0.006	0.000	0.026
							(0.000)	*(0.052)*	*(0.056)*	*(0.023)*	*(0.031)*	*(0.032)*
4	A	A	A	B	B	A	0.133**	0.110	0.036	0.228***	0.262***	0.243***
							(0.060)	*(0.071)*	*(0.038)*	*(0.071)*	*(0.086)*	*(0.075)*
5	A	A	B	B	B	A	0.192***	0.031	0.000	0.133**	0.035	0.044
							(0.069)	*(0.049)*	*(0.014)*	*(0.063)*	*(0.051)*	*(0.048)*
6	A	B	A	B	B	A	0.000	0.031	0.000	0.000	0.016	0.016
							(0.000)	*(0.039)*	*(0.003)*	*(0.000)*	*(0.046)*	*(0.031)*
7	A	B	B	B	B	A	0.000	0.109	0.085	0.000	0.081	0.000
							(0.000)	*(0.076)*	*(0.058)*	*(0.000)*	*(0.067)*	*(0.019)*
8	B	A	A	B	B	A	0.000	0.000	0.146*	0.000	0.036	0.052
							(0.000)	*(0.016)*	*(0.076)*	*(0.000)*	*(0.048)*	*(0.044)*
9	B	A	B	B	B	A	0.000	0.004	0.000	0.000	0.078	0.065
							(0.000)	*(0.021)*	*(0.027)*	*(0.000)*	*(0.061)*	*(0.051)*
10	B	B	A	A	A	A	0.056	0.000	0.045	0.000	0.020	0.042
							(0.036)	*(0.028)*	*(0.045)*	*(0.000)*	*(0.040)*	*(0.035)*
11	B	B	A	B	B	A	0.085	0.026	0.000	0.068	0.037	0.002
							(0.056)	*(0.038)*	*(0.011)*	*(0.052)*	*(0.045)*	*(0.024)*
12	B	B	A	B	B	B	0.105**	0.000	0.000	0.102	0.036	0.019
							(0.042)	*(0.000)*	*(0.026)*	*(0.053)*	*(0.044)*	*(0.025)*
13	B	B	B	B	B	A	0.221***	0.217***	0.315***	0.256***	0.087	0.220***
							(0.071)	*(0.081)*	*(0.118)*	*(0.089)*	*(0.123)*	*(0.074)*
14	B	B	B	B	B	B	0.095*	0.165**	0.180**	0.110*	0.263***	0.271***
							(0.053)	*(0.075)*	*(0.083)*	*(0.058)*	*(0.092)*	*(0.073)*
						beta	0.926***	0.880***	0.881***	0.930***	0.865	0.920***
							(0.022)	*(0.030)*	*(0.068)*	*(0.018)*	*(1.285)*	*(0.019)*
						# subjects	59	59	59	60	60	60

Bootstrapped standard erors in parentheses.
Significance levels are *** 1%, ** 5%, and * 10%.
The significance levels for the estimates of beta apply to H0: beta = 1/2.

Table 7: Estimation of Decision Rules, B-helps treatments

Rule	**Game**						**Negative ext-ty, B helps**			**Positive ext-ty, B helps**		
No	**PD**	**PDU**	**PDA**	**NS**	**SE**	**CO**	**Part 1**	**Part 2**	**Part 3**	**Part 1**	**Part 2**	**Part 3**
1	A	A	A	A	A	A	0.000	0.047	0.034	0.041	0.085**	0.000
							(0.000)	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.000)*
2	A	A	A	A	B	A	0.000	0.020	0.000	0.055	0.037	0.066*
							(0.000)	*(0.035)*	*(0.008)*	*(0.037)*	*(0.029)*	*(0.040)*
3	A	A	A	B	A	A	0.041	0.000	0.091	0.000	0.000	0.000
							(0.036)	*(0.026)*	*(0.068)*	*(0.000)*	*(0.000)*	*(0.000)*
4	A	A	A	B	B	A	0.121**	0.095	0.128**	0.126***	0.132**	0.249***
							(0.057)	*(0.059)*	*(0.065)*	*(0.056)*	*(0.053)*	*(0.091)*
5	A	A	B	B	B	A	0.254***	0.074	0.000	0.111*	0.038	0.028
							(0.073)	*(0.056)*	*(0.024)*	*(0.057)*	*(0.032)*	*(0.039)*
6	A	B	B	B	B	A	0.000	0.000	0.070	0.000	0.000	0.028
							(0.000)	*(0.003)*	*(0.083)*	*(0.000)*	*(0.000)*	*(0.036)*
7	B	A	A	B	B	A	0.000	0.069	0.000	0.000	0.000	0.027
							(0.000)	*(0.073)*	*(0.008)*	*(0.000)*	*(0.000)*	*(0.029)*
8	B	B	A	A	A	A	0.115**	0.000	0.000	0.000	0.000	0.000
							(0.055)	*(0.000)*	*(0.008)*	*(0.000)*	*(0.002)*	*(0.000)*
9	B	B	A	B	B	A	0.026	0.087	0.000	0.122**	0.080**	0.000
							(0.048)	*(0.056)*	*(0.008)*	*(0.060)*	*(0.037)*	*(0.000)*
10	B	B	A	B	B	B	0.088*	0.000	0.000	0.037	0.000	0.021
							(0.051)	*(0.006)*	*(0.008)*	*(0.029)*	*(0.000)*	*(0.031)*
11	B	B	B	B	B	A	0.344***	0.117	0.251***	0.34***	0.159**	0.314***
							(0.075)	*(0.083)*	*(0.096)*	*(0.072)*	*(0.062)*	*(0.085)*
12	B	B	B	B	B	B	0.011	0.491***	0.425**	0.17***	0.469***	0.267***
							(0.032)	*(0.097)*	*(0.132)*	*(0.056)*	*(0.084)*	*(0.072)*
						beta	0.912***	0.892***	0.899**	0.980***	0.964***	0.921***
							(0.019)	*(0.028)*	*(0.094)*	*(0.012)*	*(0.016)*	*(0.022)*
						# subjects	24	24	24	24	24	24

Bootstrapped standard erors in parentheses.
Significance levels are *** 1%, ** 5%, and * 10%.
The significance levels for the estimates of beta apply to H0: beta = 1/2.

the coordination game and the prisoners' dilemma games, or not at all, suggesting Nash equilibrium play and welfare maximization as the two most prevalent decision principles among the players.

Support: Tables 6-7. In Part 1 (one-shot games), the most prominent decision rules are (1) "All A except for uniform dominance games" (AAABBA) and "A in PD and CO" (AABBBA)[13], corresponding to welfare maximization (Pareto Optimality) motive in play; (2) "A only in CO" (BBBBBA), corresponding to payoff-dominant Nash equilibrium play; and (3) "All B", corresponding to (less risky) Nash equilibrium play. These four decision rules alone account for 64.1 percent of the data under Negative Externality A-helps; 72.7 percent under Positive Externality A-helps; 71.9 percent under Negative Externality B-helps; and 74.7 percent under Positive Externality B-helps treatment; all the estimates are significant. □

In predecessor games (part 2), the prevalence of decision rules changes towards the rules that help the followers, especially under negative externality treatments.

Result 8 (Decision rules in predecessor games) *In Part 2 (predecessor games) under negative externalities, there is a significant increase (relative to Part 1) in the proportion of subjects playing "All A" under A-helps, and playing "All B" under B-helps. That is, under negative externalities, there is a significant shift toward 'All help" rule. Under positive externalities, a shift towards "All help" decision rule only occurs under B-helps, when the helping actions coincide with the Nash equilibrium play, but not under A-helps, when the helping and the Nash plays disagree.*

Support: Tables 6-7. Under Negative Externality A-helps, 21 percent of the subjects are estimated to play "All A" in Part 2 (as compared to insignificant 1.2 percent in part 1), although there is also a slight increase in "All B" decision rule (from 9.5 percent in Part 1 to 16.5 percent in part 2); "Play A only in CO" also stays prominent (21.7 percent). Under Positive Externality A-helps, in Part 2 no one plays "All A;" "All B" (26.3 percent) and "All A except for uniform dominance games" (26.2 percent) are the only prominent decision rules. Under Negative Externality B-helps, in Part 2 "All B" is the only prominent and significant decision rule, attributed to half of the population (49.1 percent). The share of "All B" rule under Positive Externality B-helps also increases significantly (from 17 percent

[13]Note that in Part 1 (one-shot games), PDU was not played, as it was identical to PD. We include PDU in the decision rules for all parts for consistency. In estimations, the subject decisions for Part 1 PDU were generated by cloning their decisions in Part 1 PD. Excluding PDU from Part 1 estimations gives qualitatively similar results.

in Part 1 to 46.9 percent in Part 2), although the rules "All A except for uniform dominance games," and "A in CO only" stay prominent. □

Finally, we turn to the followers' decision rules.

Result 9 (Decision rules in follower games) *In Part 3 (follower games), there is a stronger return to stage game welfare maximization and Nash equilibrium play decision principles, but also a clear persistence of decision rules adopted in Part 2 of the experiment.*

Support: From Tables 6-7, in Part 3, three most prominent decision rules that persist across treatments are: (1) "All A except for uniform dominance games;" (2) "A in CO only;" and (3) "All B." However, the proportion of these decision rules varies across treatments, as decision rules that were prominent in Part 2 (predecessor games) carry over into Part 3 (follower games). Specifically, under Negative Externality A-helps, decision rule"All A" persists, remarkably, from the previous part (11 percent). Likewise, the proportion of subjects playing "All B" strategy is low under Negative Externality A-helps (18 percent) as compared to Negative Externality B-helps (42.5 percent), as these proportions exhibit little change from the corresponding proportions in Parts 2. Under Positive Externality B-helps, there is an increase in proportions "A only in CO" and "A except for uniform dominance games," and a corresponding decrease in "All B," providing evidence that own game welfare maximization and Pareto Dominance receive more weight in some subjects' decisions, when not countered by concerns for the followers. □

Overall, SFEM analysis confirms and strengthens our findings. It documents (Pareto dominant) Nash equilibrium play, stage game welfare maximization, concern for the followers, and mimicking the predecessors as the most prominent behavioral principles that manifest themselves in different parts of our experiment.

3.4 Effects of demographics and personal opinions

Before concluding, we briefly turn to the effects of demographics and personal opinions on cooperative behavior. Here we focus on the effects that persist across different parts of the experiment, and therefore should not be attributed to other-regarding motives, but rather to welfare maximization motives in stage games. As "A" is the cooperative action leading to welfare maximizing outcome in PD, PDU, PDA, CO games (i.e., all games other than uniform dominance games NS and SE), we now focus on these four games. We return to one-shot and predecessor regression results presented in Tables 3-4, and follower regressions reported in Table 5, to support our statements.

Result 10 (Demographics) *Age has a positive effect on cooperation, while being male has a negative effect.*

Support: Tables 3-5. From Table 3, in Parts 1 and 2 of the experiment (one-shot and predecessor games), each year of age increases the probability of chosing A in PD, PDA, PDU and CO games by 1 percent ($p < 0.1$) while being male decreases this probability by 14 percent ($p < 0.01$, full regression). These results are also confirmed considering regressions for each of the four games: from Table 4, each year of age increases the probability of cooperation by 1 percent in PD and PDU games, and by 2 percent in PDA; the coefficients on the "male" dummy are negative and large in all games. The effects persist in magnitude and stay significant in Part 3 (follower games) as well; see Table 5 (full regression). □

These findings are consistent with previous experimental evidence. For example, Croson and Buchan (1999) find significantly more reciprocity among women than men in their analysis of data from four countries. Sutter and Kocher (2007) note that the level of trust seems to increase with age, peaking at around 30 or 40 years of age; see also Shen and Saijo (2008). Since our subject pool's average age is 27, our findings are in line with these results.

Result 11 (Policy opinions) *People who prefer high taxes, with high support and services provided by the government, cooperate less than those who prefer little taxes and little support and services from the government. People who do not believe in conserving scarce resources for future generations cooperate less.*

Support: Tables 3, 5. From Table 3, full regression for PD, PDU, PDA and CO games, the subjects who "prefer high taxes, with high support and services provided by the government" are 8 percent less likely to choose "A" in Parts 1 and 2 ($p < 0.01$); this effect continues to be negative and significant in the follower regression as well (Table 5). Those who believe that "we should not conserve scarce resources for future generations, they will have enough resources and new technologies" choose "A" 38 percent less overall (Table 3, $p < 0.01$); this effect persists but becomes insignificant in Part 3 (follower games, Table 5). □

The finding on the negative impact of reliance on government support on cooperation is intriguing. It may indicate that those who prefer more government support do so because of free-riding motives, or they prefer more collective support because they are less trusting of cooperation without intervention. Likewise, our results suggest that there is a connection between personal opinions on resource conservation and cooperative behavior. The significance of this effect for behavior in the predecessor games, but not in the follower games, suggests a link between other-regarding preference and resource conservation. We are not aware of similar findings in the previous literature.

Result 12 (Goals) *People whose goal was to avoid getting the lowest payoff for themselves chose "A" significantly less, while people seeking getting the highest payoff cooperated significantly more.*

Support: From Table 3, full regressions (for all games pooled as well as all but uniform dominance games pooled), the subjects whose goal was to avoid getting the lowest payoff for themselves were 21 percent less likely to choose "A." For the four games where "AA" is a joint payoff maximizing outcome, from the full regression, people who agreed with statements "My goal was to get the highest payoff, considering what others will do," or "My goal was to keep a balance between a payoff for me, and a payoff for the followers", were 20 or 24 percent more likely to choose the cooperative action "A." □

The negative relation between the goal to avoid the lowest payoff for themselves and choosing "A" is not surprising. Since choosing "A" in most games (all but NS) involved strategic uncertainty, these subjects chose the safe action "B". The positive relationship between the payoff maximization goal and the choice of cooperative action "A," on the other hand, gives us an additional support for welfare maximization as one of the decision principles guiding our subject behaviors.

4 Summary and conclusions

Our experimental results from two-stage, two-player predecessor-follower games clearly indicate that people indeed exhibit follower-regarding behavior under collective action, and they expect others to do so as well. However, the positive/negative externality treatment variations revealed, beyond doubt, that our subjects were concerned about predecessor-follower equity: they were willing to help their followers not fall behind themselves, but not get ahead of themselves in terms of payoffs. Further, other-regarding behavior disapeared in the presence of payoff asymmetry or under volunteers' dilemma setting for the predecessors, further indicating that symmetry (implying equal sharing) of costs between the predecessors was an important factor for willingness to help the followers. Under symmetry, remarkably, we observe other-regarding behavior even in the uniform dominance NS game, where the helping action is strictly dominated and is also Pareto-dominated in the predecessor game. Comparison with the SE game suggests, however, that other-regarding behavior disappears when, in addition to being a strictly dominated and Pareto-dominated strategy, helping the followers also involves strategic uncertainty for the predecessors.

The results on the coordination game CO indicate that follower-regarding motives may serve as a coordination device in multiple-equilibrium games: we observe that while most of our subjects chose the payoff-dominant equilibrium strategy in the one-shot games, many of them were willing to switch to a lower-payoff equilibrium if such action also helped the followers.

Can we conclude that a concern for the followers helps current decision makers resolve social dilemma and coordination problems? We learn that it may help indeed, provided this concern for the followers is aligned with own stage game welfare maximization motive. Conversely, a conflict in motives greatly exacerbates both free-riding in collective action games, and coordination failure in coordination games, as the subjects choose non-cooperative actions more frequently under such conflict.

It is informative to discuss our results in light of the vast literature on social preferences. A popular model by Charness and Rabin (2002) allows for different types of social preferences, including competitive preferences, social welfare maximization, and difference aversion. While it is straightforward to extend the model of Charness and Rabin (2002) to our setting, it is impossible to quantitatively estimate the extended model's parameters due to the design complexity.[14] However, different games and treatment variations we employed allow us to draw some inferences about the types of social preferences that the subjects exhibit. Our findings on the differences in the helping actions between positive and negative externality treatments for games where these helping actions are not a stage-game Nash equilibrium (Result 2) indicate that simple altruism or global (inter-generational) social welfare maximization are not prominent across all treatments, and therefore charity or inequity aversion motives explain the increased helping under negative externalities better than global welfare maximization. However, a significant increase in the helping action under both positive and negative externalities in the coordination game illustrates that when global welfare improving action is supported as an equilibrium in the stage game, the global welfare maximization motive becomes prominent. In addition, we observe strong evidence of own game welfare maximization as a prominent decision principle in Parts 1 and 3 of the experiment, indicating the presence of the social welfare maximization preference.

Overall, these results suggest that in situations where people believe they are preventing a negative externality, rather letting the future generations get ahead at today's generation's expense, people may care about the consequences they impose on their followers, and may help the followers in collective action settings. As long as own group's and the follower group's objectives are aligned, this may have a positive effect on resolving dynamic social dilemmas. This suggests that raising awareness of the public on the effect of their actions for the future may be important.

[14] Indeed most papers that estimate such models use simpler sequential games; see Charness and Rabin (2002) and Chen and Li (2009).

Finally, one of our most intriguing results concerns follower behavior. We found that the followers tended to blindly follow their predecessors, and blindly oppose the other group's predecessors, even though their own strategic situation was different (no dynamic externality present). This may be because of "decision fatigue," strong group adherence, or other reasons. This differentiated learning from own and other predecessors is among the most surprising results that may have broad real world implications.

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Supplementary Materials

- Games: real-world applications
- Experimental instructions
- Figure 8: Sample screenshots for predecessor and follower stage games
- Figure 9: Survey questions
- Table 8: Increase in helping action ("A" in A-helps, "B" in B-helps treatments) from Part 1 to Part 2, in percentage points
- Table 9: Frequency of choice-prediction pairs by predecessors, by treatment
- Table 10: Follower decisions (Part 3)

Games: real-world applications

Potential real-world applications of each game discussed in Section 2 are illustrated below. These examples are mostly geared towards environmental policy issues; equally relevant applications include other long-term international policy issues, or public education policy.

1. **Prisoners' Dilemma game (PD).** We use PD games to investigate whether the presence of dynamic externality can help to resolve the social dilemma between the Pareto Optimal (PO) outcome and the Dominant Strategy Equilibrium (DSE) outcome. A possible application of multi-stage PD would be climate change mitigation, or a setting in which pollution reduction by two countries benefits both their present and future generations, but is more costly if only one country makes the economic sacrifice of pollution reduction.

2. **The asymmetric PD game (PDA)** A much discussed issue associated with international climate change mitigation and with preserving the European monetary union is income and wealth inequality among countries. The PDA game may be used to model such inequality in a simple way.

3. **No Static Externality game (NSE).** Consider two countries investing in a technology that will potentially help future technological development. If only one invests, both countries will benefit in the future. If both invest, the new technology will be available in less time resulting in higher benefits for the future. Another example is two countries that ban the harvesting of a crossboundary species. One or both countries halting the species exploitation results in clear costs for the present and benefits for the future.

4. **Static Externality game (SE).** Suppose two countries consider reducing the use of polluting (but cheap) production processes. This is much more costly if only one country switches to a clean but expensive process, because they lose market share to the other country compared to when both or neither of them switch to a new process. If the effect of reduced pollution only appears in the distant future, then the clean production process only benefits the future, and at an uncertain cost.

5. **Coordination game (CO).** An example could be two countries choosing between the development of two competing technologies (one clean and one dirty) that could potentially help or hurt the future. Suppose that if two different technologies are developed, it undermines the countries' trade prospects with each other and results in lower payoffs for both. In this case both countries know that developing the clean technology is best for both, but it is riskier if each country is uncertain about the other country's choice.

Instructions

Introduction

Welcome and thank you for participating.

Do not communicate with the other participants except according to the specific rules of the experiment. If you have a question, feel free to raise your hand. I will come over to you and answer your question in private. Please turn off and put away all your electronic equipment.

You are about to participate in an experiment in the economics of decision making, in which you will earn money based on decisions you make. All earnings you make are yours to keep and will be paid to you IN CASH at the end of the experiment.
During the experiment all units of account will be in experimental dollars. Upon concluding the experiment the amount of experimental dollars you earn will be converted into dollars at the conversion rate of US $1.8 dollars per experimental dollar. Upon concluding the experiment you will be paid, in private, your earnings, plus $5 for showing up on time. The experiment will take up to 2 hours.

The experiment will consist of several parts, each of which will have several rounds. You will also be asked to complete a short exit questionnaire. You will receive further instructions before each part.

At the end of the experiment, one round of one of the parts will be randomly chosen for payment. All parts and all rounds are equally likely, so we suggest you pay attention to your decisions in all parts and rounds.

General Instructions

Groups. At the beginning of the experiment, each of you will be assigned to either the BLUE group or the GREEN group. All participants who sit on my left side will be in the BLUE group, and all participants who are on my right side will be in the GREEN group. Your group assignment will stay the same throughout the session.

Now, I would like to ask each group to stand up and move to two different parts of the room. Next, I would like each of you to share with your group the following information about yourself: your name and major, your favorite food, and your favorite way to spend your free time. You are welcome to discuss these topics, but please do not talk about any other topics. You will have 5 minutes for this discussion.

Consent forms. You have two consent forms in your folder. One is for you to keep (if you wish) and I will collect the other. Please read and sign a copy now.

Part 1.
Decisions. In this part, you will be asked to make decisions in a sequence of independent rounds. In each round, your decision screen will look like the figures below. If you are in the Green group, please refer to Figure 1G. If you are in the Blue group, please refer to Figure 1B.

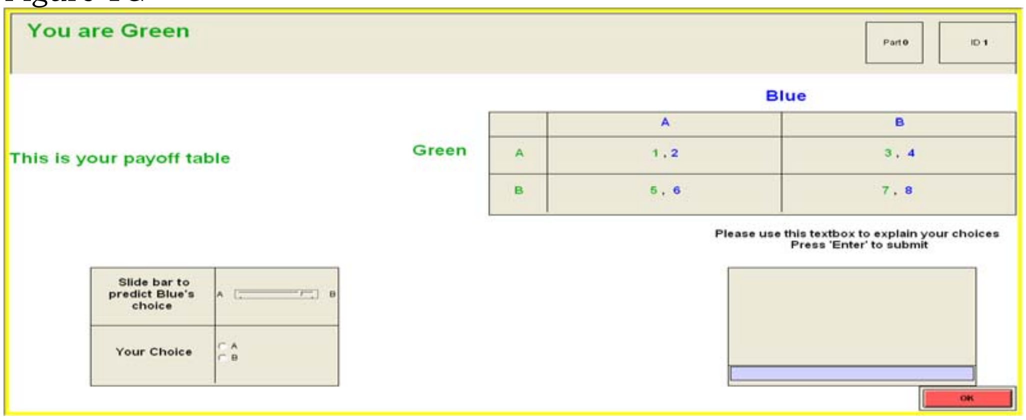
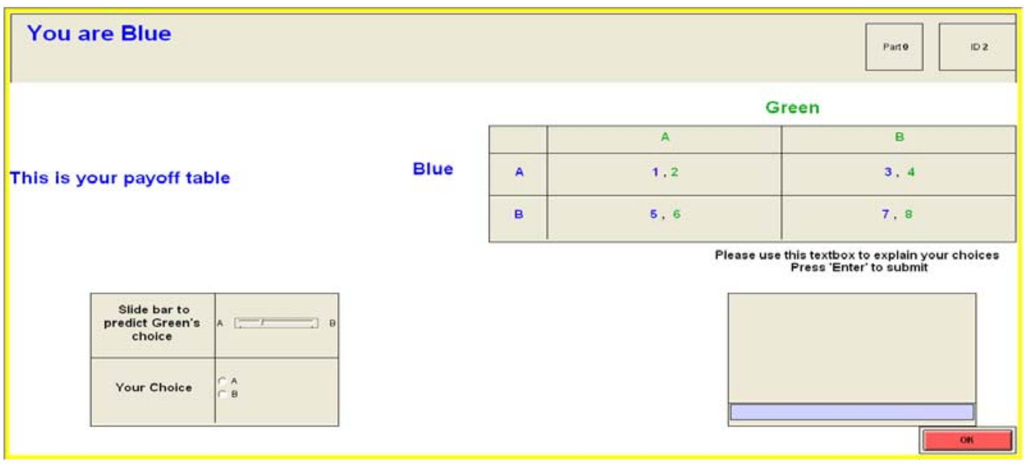
Figure 1G


Figure 1B



You will see several items on your screen. You will see a "payoff table" on top, a "decision box" on the bottom left, a "comment box" on the bottom right, as well as a red "OK" button.

Payoff table. Let us look at the payoff table first. This table shows how much you can earn based on your decisions. (The numbers in these tables are hypothetical and are only used to explain how to identify your payoffs. The tables in the actual experiment will be different.) There are two participants, Blue and Green. Both participants can choose A or B.

<u>Your payoff table will always display you as the row chooser</u>, and the other participant as the column chooser. Your and the other participant's payoffs are displayed in the cells corresponding to your and the other participant's choices, with <u>your payoff first, and the other's payoff second</u>.

Example for Green: Suppose, for example, that you are Green, and your payoff table is as given in Figure 1G above, then:

- If you choose A, and the other participant (Blue) also chooses A, then the payoffs will be the ones written in the upper left hand corner of the table: Here you (Green) will earn a payoff of 1 while the column chooser (Blue) will earn 2.
- If you choose B and Blue also chooses B, then the payoffs will be the ones written in the lower right hand corner of the table. Here you (Green) will earn 7 while the column chooser (Blue) will earn 8.
- If you choose A and Blue chooses B, then you earn 3 while Blue will earn 4.
- If If you choose B and Blue chooses A, then you earn 5 while Blue will earn 6.

Example for Blue: Now suppose that that you are Blue, and your payoff table is as given in Figure 1B above, then:

- If you choose A, and the other participant (Green) also chooses A, then the payoffs will be the ones written in the upper left hand corner of the table: Here you (Blue) will earn a payoff of 1 while the column chooser (Green) will earn 2.
- If you choose B and Green also chooses B, then the payoffs will be the ones written in the lower right hand corner of the table. Here you (Blue) will earn 7 while the column chooser (Green) will earn 8.
- If you choose A and Green chooses B, then you earn 3 while Green will earn 4.
- If If you choose B and Green chooses A, then you earn 5 while Green will earn 6.

ARE THERE ANY QUESTIONS?

Please complete the exercise, labeled "Tutorial 1", on your computer screen now. Your screen shows how your payoff table will look like in general. Please answer the questions on your screen regarding your payoff: enter numbers from your payoff table. When you have answered all questions, click the OK button, and wait for further instructions.
(Keep your cursor in the box when typing)

Instructions continued
Decisions and predictions. Your decision box is located in the bottom left portion of your screen, as Figures 1G and 1B show. Before you choose A and B, you will be asked to predict the choice of the other person you are matched with using a predictions sliding bar. Use the sliding bar to make a prediction about the the chance that the person you're matched with will choose A or B.

For example, suppose you think there is a 33.3% chance that the other person will choose A, and hence a 66.6% chance that B will be chosen. This indicates that you believe that A is twice less likely to be chosen than B, but that there is still a pretty good chance of A being chosen. If this is your belief about the likely choice of the person you are matched with, then slide the bar so that it is twice as close to B than to A. As another example, if you think there is an 80% chance that the person you are matched with will choose A and a 20% chance he or she will choose B, slide the bar so that it is about 4 times closer to A than to B.

In general, the higher your belief of the chance that the other person choses A relative to B, the closer you should slide the bar to A. If you believe that A and B are equally likely, slide the bar to the middle. If you believe that A will be chosen for sure, slide the bar all the way towards A. Likewise, if you believe that B will be chosen for sure, slide the bar all the way towards B.

At the end of the experiment, we will look at the choice actually made by the person you are matched with and compare his or her choice to your predictions. If this part and round is chosen for payment, your payment for prediction will be determined according to the following table:

Your prediction of other's choice	A for sure	90% chance A, 10% chance B	80% chance A, 20% chance B	70% chance A, 30% chance B	60% chance A, 40% chance B	50% chance A, 50% chance B	40% chance A, 60% chance B	30% chance A, 60% chance B	20% chance A, 80% chance B	10% chance A, 90% chance B	B for sure
Payoff if A	1	0.99	0.96	0.91	0.84	0.75	0.64	0.51	0.36	0.19	0
Payoff if B	0	0.19	0.36	0.51	0.64	0.75	0.84	0.91	0.96	0.99	1

In other words, we will give you a fixed amount of 1 experimental dollar from which we will subtract an amount which depends on how inaccurate your prediction was. Note that the worst you can do under this payoff scheme is to state that you believe that there is a 100% chance that a certain action is going to be taken when in fact the other choice is made. Here your payoff from the prediction would be 0. Similarly, the best you can do is to guess correctly and assign 100% to that choice which turns out to be the actual choice of the other person. Here your payoff will be 1.

However, since your prediction is made before you know what the other person will actually choose, the best thing you can do is to simply state your true beliefs about what you think the other person will do. Any other prediction will decrease the amount you can expect to earn as a prediction payoff. After you slide the bar to make your prediction, you will make your own decision to choose A or B.

ARE THERE ANY QUESTIONS?

Please practice making predictions using the slide bar, and making your decision, on your computer screen now. Make a predicition, and enter a choice. Feel free to practice, as this will not count towards your payment.

Instructions continued
Comment box. Your screen will also show a comment box in which you may explain your choice. Please remember to hit ENTER to submit your comment, otherwise it will not be saved. Your comment is private, and will not be seen by anyone else participating in the experiment. Please keep your comment short (one or two sentences).

The next screen on your computer shows how your comment box will looks like.

Practice entering a comment on your computer screen now. Type a few letters, and then press ENTER. You should see your text move up into the box. Please also look at the upper right corner of your screen, and write down your ID number. This number will be used for payment.

Instructions continued
This will continue for a number of rounds. In each round, you will be matched with a DIFFERENT person from the other group. You will not know the identity of the other person. You will not be informed about the other person's choice and about your payoff in this round until the end of the experiment.

Please pay attention to the payoff table in each round, as it will change every time. You will be asked to make a decision about your own choice and a prediction about the other person's choice in each round.

ARE THERE ANY QUESTIONS?

Part 2.

In Part 2, you will make decisions similar to those you made in Part 1, except for one difference. Your choices in this part will not only affect the payoff of you and your match, but also the payoff opportunities that will be given to <u>your "successor" in Part 3. Your successor in Part 3 will be another person from your group.</u>

If you are in the Green group, your decision screen will look like Figure 2G. If you are in the Blue group, your decision screen will look like Figure 2B.

Figure 2G

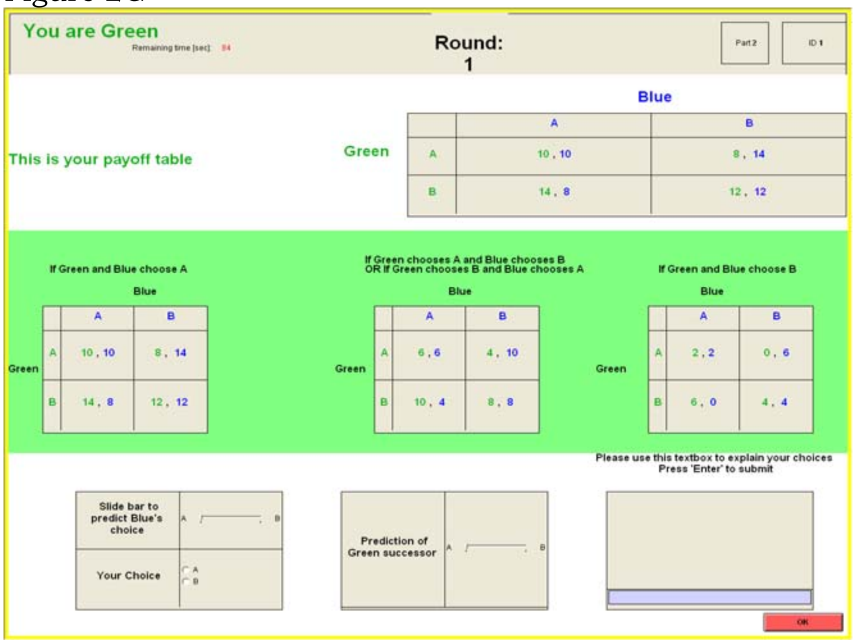
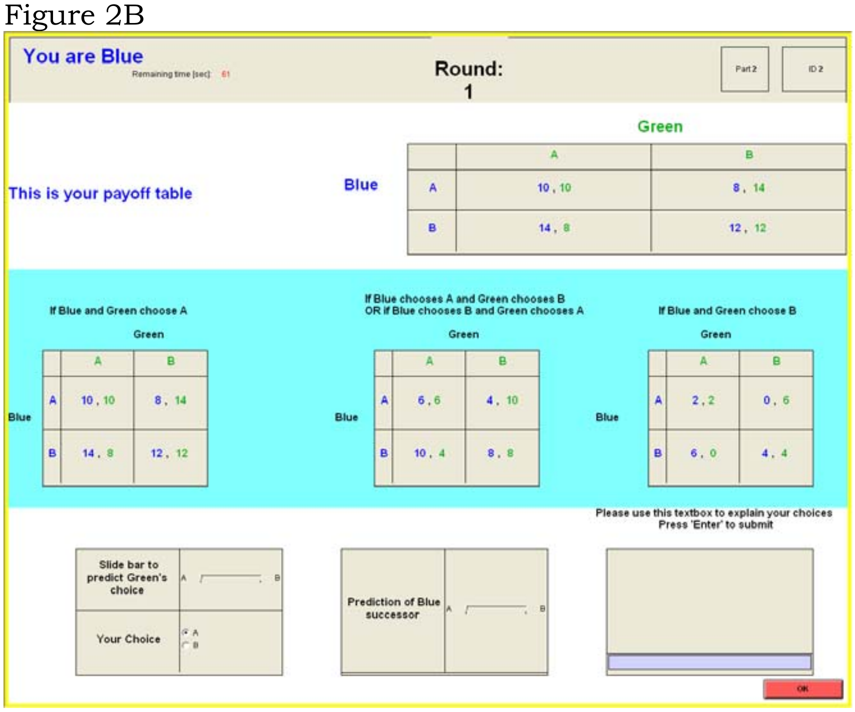


Figure 2B



As before, your own possible payoffs will be given by your payoff table, located in the upper right portion of your screen.

The possible payoff tables that your successor may face in Part 3 will be shown in the middle part of your screen. Your successor will be a person from your group matched with a participant from the other group, just like you. That is, if you are Blue, you will be matched with a Green person, and your successor will be matched with another Green person; and if you are Green, you will be matched with a Blue person, and your successor will be matched with another Blue person.

The values in the successors payoff table will depend on your decisions and decision of the other person you are matched with. Consider the following example.

- Suppose you are Green and you choose A, and the other person (Blue) also chooses A. Then your payoff will be 1, and the other person's payoff will be 2. Your successor in Part 3 will receive the first table in the middle part of the screen titled "If Blue and Green choose A".

- As another example, suppose you are Blue and you choose B. The other person (Green) chooses A. Then your payoff will be 6, and the other person's payoff will be 5. In Part 3, your successor will have the middle table as their payoff table (titled "If Blue chooses A and Green chooses B or if Blue chooses B and Green chooses A").

ARE THERE ANY QUESTIONS?

Please complete the exercises on your computer now (Tutorial 2). The questions on the bottom ask you to select which payoff table your successor will see in Part 3 if you and the other person choose as indicated.

Instructions continued

As in Part 1, you are asked to choose A or B and make a short comment on your choice. You are also asked to predict the choice of the other person you're matched with, and predict what your successor will choose. You will get the prediction payoffs as explained in part 1, depending on how correct each of your predictions are. You will not be informed about the decision of the person you are matched with, and about your payoff in this round, until the end of the experiment.

While some participant from your group will be your successor in Part 3, you will also be someone else's successor in Part 3. That is, you will encounter the payoff tables that resulted from this participant's and their match's decisions in Part 2. You will never get the payoff tables that resulted from your own decisions; that is, you will receive payoff tables that result from someone else's decisions in Part 2.

This will continue for a number of independent rounds. Please look at the payoff tables carefully before making your decisions. Your payoff tables and/or your successors' payoff tables will change in every round.
Remember that all parts are equally likely to chosen, and you will be paid based on one of the rounds in this chosen part.

ARE THERE ANY QUESTIONS?

Part 3.
In each round of Part 3, you will make decisions similar to those you made in Part 1, except for one difference. The payoff tables you will be given will be determined by the choices of your predecessor and their match from part 2. You will NEVER get the payoff tables that resulted from your own decisions; you will receive payoff tables that result from someone else's decisions in Part 2. On your screen you will see the payoff table and decisions made by your predecessor and their match from the other group that generated your payoff table.

If you are in the Green group, your decision screen will look as in Figure 3G. If you are in the Blue group, your decision screen will look as in Figure 3B.

Figure 3G

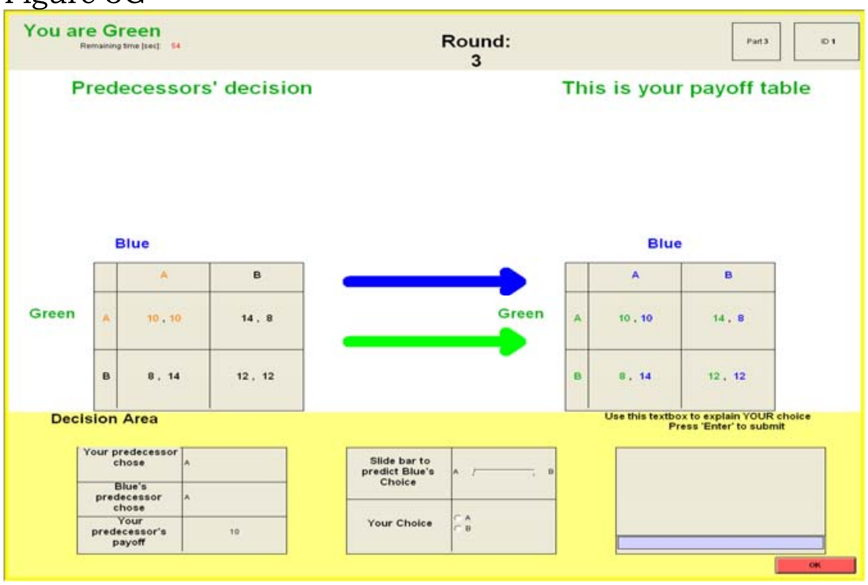
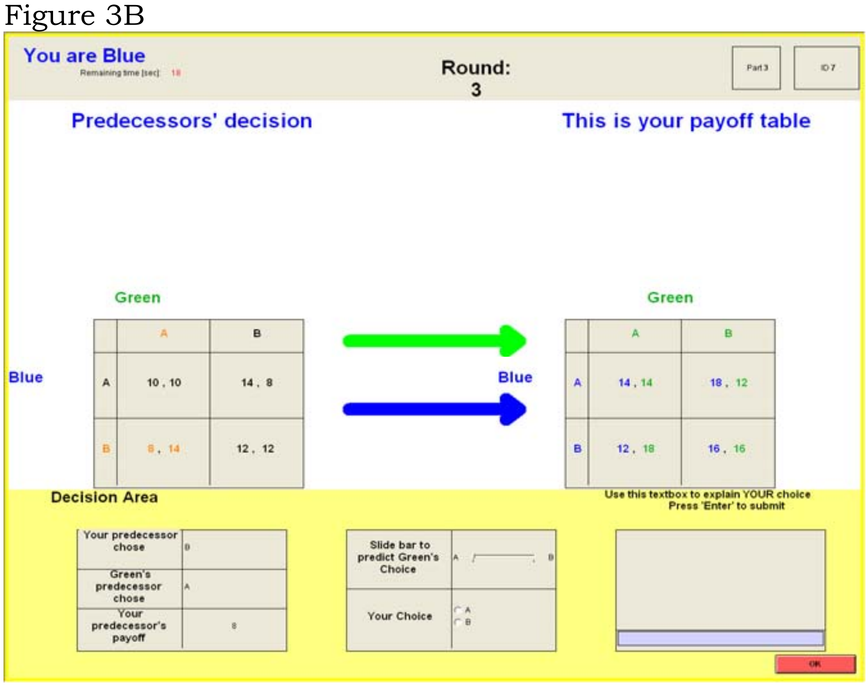


Figure 3B



On the left side of your screen will be the payoff table that your predecessor had in Part 2. The predecessors' decisions that resulted in your payoff table will be highlighted. Your payoff table is on the right part of your screen.

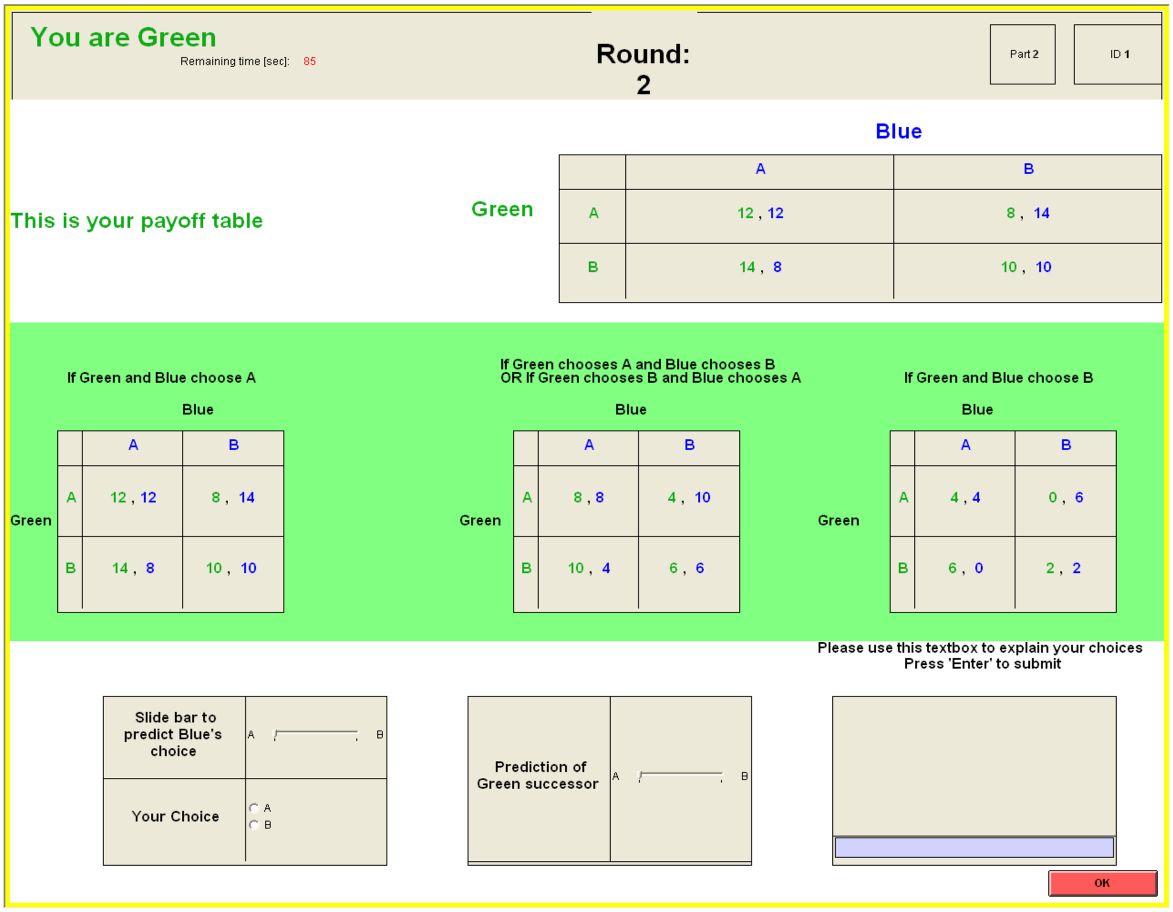
At the end of Part 3, you will be asked to fill out a questionnaire, and will receive payment.

Remember that all parts are equally likely to chosen, and you will be paid based on one of the rounds in this chosen part.

ARE THERE ANY QUESTIONS?

Figure 8: Sample screenshots for predecessor and follower stage games

Example screen for Part 2, Predecessor Game



Example screen for Part 3, Follower Game

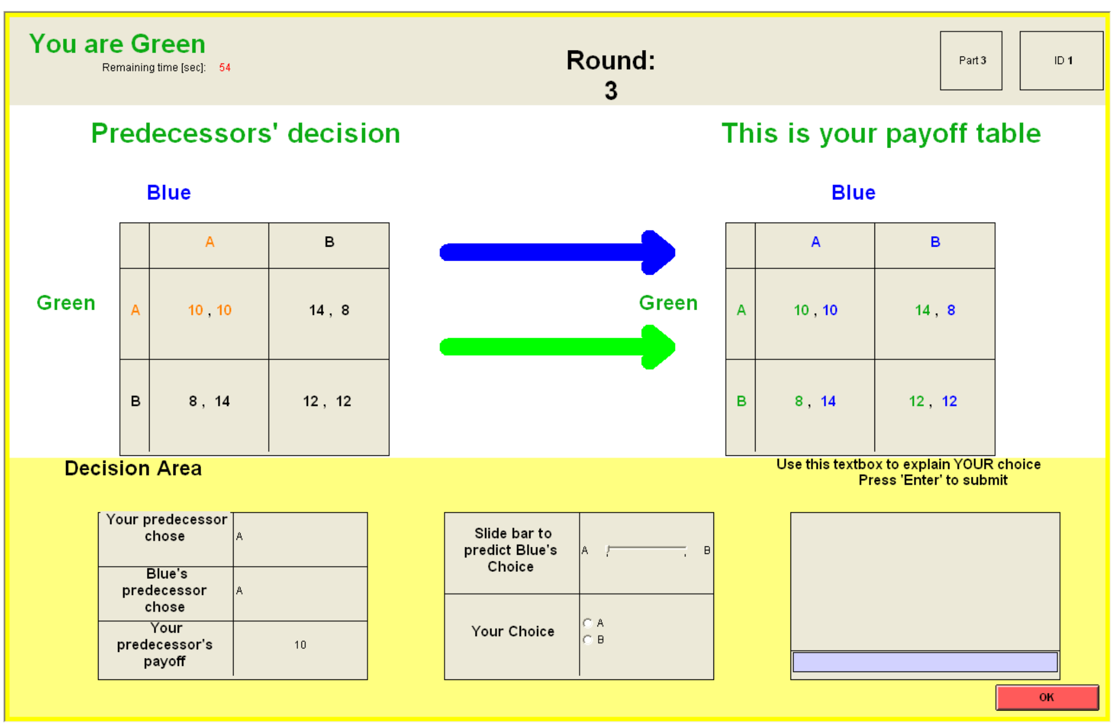


Figure 9: Survey Questions (screenshots)

Exit Questionnaire

(Scroll down for more questions)

If your opinion is not represented, please choose the option that is CLOSEST to your position.

1. Your age (enter a number):

2. Your major:

3. How many children do you have? (enter a number)

4. How many siblings do you have? (enter a number)

5. Which gender do you identify with?

6. Which region do you identify with in terms of your cultural identity?

- America
- Oceania
- Central Asia
- East Asia
- South Asia
- Other parts of Asia
- Africa
- Europe

7. Do you believe that people's lives are influenced by a higher being (such as a God)?
- Yes
- No

8. Do you believe that people's actions are judged by a higher being (such as a God)?
- Yes
- No

9. How often do you participate in organized religious activities?

- Never
- Less than 5 times a year
- About once a month or less
- About once a month or more
- Every week or more

Q1 Mean age: 26.93

Q3 Mean "any children": 15%

Q4 Mean siblings: 1.80

Q5 Male: 52% Female: 48%

Q6 (N=164)
Asia 66%
Africa 1%
Europe 2%
America 26%
Oceania 5%

Q7 yes: 64%

Q8 yes: 50%

Q9 (n=167)
1: 13%
2: 13%
3: 14%
4: 35%

10. On a scale 1 to 5, indicate which would you prefer:

- 1. Everybody should be provided with a minimum standard of living by better-off members of the society
- 2.
- 3.
- 4.
- 5. Everybody's standard of living should be determined by their effort and abilities

11. On a scale 1 to 5, indicate which would you prefer where 1 and 5 are options as shown:

- 1. Very low taxes, and very little support and services (such as health and education) provided by the government
- 2.
- 3.
- 4.
- 5. High taxes, with high support and services (such as health and education) provided by the government

12. Suppose parents and children have similar incomes, but may have different expenses. Which characterizes your opinion more:

- Parents should provide financial support for their adult children when they need it
- Adult children should never rely on their parents for financial support

13. Which characterizes your opinion more:

- Society should regulate scarce resources to ensure that there is enough for future generations.
- It is up to each person to conserve scarce resources to ensure that there is enough for future generations.
- I don't believe that we should conserve scarce resources for future generations, they will have enough resources and new technologies.
- None of the above.

14. On a scale of 1 to 5, indicate which characterizes your opinion more:

- 1. Everybody should be given equal chance to succeed. Those who don't succeed are only themselves to blame.
- 2.
- 3.
- 4.
- 5. Everybody should be given a chance for a good life. Those who are successful should help those who are not.

15. Which characterizes your opinion more:

- If I have a comfortable income, I save much of it for the future
- If I have a comfortable income, I spend all of it to enjoy the present
- If I have a comfortable income, I save a little for the future, and spend most of it to enjoy the present

16. Which characterizes your opinion more:

- In the next 50 years people will invent amazing new technologies that solve most of the problems we have today
- In the next 50 years people will improve existing technologies but won't experience drastically different lifestyles than ours
- In the next 50 years people will not be able to solve many of the problems we have today
- In the next 50 years people will experience more problems than we have today

Q10 1: 8%
2: 12%
3: 27%
4: 29%
5: 24%

Q11 1: 5%
2: 7%
3: 45%
4: 28%
5: 16%

Q12
1: 54% 2: 46%

Q13 1: 60%
2: 25%
3: 5%
4: 10%

Q14 1: 14%
2: 19%
3: 26%
4: 19%
5: 23%

Q15
1: 43% 2: 8% 3: 49%

Q16 1: 23%
2: 34%
3: 15%

17. Which characterizes you more:

- I'm willing to take significant risks in my personal life, finances and career
- I'm willing to take small calculated risks in my personal life, finances and career
- I do not like to take risks in my personal life, finances and career
- None of the above

18. Which characterizes your opinion on climate change more:

- If we don't make drastic changes, the world will be much worse for future generations.
- If we don't make some gradual changes, the world will be worse for future generations.
- We do not need to make changes, future generations will not be worse off than we are.
- Whether we make changes or not, it will not affect future generations. That is, we cannot affect the natural climate change process.
- Whether we make changes or not, it will not affect future generations. That is, I believe our climate is not changing.

19. Which characterizes your opinion more:

- Generally, most people are trustworthy
- Generally, most people cannot be trusted

20. During Part 2 of this experiment, how did you make your decision generally?

- My goal was to get the highest payoff for myself
- My goal was to get the highest payoff for myself, considering what I thought the other person will do
- My goal was to get the highest payoff table for the followers
- My goal was to keep a balance between a good payoff for me, and a good payoff table for the followers
- My goal was to avoid getting the lowest payoff, because I didn't know what the other person would do
- None of the above

21. Have you ever studied game theory as part of a university-level class:
- Yes
- No

22. Have you ever studied enviromental issues as part of a university-level class:
- Yes
- No

23. How many people did you personally know in your group? (Enter a number)

24. How many people did you personally know in the other group? (Enter a number)

25. Please indicate you current level of education
- Freshman
- Sophomore
- Junior
- Senior
- Graduate Student

26. If you would like to be notified of future economics experiments on campus, please enter your email address. (Your email will be stored separately from your survey responses and your experiment results).

Q17
1: 21% 2: 61%
3: 11% 4: 7%

Q18
1: 36%
2: 45%
3: 7%
4: 10%
5: 1%

Q19
trusting: 64% not trusting: 36 %

Q20
1: 19%
2: 31%
3: 6%
4: 35%
5: 4%
6: 5%

Q21 Yes: 30%

Q22 Yes: 51%

Q23 Mean: 0.90

Q24 Mean: 0.72

exit questionnaire jan26

- Adresse
- Exit Questionnaire: Exit Questionnaire(Scroll down for more questions)If your opinion is not represented, please choose the option that is
  - 1. Your age (enter a number):: IN(age)
  - 2. Your major: : IN(major)
  - 3. How many children do you have? (enter a number): IN(children)
  - 4. How many siblings do you have? (enter a number): IN(siblings)
  - 5. Which gender do you identify with?: IN(gender)
  - 6. Which region do you identify with in terms of your cultural identity?: IN(culture)
  - 7. Do you believe that people's lives are influenced by a higher being (such as a God)?: IN(godinfluence)
  - 8. Do you believe that people's actions are judged by a higher being (such as a God)?: IN(godjudge)
  - 9. How often do you participate in organized religious activities?: IN(church)
  - 10. On a scale 1 to 5, indicate which would you prefer:: IN(standardofliving)
  - 11. On a scale 1 to 5, indicate which would you prefer where 1 and 5 are options as shown: : IN(taxes)
  - 12. Suppose parents and children have similar incomes, but may have different expenses. Which characterizes your opinion more:: IN(
  - 13. Which characterizes your opinion more:: IN(resources)
  - 14. On a scale of 1 to 5, indicate which characterizes your opinion more:: IN(success)
  - 15. Which characterizes your opinion more:: IN(saving)
  - 16. Which characterizes your opinion more:: IN(technology)
  - 17. Which characterizes you more:: IN(risk)
  - 18. Which characterizes your opinion on climate change more:: IN(climate)
  - 19. Which characterizes your opinion more:: IN(trust)
  - 20. During Part 2 of this experiment, how did you make your decision generally?: IN(reason)
  - 21. Have you ever studied game theory as part of a university-level class:: IN(gametheory)
  - 22. Have you ever studied enviromental issues as part of a university-level class:: IN(climatechange)
  - 23. How many people did you personally know in your group? (Enter a number): IN(knowgroup)
  - 24. How many people did you personally know in the other group? (Enter a number): IN(knowothergroup)
  - 25. Please indicate you current level of education: IN(educ)
  - 26. If you would like to be notified of future economics experiments on campus, please enter your email address. (Your email will be s
  - Finish
- End: Thank you for your participation

Table 8: Increase in helping action ("A" in A-helps, "B" in B-helps treatments) from One-Shot Games (Part 1) to Predecessor Games (Part 2), in percentage points

	positive externality		negative externality	
	A-helps	B-helps	A-helps	B-helps
PD	0%	8%	15%	13%
PDU	0%	0%	-2%	8%
PDA	-3%	4%	2%	8%
NS	5%	0%	7%	17%
SE	7%	-8%	15%	0%
CO	2%	25%	3%	29%

Table 9: Frequency of choice-prediction pairs by predecessors, by treatment

All games		A helps	B helps		p-value
	mostly chose B, predicted B	22%	58%	***	0.000
	mostly chose A, predicted A	18%	10%		0.346
	Other	61%	31%		

Note: "mostly" means chosen 4 or more times out of 6

By game		A helps	B helps		p-value
PD	Chose B, predicted B	29%	56%	***	0.001
	Chose A, predicted A	34%	13%	***	0.004
	Other	36%	31%		
	total predicted A	*45%*	*19%*		
	total predicted B	*42%*	*67%*		
PDU	Chose B, predicted B	33%	46%		0.114
	Chose A, predicted A	27%	23%		0.596
	Other	40%	31%		
	total predicted A	41%	27%		
	total predicted B	41%	52%		
PDA	Chose B, predicted B	34%	54%	**	0.014
	Chose A, predicted A	27%	25%		0.802
	Other	39%	21%		
	total predicted A	37%	29%		
	total predicted B	48%	60%		
NSE	Chose B, predicted B	52%	83%	***	0.000
	Chose A, predicted A	11%	2%	*	0.063
	Other	35%	15%		
	total predicted A	*24%*	*2%*		
	total predicted B	*61%*	*90%*		
SE	Chose B, predicted B	46%	73%	***	0.002
	Chose A, predicted A	10%	13%		0.650
	Other	44%	15%		
	total predicted A	*24%*	*15%*		
	total predicted B	*55%*	*77%*		
CO	Chose B, predicted B	16%	35%	***	0.006
	Chose A, predicted A	56%	40%	*	0.051
	Other	28%	25%		
	total predicted A	*61%*	*42%*		
	total predicted B	*25%*	*40%*		

Note: stars and p-values show significance level of Wilcoxon-Mann-Whitney two-sample statistic of the difference of choice-prediction pairs between treatments.

Table 10: Follower decisions (part 3)

Influence of own group predecessor

		Pooled			A helps treatments			B helps treatments		
		N	Mean A	diff> 0*	N	Mean A	diff>0*	N	Mean A	diff>0*
All Games	own predecessor chose A	464	0.407		313	0.444		151	0.331	
	own predecessor chose B	538	0.303	0.000	401	0.312	0.000	137	0.277	0.162
PD	own predecessor chose A	84	0.488		57	0.491		27	0.481	
	own predecessor chose B	83	0.217	0.000	62	0.210	0.001	21	0.238	0.044
PDU	own predecessor chose A	74	0.419		44	0.500		30	0.300	
	own predecessor chose B	93	0.398	0.392	75	0.400	0.146	18	0.389	0.731
PDA	own predecessor chose A	80	0.388		53	0.472		27	0.222	
	own predecessor chose B	87	0.356	0.340	66	0.348	0.088	21	0.381	0.881
NS	own predecessor chose A	61	0.164		42	0.238		19	0.000	
	own predecessor chose B	106	0.123	0.230	77	0.117	0.043	29	0.138	0.953
SE	own predecessor chose A	71	0.169		21	0.143		50	0.180	
	own predecessor chose B	96	0.208	0.737	27	0.185	0.648	69	0.217	0.690
CO	own predecessor chose A	94	0.681		67	0.672		27	0.704	
	own predecessor chose B	73	0.603	0.149	52	0.673	0.507	21	0.429	0.028

Influence of other group predecessor

		Pooled			A helps treatments			B helps treatments		
		N	Mean A	diff<0*	N	Mean	diff<0*	N	Mean	diff<0*
All Games	other predecessor chose A	467	0.259		316	0.288		151	0.199	
	other predecessor chose B	535	0.432	0.000	398	0.435	0.000	137	0.423	0.000
PD	other predecessor chose A	84	0.262		60	0.283		24	0.208	
	other predecessor chose B	83	0.446	0.006	59	0.407	0.080	24	0.542	0.008
PDU	other predecessor chose A	76	0.263		46	0.326		30	0.167	
	other predecessor chose B	91	0.527	0.000	73	0.507	0.027	18	0.611	0.001
PDA	other predecessor chose A	82	0.207		54	0.259		28	0.107	
	other predecessor chose B	85	0.529	0.000	65	0.523	0.002	20	0.550	0.000
NS	other predecessor chose A	61	0.066		42	0.071		19	0.053	
	other predecessor chose B	106	0.179	0.020	77	0.208	0.027	29	0.103	0.272
SE	other predecessor chose A	70	0.057		20	0.050		50	0.060	
	other predecessor chose B	97	0.289	0.000	28	0.250	0.035	69	0.304	0.000
CO	other predecessor chose A	94	0.574		64	0.609		30	0.500	
	other predecessor chose B	73	0.740	0.013	55	0.745	0.058	18	0.722	0.068

"Mean A" shows the frequency of A-choice

* p-values, one-sided (identical results for WMW and t-tests)