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Abstract

Sequentiality of moves in an infinitely repeated prisoner's dilemma does not change the conditions under which mutual cooperation can be supported in equilibrium as compared to simultaneous decision-making. The nature of the interaction is different, however, given that the second mover in a sequential-move game does not face strategic uncertainty in the stage game. We study in an experiment whether sequentiality has an effect on cooperation rates. We find that with intermediate incentives to cooperate, sequentiality increases cooperation rates by around 40 percentage points after learning, whereas with very low or high incentives to cooperate, cooperation rates are respectively very low or high in both settings.

Keywords: cooperation, infinitely repeated game, sequential prisoner's dilemma, strategic uncertainty, experiment

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1 Introduction

The prisoner's dilemma (PD) is the simplest game that captures the tension between opportunism and cooperation, a tension which is prevalent in many interactions. Folk theorems show that both opportunism and equilibria with cooperative outcomes can be sustained when the interaction is repeated and decision-makers are sufficiently patient (Fudenberg and Maskin, 1986). The lack of clear theoretical predictions has spurred researchers to design laboratory experiments that help to identify conditions under which cooperation arises (see Dal Bó and Fréchette, 2018, for a survey). The majority of these experiments focus on decision-makers who make their choices simultaneously. However, in many cases the choice of the partner is observed before one makes her own choice, and payoffs are realized after both have made a choice. Think for example of employer-employee relations (Akerlof, 1982; Fehr, Kirchsteiger, and Riedl, 1993), trade relations (Greif, 1993, 1994; Brown, Falk, and Fehr, 2004), and trust relations (Kreps, 1990), or of entrant-incumbent interactions (Selten, 1978). Therefore, a crucial question is whether and how sequentiality of moves influences outcomes. Moreover, from the perspective of a (behavioral) mechanism designer, whose goal is to stimulate cooperation, it is important to know whether simultaneity or sequentiality of moves is more conducive to cooperation. This paper studies behavior in repeated sequential PDs.

According to the theory of infinitely repeated games mutual cooperation can be supported in equilibrium under the exact same condition in sequential-move PDs as in simultaneous-move PDs: the decision-makers' discount factor should be above a threshold that depends on the parameters of the game.[1] As far as standard theory is concerned, there are thus no clear reasons why one would expect different mutual cooperation rates in the two settings. Yet, the strategic environment is very different in sequential than in simultaneous relationships: the second mover in a sequential PD faces no strategic uncertainty in the stage game, unlike decision-makers in a simultaneous PD. In particular, a second mover who intends to cooperate can avoid suffering the low sucker payoff by cooperating in the stage game conditional on the first mover

[1] This builds upon the use of the grim trigger strategy as a cooperative strategy (Friedman, 1971). Given that the grim trigger strategy leads to minimax payoffs (equal to static Nash payoffs) independent of sequentiality, it is the worst possible punishment strategy in both settings (Fudenberg and Maskin, 1986). See Wen (2002) for an extension of the folk theorem result to sequential games.

cooperating. If the first mover understands this, he is also exposed to less strategic uncertainty than a player in a simultaneous PD. This may have important implications for equilibrium selection in the repeated game. Intuitively, the lower extent of strategic uncertainty in sequential-move settings may make it more likely that a cooperative equilibrium is selected than in a simultaneous-move setting.

Strategic uncertainty has been highlighted as an important determinant of behavior even within the class of repeated simultaneous PDs (Dal Bó and Fréchette, 2018). In PDs with a relatively low sucker payoff more money is lost if one cooperates with someone who defects than in other PDs, and this risk influences behavior. The role of strategic uncertainty has been formalized using two different approaches. Both approaches simplify the repeated PD to a game with two strategies: "always defect" (AD) and a conditionally cooperative strategy such as for instance grim trigger (GT). Conditions are identified under which players are more likely to use GT given that it is supported as an equilibrium strategy, which helps to predict whether players end up in a defective or cooperative equilibrium. The first approach, due to Blonski, Ockenfels, and Spagnolo (2011), applies the concept of risk dominance to the two-strategy version of the repeated game (see also Blonski and Spagnolo, 2015). The bottom line is that cooperation is more likely, the closer GT is to being risk dominant. The second approach, due to Dal Bó and Fréchette (2011), refers to the size of the "basin of attraction" of the strategies: cooperation is more likely if the set of beliefs that makes AD optimal is smaller, that is, if the maximal probability of a matched player using GT that makes AD optimal is lower.

The two approaches also help to formalize the above-mentioned intuition that sequentiality of moves may make it more likely that players end up in a cooperative equilibrium. Since the second mover can condition her choice on that of the first mover, and can thus avoid getting the sucker payoff, she is not confronted with strategic uncertainty in the stage game. Neither is the first mover under the assumption of common knowledge. The implication is that both approaches provide a bang-bang prediction for sequential PDs: second movers are predicted to conditionally cooperate and first movers are predicted to cooperate whenever second movers have an incentive to conditionally cooperate, that is if the discount factor is above the threshold of the standard theory of infinitely repeated games.[2] This is in contrast to the case of simultaneous decision-making where the approaches predict a smooth relation between the game's parameters and the likelihood of cooperation, provided that mutual cooperation is an equilibrium outcome (see Dal Bó and Fréchette, 2018, for an extensive discussion). In summary, the expectation is that provided that mutual cooperation is supported in equilibrium the cooperation rate in sequential PDs is higher than in simultaneous PDs, in particular if the parameters of the game are such that incentives to cooperate are not too high.

In our experiment participants play 50 supergames of an indefinitely repeated sequential or simultaneous PD with the same payoffs and continuation probabilities as those in the simultaneous PDs of Dal Bó and Fréchette (2011). In each round the supergame proceeds to a next round with a constant probability δ known to the participants.[3] The experiment includes variations in δ and in the mutual cooperation payoff; in one parametrization the continuation probability is below the threshold of the standard theory of infinitely repeated games and in five parametrizations it is above the threshold. We formulate predictions taking into account strategic uncertainty. In the first treatment, where cooperation cannot be sustained in equilibrium, no difference is predicted between the sequential and simultaneous settings. In the latter five treatments the above-described approaches predict (weakly) higher rates of (mutual) cooperation in the sequential version than in the simultaneous version. Moreover, the difference in cooperation between the sequential and simultaneous PD is predicted to be higher, the larger the set of beliefs about the strategy of the partner that can rationalize the strategy that subscribes to always defect in the simultaneous PD (that is, the larger the basin of attraction of "always defect" in the latter game). Thus the expected effect of sequentiality is highest in the games with intermediate cooperation incentives, and not much of an effect is expected in the games with the highest incentives to cooperate.

[2]The prediction is reminiscent to a case discussed by Camera, Casari, and Bigoni (2013) in relation to a game where strangers decide whether to help one another in exchange for fiat money. In this case, the only two stable population configurations are a population full of defectors and a population full of conditional cooperators (traders), with basins of attraction depending on the parameters of the game.

[3]Building upon the assumption that participants do not discount the future in the short period of time they are in the lab, δ has the same role as that of the rate at which a risk-neutral player discounts the future in an infinitely repeated game (Roth and Murnighan, 1978).

The experimental data show that treatment effects are overall well in line with the predictions put forward. In general, sequentiality increases the cooperation rate and the use of cooperative strategies. More precisely, in the treatment where mutual cooperation is not sustainable in equilibrium, the cooperation rate is at a similar level in the sequential-move and simultaneous-move games, whereas in the treatments where mutual cooperation is an equilibrium outcome the cooperation rate in the sequential PDs is overall at a similar or higher level than in the corresponding simultaneous PDs. In particular, in the treatments with intermediate incentives to cooperate, where the difference is predicted to be largest, the cooperation rates in the sequential setting are substantially higher than these in the simultaneous setting, particularly after learning; the cooperation rate in these treatments is around 40 percentage points higher with sequential moves after learning. In the treatments with the highest incentives to cooperate, cooperation rates are high in both settings and do not differ significantly. Some behavioral patterns are not in line with the predictions and in section 5 we show that the "anomalies" can be rationalized, for example, by appealing to social preferences.

There are other experimental studies that have compared sequential moves to simultaneous moves in repeated dilemma games. An early contribution is Oskamp (1974), comparing repeated sequential- and simultaneous-move PDs with different payoff *levels* but otherwise the same repeated-game incentives.[4] The study finds evidence for an interaction between sequentiality of moves and level of payoffs in the game: in the sequential-move games cooperation rates tend to be less responsive to a change in the payoff level than in the simultaneous-move games. Furthermore, there is a literature on leading-by-example where a leader is modeled as the first mover in a voluntary contributions setting. In this literature (exogenously imposed) sequentiality of moves increases contributions compared to a simultaneous-move setting if the leader has private information about the parameters of the game (Potters, Sefton, and Vesterlund, 2005) but leads to mixed results in full information settings (for example Andreoni et al., 2002; Güth et al., 2007).[5] Finally, inspired by a model with hetero-

[4] In the experiments the repeated game was announced to last for 60 rounds but ended after 50 rounds to avoid end-game effects.

[5] See also Clark and Sefton (2001), who study the effect of stakes and subject pool on the cooperation rate in one-shot sequential PDs, Engle-Warnick and Slonim (2006), who study behavior in infinitely repeated trust games, and Reuben and Suetens (2012), who elicit stage-game strategies of players in in-

geneous types and private information, Kartal and Müller (2018) also compare indefinitely repeated sequential- and simultaneous-move PDs but only focus on the case where cooperation cannot be sustained in equilibrium. We discuss the paper in more detail in the final paragraph of section 5.

The remainder of our paper is organized as follows. Section 2 describes the experimental design and procedures. Section 3 includes theoretical predictions related to the effect of sequentiality of moves on cooperation. Section 4 presents the main results, with a focus on the treatment effect of sequentiality and behavior of first and second movers in the sequential games. Section 5 explores the main behavioral "anomalies" and provides a rationalization. Section 6 reports the results from estimations of repeated-game strategies based on the experimental data. Section 7 summarizes and draws some implications of our findings.

2 The experiment

Participants in the experiment played 50 supergames, each corresponding to a repeated PD game. The number of repetitions within a supergame (referred to as rounds) was stochastic and *ex ante* unknown to the participants and the experimenter. In each round, the probability that the supergame proceeded to a next round was δ, and this was known to the participants. At the beginning of each supergame, participants were randomly divided in pairs within matching groups of ten. They remained matched with the same counterpart for all rounds of a supergame. In the sequential PDs, participants were also randomly allocated the role of first or second mover at the beginning of each supergame. We expected that letting participants play in both roles would facilitate understanding of the strategic nature of the game.[6] The software had a built-in history box that participants could use to review all previous actions in the current supergame.

We used the same parameters that have been used in the simultaneous PD experi-

finitely repeated sequential PDs where players can condition their strategy on whether they are playing the last round or not.

[6]Reassigning roles at the beginning of each supergame also ensured that contagion effects à la Kandori (1992) were constant across simultaneous and sequential treatments. If the participants' roles in the sequential games would have been fixed, the total number of possible pairs in a matching group would have been lower than that under simultaneous moves (participants in the same role can never meet).

Table 1: The treatments

	Sim						Seq						Total
	$\delta = 0.5$			$\delta = 0.75$			$\delta = 0.5$			$\delta = 0.75$			
c	32	40	48	32	40	48	32	40	48	32	40	48	
# Participants	30	30	30	30	30	30	60	60	60	60	60	60	540
# Matching groups	3	3	3	3	3	3	6	6	6	6	6	6	54
# Supergames	50	50	50	50	50	50	50	50	50	50	50	50	600
Avg. length supergame	3.1	2.9	2.9	7.1	7.3	7.3	2.9	2.9	2.9	7.7	7.7	5.4	–

Notes: Sessions were conducted with 40, 50, or 60 participants and treatments were distributed across several sessions. Apart from one exception, matching groups in a session faced the same δ and the same style of decision-making but a different c.

ment by Dal Bó and Fréchette (2011) (henceforth, DBF). The mutual defection payoff is $d = 25$, the temptation payoff is $t = 50$, and the sucker payoff is $s = 12$, and there is treatment variation in both continuation probability ($\delta = 0.5$ or $\delta = 0.75$) and mutual cooperation payoff ($c = 32$, $c = 40$ or $c = 48$). These parameters cover a wide range of settings ranging to (in expectation) short games with low gains to mutual cooperation to longer games with high gains to mutual cooperation. Table 1 gives an overview of the treatments in our experiment, where Sim and Seq refer to the treatments with respectively simultaneous and sequential moves.[7] The experiment was programmed with zTree (Fischbacher, 2007) and conducted at the LINEEX lab in Valencia between July 2017 and April 2018. Sessions lasted on average 106 minutes and participants earned on average €22.7. Details on the procedures are in section A of the Supplementary Material (SM), and an English translation of the instructions can be found in section B of the SM.[8]

3 Predictions

Based upon the assumption that the payoffs in the PD represent utilities and that there is common knowledge thereof, in the standard theory of infinitely repeated games it

[7] Given that data on simultaneous-move games are already available in DBF, we ran fewer treatments with simultaneous PDs than with sequential PDs. Merging our data from the simultaneous-moves games with the data from DBF leaves us with the same qualitative conclusions regarding the effect of sequentiality on cooperation. We report these analyses in the Supplementary Material.

[8] We also ran treatments where the strategy method was used to elicit choices of second movers. These data will be analyzed in a separate paper.

holds that mutual cooperation in a simultaneous PD can be supported as an equilibrium outcome if $\delta \geq \delta^* \equiv \dfrac{t-c}{t-d}$ (see proposition 4 in Friedman, 1971). In particular, both players playing GT constitutes an equilibrium, where GT is defined as follows: start by cooperating and continue to do so if both players cooperate, and if one of the players defects, switch to defection forever after. For the sequential PD, the theory predicts that mutual cooperation can be supported in equilibrium under the same condition as in the simultaneous PD, that is, if $\delta \geq \delta^*$. Likewise, GT leads to the harshest possible punishment and both players using a GT strategy constitutes an equilibrium (see section C.1 of the SM for calculations).[9] In summary, standard theory does not provide a specific reason why cooperation rates should be different in sequential PDs than in simultaneous PDs; if $\delta < \delta^*$ the only equilibrium is one where both players defect and if $\delta \geq \delta^*$ mutual cooperation is sustainable and cooperative and non-cooperative equilibria exist in both cases.

By appealing to risk dominance (Blonski, Ockenfels, and Spagnolo, 2011) or to the basin of attraction of repeated-game strategies (Dal Bó and Fréchette, 2011) more precise predictions can be obtained that help to select among a cooperative and a non-cooperative equilibrium. The key is that the cost of cooperating with a partner who defects enters as a determinant of behavior, which is relevant given that players do not know with certainty whether their partner will defect or not. To focus, consider a simplification of the repeated game to a game where players choose AD or a conditionally cooperative strategy (CC) à la GT at the beginning of the repeated game. Notice that allowing for tit-for-tat (TFT) or other conditionally cooperative strategies with limited punishment in addition to or instead of GT leads to the same predictions since players are assumed to choose their strategy at the beginning of the repeated game. The basin of attraction of AD versus CC (referred to as SizeBAD) is defined as the maximum probability of the partner following the CC strategy that makes AD optimal. It refers to the set of beliefs about the strategy of the partner that makes AD optimal. To predict behavior in sequential PDs, and how it possibly differs from that in the simul-

[9]Since a second mover's choice in the stage-game is preceded by the matched first mover's choice so that a second mover never "starts", the implementation of GT is as follows: cooperate if the first mover cooperates and if one cooperated oneself on the previous move, and switch to defection forever after a defection of one of the two players.

taneous PDs, SizeBAD turns out to be highly useful. In what follows, we explain the intuition and use it to formulate predictions on how sequentiality of moves influences cooperation rates. Details on calculations are in section C.2 of the SM.

Consider first the simultaneous PDs. In the treatments with $\delta > \delta^*$, the reduced game in which players choose between AD and CC is in fact a stag-hunt game. This game has two pure strategy equilibria: the "bad" equilibrium (AD, AD) and the "good" equilibrium (CC, CC). Players are more likely to choose CC, and thus more likely to end up in (CC, CC), if the expected payoff of CC exceeds that of AD. This holds true if they believe that their partner will choose CC with sufficiently high probability. The threshold belief above which the expected payoff of CC exceeds that of AD depends on the game's parameters: the expected payoff of CC increases (so SizeBAD decreases) as c increases or as δ increases. The prediction is thus that participants are more likely to cooperate, the higher c or the higher δ. A repeated sequential PD where $\delta > \delta^*$, in contrast, does not become a stag-hunt game in its reduced form. In the reduced form, the expected payoff of CC for the second mover is (weakly) larger than that of AD for all possible beliefs about the strategy of the first mover, making CC a (weakly) dominant strategy. This is because a second mover who uses CC avoids obtaining the sucker payoff by cooperating *if and only if* the first mover cooperates within the round. She therefore uses the CC strategy if the discounted payoff of CC is higher than that of AD, namely if $\delta > \delta^*$, and plays AD otherwise. The first mover is not confronted with strategic uncertainty either because he anticipates that the second mover will conditionally cooperate (recall the assumption that the PD's payoffs represent the utilities of the players and there is common knowledge thereof). Therefore, and given that he cannot obtain the temptation payoff, the first mover imitates the strategy of the second mover and also plays CC if $\delta > \delta^*$ and AD if $\delta < \delta^*$.

In summary, the basin of attraction approach gives the same prediction for a sequential PD as for a simultaneous PD with the same parameters if $\delta < \delta^*$, i.e. everyone plays AD for any belief about the strategy of the opponent. Instead, if $\delta > \delta^*$, the approach predicts that players in sequential PDs should play CC for any belief, while in the simultaneous PDs players with pessimistic beliefs still find it optimal to play AD. The values of SizeBAD for the simultaneous and sequential PDs are reported in Table 2. The implication for the expected comparative statics in our experiment is that after learning (a) in both games the cooperation rate is expected to be close to zero if $\delta < \delta^*$

Table 2: SizeBAD by treatment

(a) Sim

		c		
		32	40	48
δ	0.5	-	0.72	0.38
	0.75	0.81	0.27	0.16

(b) Seq

		c		
		32	40	48
δ	0.5	-	0	0
	0.75	0	0	0

Notes: The table indicates the basin of attraction of AD (SizeBAD) in the different treatments. SizeBAD is defined as the maximum probability of the partner following a CC strategy that makes AD optimal.

(in treatment $c = 32, \delta = 0.5$), (b) in both games the cooperation rate is expected to be close to 100% if $\delta > \delta^*$ and the SizeBAD in the simultaneous PD is very low (in treatment $c = 48, \delta = 0.75$), and (c) the cooperation rate in sequential PDs is expected to be higher than that in the simultaneous PDs if $\delta > \delta^*$ and the SizeBAD in the simultaneous PDs is intermediate (in the other treatments).[10]

4 Main results

4.1 Effect of sequentiality on cooperation rates

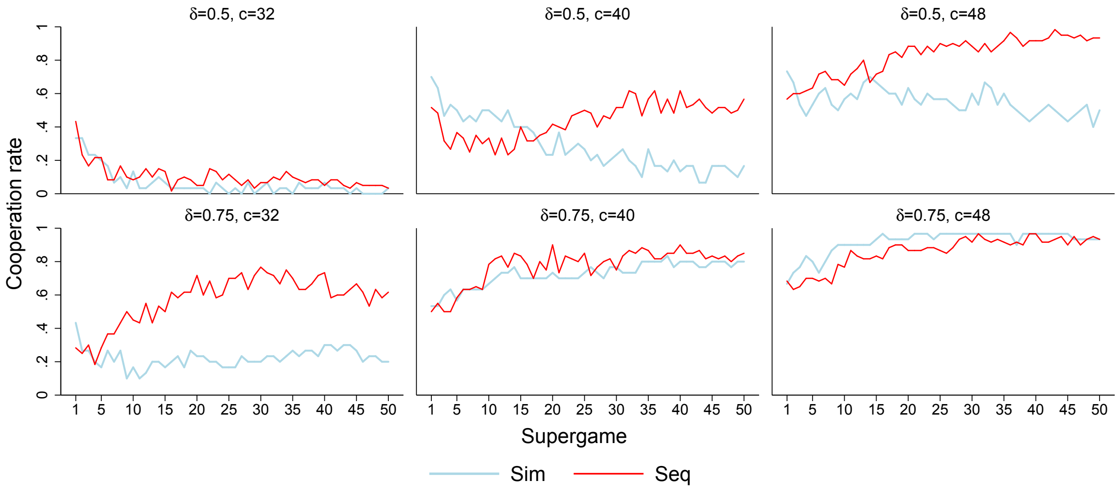
This section focuses on treatment effects of sequentiality on cooperation rates. Figure 1 illustrates for each treatment how aggregate cooperation rates evolve across the fifty supergames.[11] The upper panel shows cooperation rates in the first rounds only and the lower panel shows cooperation rates across all rounds. We report cooperation rates based on first-round decisions separately because supergames may have different lengths, and cooperation rates may depend on histories within these supergames. Moreover, first-round decisions are more appropriate to test our hypotheses, since the basin of attraction approach concerns the decision to adopt a cooperative or non-cooperative strategy at the beginning of the supergame. Unless otherwise mentioned the statistics reported in this section and section 4.2 are based on pairwise treatment comparisons using probit regressions. The regressions take the choice to cooperate as a dependent variable and include a treatment dummy as an independent variable, and

[10]The measure proposed by Blonski, Ockenfels, and Spagnolo (2011) leads to the same comparative static predictions across the different simultaneous PDs and between simultaneous and sequential PDs.

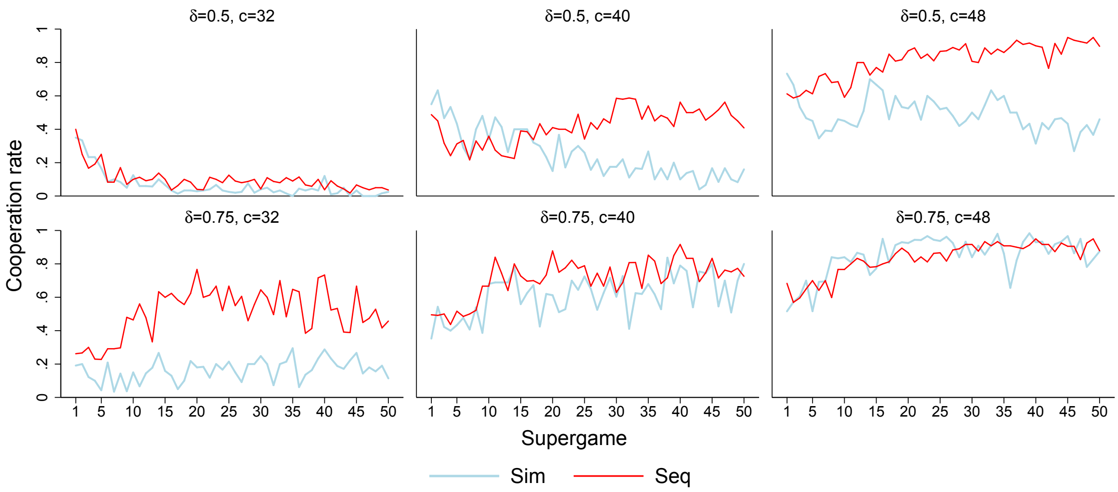
[11]Patterns by matching group are shown in Figure G.2 in the SM.

Figure 1: Evolution of cooperation rate by treatment

(a) Round 1



(b) All rounds



Notes: The figure shows cooperation rates across supergames by treatment. The unit of observation is a participant's decision in a round.

have standard errors clustered at the matching group level. The test results are extensively documented in Tables D.1 to D.4 in the SM.

Figure 1 shows that in the sequential-move games with $\delta = 0.5, c = 32$, in which cooperation cannot be sustained in equilibrium, the cooperation rate across first rounds declines to a rate close to zero. In the other treatments, in which cooperation can be sustained in equilibrium, the cooperation rate increases across the supergames. In contrast, in the simultaneous PDs the cooperation rate increases substantially only in treatments $\delta = 0.75, c = 40$ and $\delta = 0.75, c = 48$, both characterized by a low SizeBAD. First-round cooperation thus evolves along the lines predicted by the basin of attraction approach. Patterns are highly similar for cooperation rates calculated across all rounds (see the lower panel of Figure 1).

If we focus on the effect of sequentiality on first-round cooperation rates after learning, we see that sequentiality has basically no effect on the cooperation rate in the treatments with the lowest or highest incentives to cooperate ($p = 0.212$ and $p = 0.627$ respectively). The cooperation rate is respectively close to zero or close to one in these two treatments. However, in the treatments with intermediate incentives to cooperate, sequentiality substantially increases the cooperation rate. To be precise, cooperation starts off at a similar level as in the equivalent simultaneous-move game but increases to higher levels over time. In treatments $\delta = 0.5, c = 40$; $\delta = 0.5, c = 48$ and $\delta = 0.75, c = 32$, that are characterized by an intermediate to high simultaneous-game SizeBAD, sequentiality increases the post-learning cooperation rate by 35 to 45 percentage points ($p = 0.007$, $p < 0.001$ and $p < 0.001$ respectively). In treatment $\delta = 0.75, c = 40$, in which the simultaneous-game SizeBAD is lower, sequentiality also increases the cooperation rate somewhat but the effect is statistically not significant ($p = 0.658$). Results are highly similar for all-rounds cooperation rates.

Next, we consider the effect of c and δ on the cooperation rate. It can be seen in Figure 1 that we replicate the result of DBF that an increase in c or δ generally increases the post-learning cooperation rate in the simultaneous-move games. It can also be seen that a similar effect occurs in the sequential-move games, even if $\delta > \delta^*$. To test for statistical significance, we run regressions where the choice to cooperate is regressed on c and δ. Table 3 shows that in both Sim and Seq c and δ have a significantly positive effect on cooperation. For Sim this finding is consistent with SizeBAD, which predicts a smooth relation between c and δ on the one hand and the cooperation rate on the other hand. For Seq, although the estimated effects of c and δ are smaller in size than in Sim, the finding is not consistent with SizeBAD because SizeBAD predicts a cooperation rate of 100% in all treatments with $\delta > \delta^*$.

We conclude that much of the behavior observed in the experiment is well in line with the SizeBAD predictions: in the treatments with the lowest or highest incentives to cooperate sequentiality has no effect on the cooperation rate, whereas in the treatments with intermediate incentives to cooperate sequentiality substantially increases

Table 3: Effect of c and δ on cooperation

	Sim		Seq	
	(1) Round 1	(2) All rounds	(3) Round 1	(4) All rounds
c	0.041***	0.038***	0.022***	0.031***
	(0.000)	(0.000)	(0.000)	(0.000)
δ	0.438***	0.347***	0.168**	0.131*
	(0.000)	(0.000)	(0.010)	(0.067)
Observations	3000	9480	6000	21120

Notes: The table reports marginal effects from probit regressions with standard errors clustered at the matching group level. The variable δ is a dummy taking value 1 when $\delta = 0.75$, and 0 otherwise. The variable c is a continuous variable ranging from 32 to 48. Data are based on the last 20 supergames of the treatments with $\delta > \delta^*$. p-values are in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

the cooperation rate. Not all of the behavior fits with the predictions though. In the sequential-move treatments with $\delta > \delta^*$ the cooperation rate varies substantially with c or δ whereas it is predicted to be close to one independent of c or δ. Particularly in treatments $\delta = 0.5, c = 40$ and $\delta = 0.75, c = 32$ the cooperation rate remains well below one after learning. In the following section we investigate behavior in Seq in more detail and in section 5 we discuss how the "anomalies" can be rationalized.

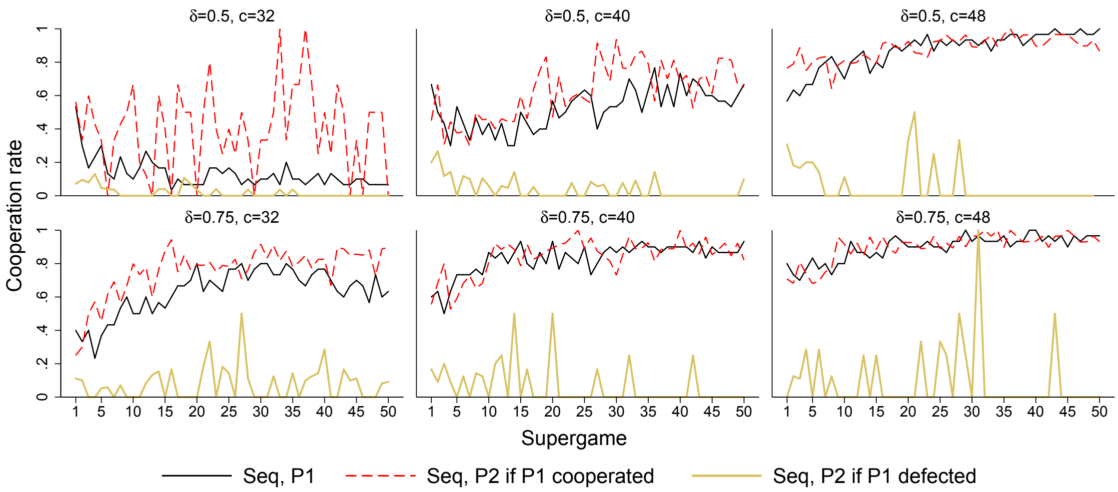
4.2 Cooperation rates by role in the sequential PDs

Figure 2 shows the evolution of cooperation rates of first movers, of conditional cooperation rates of second movers (i.e. cooperation conditional on cooperation by the first mover) and of cooperation rates of second movers conditional on defection by the first mover. The upper panel shows cooperation rates in first rounds only and the lower panel shows cooperation rates across all rounds. Results from statistical tests of treatment effects are in Table D.5 in the SM.

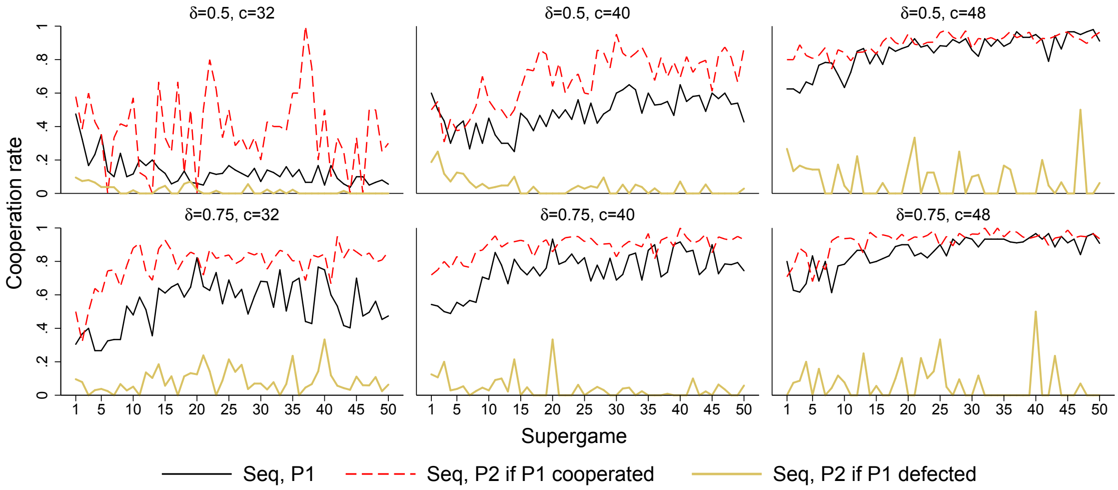
The figure shows that although the levels of cooperation diverge between the first and the second mover in some of the treatments, the dynamics of the cooperation rate of first movers and the conditional cooperation rate of second movers are similar. In particular, in the treatments with $\delta > \delta^*$, both cooperation rates increase over time, and in the treatment with $\delta < \delta^*$ both cooperation rates tend to (weakly) decrease over time. As far as the cooperation rate of second movers conditional upon defection by the first mover is concerned, it can be seen that it is overall far below the conditional cooperation rate. The reason why it fluctuates substantially in the treatments with rel-

Figure 2: Evolution of cooperation rate in Seq by treatment and role

(a) Round 1



(b) All rounds



Notes: The figure shows cooperation rates across supergames by treatment. The unit of observation is a participant's choice in a round. Notice that the fluctuations in some of the lines are due to a limited number of observations. For example, the cooperation rate of P2 conditional on defection by P1 fluctuates substantially in $\delta = 0.75, c = 48$ because P1 almost never defects.

atively high incentives to cooperate (for example, $\delta = 0.75, c = 48$) is that it is based on a limited number of observations. The cases in which the second mover cooperates even when the first defects can be interpreted as attempts of second movers to signal to a "scary" first mover to cooperate on the next round, and can be part of a cooperative strategy in which a defection by the first mover is not immediately punished. Support for this interpretation comes from the fact that such behavior is observed more frequently as the gains from cooperation are higher, i.e. as c and δ are higher.

Next, we focus on the conditional cooperation rate of second movers by emphasizing two observations in the data. First, the conditional cooperation rate of second movers in $\delta = 0.5, c = 32$ is and remains with its 44% well above zero even in the last twenty supergames, whereas in equilibrium this behavior should not be observed, nor is it consistent with SizeBAD.[12] Second, in some of the treatments with intermediate incentives to cooperate (in particular, $\delta = 0.5, c = 40$ and $\delta = 0.75, c = 32$) the conditional cooperation rate of second movers in the last twenty supergames is with its 78% well below 100%. This is inconsistent with the SizeBAD prediction since it suggests that second movers defect if the first mover cooperates, even if $\delta > \delta^*$. In line with these two observations, the data show a positive effect of c and δ on the conditional cooperation rate of second movers even for $\delta > \delta^*$ ($p < 0.01$ for both c and δ in a probit regression).

Finally, we look more closely at the cooperation rate of first movers. A first noteworthy pattern shown in Figure 2 is that the cooperation rate of first movers tends to be below the conditional cooperation rate of second movers. This is most striking in treatment $\delta = 0.5, c = 32$ but is also visible for other treatments, in particular in panel (b), which is based on all rounds.[13] Given that the choice to cooperate is an inherently riskier choice for first movers than the choice to conditionally cooperate for second movers, this does not come as a surprise.[14] Note, however, that first movers tend to correctly anticipate the risk of suffering the sucker payoff: the gap between

[12] If the choice by the second mover to conditionally cooperate in $\delta = 0.5, c = 32$ is regressed on a trend, then the trend is negative but statistically not significant ($\beta = 0.0002$, $p = 0.920$, $N = 300$). It should be noted though that the number of underlying observations is rather limited — first movers cooperate in only 10% of the cases after learning — and it is an open question whether conditional cooperation rates would stabilize at a level well above zero if first movers would cooperate more than they actually did.

[13] The observation that divergence is visible with data based on all rounds and less so with data based on first rounds only is consistent with the following two repeated-game dynamics: (a) second movers make relatively more conditionally cooperative choices the more rounds they play within the repeated games, or (b) first movers cooperate less frequently the more rounds they play within the repeated games. Figure G.3 of the SM shows that it is mostly the second effect: the cooperation rate of first movers decreases somewhat across rounds within supergames. This may suggest that at least some first movers think that with some probability the matched second mover stops conditionally cooperating at some point within the supergame.

[14] In practice, the first mover is exposed to more strategic risk than the second mover because the former cannot be absolutely sure to avoid obtaining the low sucker payoff whereas the latter can. In theory, however, the first mover's exposure to strategic risk depends on whether the first mover knows the utility function of the second mover. See section 5 for a discussion.

first movers' cooperation rate and second movers' conditional cooperation shrinks in treatments where conditional cooperation is close to 100%. A second pattern is that the cooperation rate generally increases as c or δ increases. This also does not come as a surprise because it can be logically expected that the general pattern is similar to that of the conditional cooperation rate of second movers.

In summary, although SizeBAD does a good job in organizing the effect of sequentiality on cooperation, it is not sufficient to explain the responsiveness of the conditional cooperation rate of second movers and the cooperation rate of first movers to c and δ. In the next section we provide a number of suggestions on how to rationalize these patterns.

5 Discussion

We have shown that appealing to strategic uncertainty is crucial to understand the effect of sequentiality on cooperation. However, it cannot explain the observations that the conditional cooperation is "too high" in the treatment with $\delta < \delta^*$ and "too low" in some of the intermediate treatments with $\delta > \delta^*$. In summary, it cannot explain the positive effects of c or δ on the cooperation rate in the sequential-move games. We first aim to understand better these "anomalies" in the conditional cooperation patterns. We then use the insights to reconsider the effect of sequentiality of moves in repeated PDs.

5.1 Understanding conditional cooperation patterns

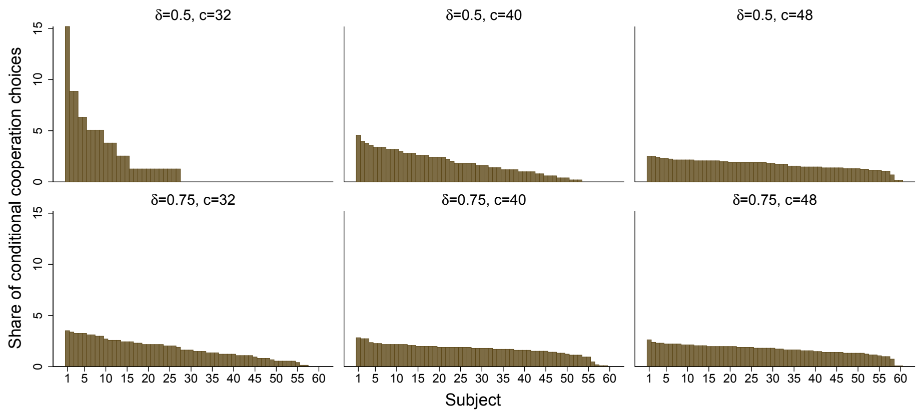
We first show that the "anomalies" cannot be attributed to *i.i.d.* noise or random mistakes, and then proceed with a discussion of how the patterns can be rationalized. In order to show that the behavioral anomalies are not randomly distributed across the subjects we study whether and to which extent conditional cooperation choices of second movers are concentrated across the subjects. Specifically, we calculate for each subject the number of times s/he conditionally cooperates in first rounds out of the total number of first-round conditional cooperation choices in her specific treatment — this is what we refer to as the share of conditional cooperation choices — and then plot this number ranked from high to low in bar graphs by treatment. If the choice to conditionally cooperate is due to *i.i.d.* noise, then the bars should be uniformly distributed because the share of conditional cooperation choices would be similar for each subject then. Graphs far away from a uniform distribution suggest that types exist with different tendencies to conditionally cooperate. As can be seen in panel (a) of Figure 3, which depicts the bar graphs, most of the conditional cooperation choices in treatment $\delta = 0.5, c = 32$ come from just a few subjects, whereas in the other treatments the distributions are much closer to uniform. In treatment $\delta = 0.5, c = 32$, using a strategy of conditional cooperation is not payoff-maximizing, and relatively few subjects use this strategy (see also section 6 on strategy estimation). These subjects can be taken as "strong" conditional cooperation types. In the treatments where conditional cooperation is supported in equilibrium, so where conditional cooperation types cannot be identified because they may pool with payoff maximizers, the distributions are much closer (albeit not equal) to the uniform distribution.

We perform a similar exercise in search for a type who always defects. We now calculate for each subject in the role of second mover the number of times s/he defects in first rounds out of the total number of first-round defection choices by second movers in a treatment — this is the share of defect choices — and plot this number ranked from high to low in bar graphs by treatment (see panel (b) in Figure 3). The interpretation is that the more the bar graphs deviate from a uniform distribution, the higher the share of defect choices that comes from relatively few subjects, and the more support is given to the existence of always defect types. Figure 3b shows that in treatments $\delta = 0.75, c = 48$; $\delta = 0.5, c = 48$ and $\delta = 0.75, c = 40$, in which the scope for separation between always defect types and payoff maximizers is highest, the distribution deviates most from the uniform distribution. In these treatments second movers can loose relatively more money by not choosing CC as compared to treatments $\delta = 0.5, c = 40$ and $\delta = 0.75, c = 32$. We take these results as evidence suggesting that always defect types indeed exist.

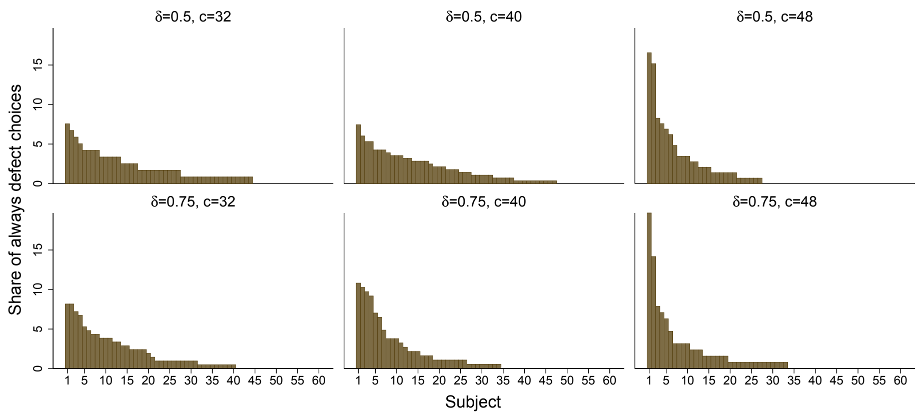
In the next step we try to understand why players conditionally cooperate in the role of second mover in cases where (risk-neutral) payoff maximizers would defect, or why they always defect in the role of second mover in cases where (risk-neutral) payoff maximizers find it a (weakly) dominant strategy to conditionally cooperate. We can think of three rationales for such behavior, all three well-documented in the literature. A first rationale comes from the literature on social preferences. Individuals with prosocial preferences are generally more inclined to conditionally cooperate in cases where

Figure 3: Distribution of choices by subject in Seq

(a) Conditional cooperation



(b) Always defection



Notes: The unit of observation is a choice of a second mover in Seq. Data from all first rounds of the supergames in which the first mover cooperated are included. In $\delta = 0.5, c = 32$ 6 second movers (10%) never experienced a round-one cooperative choice by the first mover, and the remaining 54 second movers experienced 1 to 12 cooperative choices with a median of 3 cooperative choices. In the other treatments all second movers experienced at least 4 cooperative choices with the median ranging between 12.5 and 22 cooperative choices depending on the treatment.

this is not payoff-maximizing (e.g. Fehr and Schmidt, 1999; Fehr and Gächter, 2000; Fischbacher, Gächter, and Fehr, 2001; Charness and Rabin, 2002), whereas individuals with anti-social or spiteful preferences are more inclined to defect (e.g. Levine, 1998; Abbink and Sadrieh, 2009). A second rationale relates to risk preferences. A source of risk faced by all players in our games, including second movers in sequential-move games, is the risk due to the stochastic ending of the repeated game. Risk aversion has the effect of increasing the threshold for δ above which the expected payoff of a conditionally cooperative strategy is higher than that of always defect, and may therefore lead players to always defect more easily. The opposite holds for risk-seeking players (see Sabater-Grande and Georgantzis, 2002, for evidence in the context of repeated PDs). A third rationale comes from a family of models that assumes individuals are more likely to make mistakes if these are costly (as in, for example, McKelvey and Palfrey, 1995). Individuals who are relatively prone to such mistakes conditionally cooperate more easily in the role of second mover than others even if this is not supported in equilibrium, or defect more easily even if much can be earned with conditional cooperation (see Goeree, Holt, and Laury, 2002, for evidence in the context of a public goods game).

In what follows we present evidence that speaks to the discussion. We study whether the choice of a participant in the role of second mover to conditionally cooperate across first rounds is related to proxies for the participant's social preference, risk seeking and proneness to mistakes, elicited before or after the repeated games were played. Social preferences are proxied by the choice of the participant to distribute resources equally in a binary dictator game.[15] The risk-seeking proxy comes from a question in which the participant was asked to rate the extent s/he thinks herself as a risk taker on a scale from 1 to 6. Proneness to mistakes is proxied by the number of times a participant made mistakes in the quiz with control questions about the PD before the experiment started (see section A of the SM for additional details about the proxies). To summarize, second movers are hypothesized to be more likely to conditionally cooperate if they choose the equal distribution more frequently in the distributional choice-setting or if they are more likely to report to be a risk taker. Regarding the correlation with proneness to mistakes, we expected that the relation would depend on whether conditional cooperation can be supported in equilibrium. In particular, for $\delta < \delta^*$ a positive relation between number of mistakes and conditional cooperation was expected, whereas for $\delta > \delta^*$ a negative relation was expected.

[15]Participants made ten distributional choices before they started playing the repeated PDs. For each of ten scenarios, they were asked to choose between an allocation which would yield 50 tokens for themselves and 12 for a randomly matched counterpart (corresponding to respectively sucker payoff s and temptation payoff t in our experiment) and an equal allocation in which both would earn a number of tokens that could range from 30 to 48 tokens in steps of two tokens (including 32, 40, or 48, corresponding to the c's in the PD treatments). We proxy the social preference of a participant in a game with mutual cooperation payoff c by a binary variable that indicates whether s/he chooses the equal allocation in the scenario with mutual cooperation payoff c.

Table 4: Correlates of conditional cooperation

Dep. var.: *Conditionally cooperate (yes=1)*	(1) Supergames 1 to 50	(2) Supergames 31 to 50
Choice of equal distribution=1	0.077**	0.078**
	(0.011)	(0.026)
Risk-liking	0.016	0.021
	(0.228)	(0.148)
Mistakes in quiz	0.055***	0.034
	(0.008)	(0.714)
$\delta > \delta^*$	0.432***	0.478***
	(0.000)	(0.000)
$\delta > \delta^* \times$ Mistakes in quiz	-0.067***	-0.044
	(0.002)	(0.640)
Male	0.058*	0.048
	(0.053)	(0.109)
Supergame number	0.004***	-0.002**
	(0.000)	(0.016)
Length of past supergame	0.002	0.001
	(0.320)	(0.671)
Constant	0.128*	0.313***
	(0.097)	(0.002)
Observations	5831	2523
Log pseudolikelihood	-2192.583	-646.973

Notes: The table reports estimates from mixed regressions including random effects at the matching group level and standard errors adjusted for clustering at the matching group level. The unit of observation is a conditional cooperation choice of second mover participant in round 1. p-values are in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 4 shows the results of regressions with the proxies for social preferences, risk preferences and proneness to mistakes as independent variables. To capture a possibly different relation between mistakes and conditional cooperation depending on δ, we include $\delta > \delta^*$ and an interaction between $\delta > \delta^*$ and number of mistakes in the regressions.[16] We include the gender of the participant, the number of the supergame, and the length of the past supergame as control variables in the regressions. The table shows that pro-social players are more likely to conditionally cooperate in the role of second mover, as hypothesized. The relation is very similar and statistically significant in regressions based on all and the last twenty supergames which suggests that the

[16]We use linear regressions instead of probit regressions for this analysis to simplify the interpretation of the coefficients, since marginal effects of interaction terms are not available in probit regressions. Note also that the qualitative results reported in Table 4 are similar if regressions are run with each of the relevant independent variables separately (see Tables F.10 and F.11 in the SM).

effect of social preferences survives possible learning of the repeated game. We also find a positive relation between self-reported risk-liking and conditional cooperation, albeit statistically insignificant. Furthermore, we find evidence of an effect of mistakes in the expected direction; players who make more mistakes are more likely to conditionally cooperate only if $\delta < \delta^*$ and not so if $\delta > \delta^*$. The effect of mistakes and the interaction effect are no longer statistically significant and qualitatively less strong in the last twenty supergames, which could be the outcome of participants learning the game over time.

The result that learning substantially weakens the relation between mistakes and conditional cooperation but not between social preferences and conditional cooperation seems to suggest that social preferences have a stronger bite than proneness to mistakes when it comes to understanding conditional cooperation after learning. With respect to risk preferences, such a conclusion cannot be made because they are never statistically significant, which may be due to measurement error related to the elicitation method rather than to conditional cooperation being weakly (or not) related to risk preferences. However, further evidence leads us to conjecture that risk preference may not be all that relevant for understanding conditional cooperation. The evidence comes from two additional treatments with a sequential-move game ($\delta = 0.75, c = 32$ and $\delta = 0.75, c = 40$) in which the risk associated with knowing that the round of play is the last one or not is removed. In these treatments players know whether the round they are playing is the last one or not *before* making their choice rather than after. The data show that removing this risk has little effect on the conditional cooperation rate in these treatments (see section E in the SM).

5.2 Reconsidering the treatment effects on cooperation

Now that we have shown that appealing to social preferences helps to understand the patterns of conditional cooperation observed in our experiment, we reconsider predicted treatment effects on cooperation with this in mind. We assume that players can be heterogeneous in terms of the "strength" of their social preference (as in for example Fehr and Schmidt, 1999). To focus, we discuss how players with social preferences make choices in the reduced supergames, i.e. the games simplified to games with two options (AD and CC) with CC being again a short-cut for conditionally cooperative strategies à la GT, TFT and other limited punishment strategies. We assume that player i has utility $U_i = (1 - \rho_i)\pi_i + \rho_i \pi_j$ if $\pi_i > \pi_j$ and $U_i = (1 - \sigma_i)\pi_i + \sigma_i \pi_j$ if $\pi_i \leq \pi_j$, with $\rho_i \geq \sigma_i$, which is a simplified version of the utility function in Charness and Rabin (2002).[17] In the context of the reduced games, ρ_i relates to player i's preference of CC over AD in cases in which i earns more than the matched partner. It fully determines the choice of the second mover in the sequential-move games. A player with $\rho_i > 0.29$, for example, chooses CC in all games, and a player with $\rho_i < -1.76$ chooses AD in all games in the role of second mover. A player whose ρ_i is in between these two boundaries switches from choosing AD to CC as δ or c increases. For example, if $-0.55 < \rho_i < -0.13$ player i chooses AD in the role of second mover in games $\delta = 0.5, c = 40$ and $\delta = 0.75, c = 32$ (and in games with lower c or δ) and chooses CC in the games with higher c or δ. Also for players in simultaneous-move PDs ρ_i is positively related with the willingness to cooperate, but due to the coordination nature of that game does not fully determine it. Parameter σ_i relates to player i's preference for CC over AD in cases in which player i earns less than the matched partner. It will thus have an effect on the choice of players in Sim and of players in the role of first mover in Seq. It does not affect the choice of second movers in the reduced games because they never earn less than the first mover then.

We assume for now that the strength of social preferences of each player is commonly known. That is, player j observes the matched player i's ρ_i and σ_i with $i \neq j$. An important difference between Sim and Seq is that in Seq for only one of the two players (the second mover) ρ_i needs to be sufficiently high to generate mutual cooperation in a particular game. If the second mover has a ρ_i that makes her choose CC, it is optimal for the first mover to choose CC as well, irrespective of the latter's ρ_i, because the first mover never earns a higher payoff than the second mover in the reduced game. Basically, if ρ_i is above a certain threshold that depends on the parameters of the game, the SizeBAD is equal to 0. In Sim, in contrast, mutual cooperation can only be obtained if *both* players have a sufficiently high ρ_i (see Duffy and Muñoz-García, 2015, for an application to one-shot games). And even if this condition holds, due to the coordina-

[17] Figure G.4 in the SM illustrates the utilities in normal-form representations of the reduced-form games for Sim and Seq.

tion nature of the game, both players playing AD remains a plausible outcome, with the SizeBAD depending on the parameters of the game. In summary, it holds that (a) if there is heterogeneity with respect to ρ_i in the population, the (mutual) cooperation rate is expected to increase in Seq and Sim as c or δ increases, and (b) for the same distribution of ρ-types in the population a higher (mutual) cooperation rate is expected in Seq than in Sim. Moreover, σ_i has no effect on the predicted choice of player i in the role of second mover, and given that the first mover is informed about the strength of the social preference of the second mover by assumption it has no implications for player i in the role of first mover either. For players in Sim, CC becomes more attractive for player i as σ_i increases.

In the next step we show the predicted mutual cooperation rates by treatment calibrated at a specific distribution of ρ-types, and compare it to the observed mutual cooperation rates. We use the above-mentioned insight that the range of ρ_i of player i can be identified by that player's choice to use CC in the role of second mover in Seq. The conditional cooperation rate observed in the first rounds of a particular treatment of our experiment can thus serve as a proxy for the share of players in the population with ρ_i sufficiently high so that they choose CC in that treatment. Combining first-round conditional cooperation rates from all treatments gives us a proxy of the distribution of ρ-types. The conditional cooperation rates observed in the first rounds of the last twenty supergames are largely consistent with the following distribution of types: $\rho_i > 0.29$ for 40%, $-0.13 < \rho_i < 0.29$ for 40%, $-0.92 < \rho_i < -0.13$ for 10%, and $\rho_i < -1.76$ for 10% of the players.[18] Table 5 shows the predicted mutual cooperation rates in Sim and Seq associated with this distribution under the assumption that $\sigma_i = 0$ for all i. Observed mutual cooperation rates are included as well. The table shows that the suggested approach does a good job when it comes to organizing the observed comparative statics: (a) the cooperation rate in Seq is predicted to be higher than in Sim, and (b) in contrast to the initial bang-bang prediction of SizeBAD, the cooperation rate in the treatments with $\delta > \delta^*$ is now also predicted to increase in Seq as c or δ

[18] We use approximations of the observed conditional cooperation rates for the calibration. The reason is that there are some slight inconsistencies in the data (e.g. the conditional cooperation rate observed in in game $\delta = 0.5, c = 40$ is a bit lower than that in game $\delta = 0.75, c = 32$ whereas strictly speaking it should be higher if the utility function is specified as above). The obtained distribution is in the same ballpark of the estimated (average) ρ_i reported in Charness and Rabin (2002).

Table 5: Predicted and observed mutual cooperation rates with social preferences

	$\delta = 0.5$			$\delta = 0.75$		
	$c = 32$	$c = 40$	$c = 48$	$c = 32$	$c = 40$	$c = 48$
Predicted Seq	40%	80%	90%	80%	90%	100%
Predicted Sim	[0-16%]	[0-64%]	[0-81%]	[0-64%]	[0-81%]	[0-100%]
Observed Seq	4%	45%	89%	58%	80%	91%
Observed Sim	0%	2%	28%	8%	64%	91%

Notes: The table shows the predicted mutual cooperation rate by treatment if it is assumed that $\rho_i > 0.29$ for 40% of the players, $-0.13 < \rho_i < 0.29$ for another 40%, $-0.92 < \rho_i < -0.13$ for 10%, and $\rho_i < -1.76$ for another 10% of the players. The mutual cooperation rates observed in the first rounds of the last twenty supergames of the experiment are included as well.

increases.

Finally, the assumption that players are informed about each other's type may not be realistic, especially in the context of anonymous lab experiments. It seems more realistic to assume instead that players are privately informed about their type and have common knowledge about the distribution of types in the population, as in Kartal and Müller (2018). Doing so does not change the direction of the predicted treatment effects. The cooperation rate is still predicted to be higher in sequential-move than in simultaneous-move games due to the difference in strategic risk, and is still predicted to increase as c or δ increases due to the social preferences component in the utility function. A possible different prediction induced by private information is that the cooperation rate of first movers is different than the conditional cooperation rate of second movers. Intuitively, removing the information about the type of the second mover exposes the first mover to strategic risk, which implies that the first mover's choice to use CC becomes a matter of comparing the expected payoff with that of AD rather than merely copying the strategy of the second mover. In treatment $\delta = 0.5, c = 32$ for example, with the observed 44% conditional cooperation rate of second movers, an expected-payoff maximizing first mover finds it optimal to choose AD rather than CC, which may explain why first movers learn to defect over time in this treatment. Whether the cooperation rate of first movers is predicted to be higher or lower in the aggregate than the conditional cooperation rate of second movers generally depends on the payoff parameters and the assumed distribution of σ_i in the population. The more players with a low σ_i, the more likely that the first mover's cooperation rate is relatively low. It can be calculated that in all treatments in our experiment in which $\delta > \delta^*$ the expected payoff of CC is higher than that of AD for first movers if assumed that the distribution of ρ-types is as mentioned above. Given that in some of these treatments the cooperation rate of first movers is lower than the conditional cooperation rate of second movers, it must be that there are relatively more players with $\sigma_i < 0$ than with $\sigma_i > 0$.[19]

6 Repeated-game strategies

In much of the above we have used a framework that builds upon the assumption that players choose to always defect or to conditionally cooperate at the start of the repeated game. By investigating repeated-game strategies we learn whether different conditionally cooperative strategies are used in Seq than in Sim. Moreover, by investigating the strategies that participants have used in our experiment we can tell whether the simplification to a reduced game with options AD and CC is justified. Theoretically, the threshold for δ above which mutual cooperation is supported in equilibrium is different if other than CC-like strategies are used. For example, it can be shown that the first mover in Seq using the strategy "Defect in round 1 and then tit-for-tat (D-TFT)" in combination with the second mover applying "Cooperate in round 1 and then TFT (C-TFT)" or "Cooperate in round 1 and then GT (C-GT)" is under certain conditions an equilibrium leading to mutual cooperation.[20] In Sim, however, equivalent combinations of strategies can at best constitute an equilibrium with partial cooperation. The reason is that in Seq there is no punishment of the first mover's initial defection so that from round 2 onwards both players cooperate. In Sim the player using TFT punishes in round 2 the first-round defection by the partner by defecting oneself in round 2, which sets in a series of switching back and forth between cooperation and defection. To reach full cooperation against a player who uses D-TFT in Sim, one more round of patience is needed.

The empirical identification of repeated-game strategies is challenging because we only observe choices. By using maximum likelihood, we estimate the relevance of a set of predetermined strategies within each treatment using an approach common in the

[19]Note that in the model of Kartal and Müller (2018) social preferences (or tastes for cooperation) are specified such that the cooperation rate of first movers cannot be lower than the conditional cooperation rate of second movers.

[20]In all of our treatments with $\delta > \delta^*$ these conditions are fulfilled.

Table 6: Estimated repeated-game strategies

	$\delta < \delta^*$			$\delta > \delta^*$		
	Sim	Seq, P1	Seq, P2	Sim	Seq, P1	Seq, P2
AD	0.727	0.404	0.588	0.336	0.073	0.111
	(0.000)	(0.046)	(0.000)	(0.033)	(0.202)	(0.088)
AC	0.000	0.015	0.000	0.028	0.059	0.000
	(0.381)	(0.332)	(0.477)	(0.294)	(0.310)	(0.500)
GT	0.000	0.001	0.247	0.296	0.222	0.328
	(0.381)	(0.471)	(0.057)	(0.036)	(0.136)	(0.063)
TFT	0.000	0.034	0.165	0.201	0.566	0.562
	(0.381)	(0.204)		(0.085)	(0.012)	
D-TFT	0.273	0.546	–	0.139	0.080	–
γ	0.262	0.350	0.234	0.351	0.312	0.356
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Coop. strat.	0.273	0.596	0.412	0.664	0.927	0.889

Notes: Estimates from maximum likelihood based on data from all rounds of the last 20 supergames. *p*-values are in parentheses. The share of cooperative strategies (coop. strat.) is equal to 1 minus the share of AD.

literature (e.g. Dal Bó and Fréchette, 2011; Fudenberg, Rand, and Dreber, 2012; Bigoni, Casari, Skrzypacz, and Spagnolo, 2015).[21] In an initial step we estimated strategies AD, GT, TFT, and always cooperate (AC) for all players, strategy D-TFT for players in Sim and first movers in Seq, and strategies C-TFT and C-GT for second movers in Seq. Given that the latter two strategies were estimated to have a weight close to zero, we decided to leave them out and focus on the first five strategies.[22] Table 6 reports the results for $\delta < \delta^*$ and for all treatments in which $\delta > \delta^*$. Estimations are based on data from the last 20 supergames.[23]

The first observation that can be made in the table is that the estimated share of cooperative strategies of second movers out of all strategies in the game where $\delta < \delta^*$ is very close to the conditional cooperation rate based on all rounds of the last 20 supergames, as it should be (see Table D.5 in the SM). Likewise, for $\delta > \delta^*$ the estimated

[21] A technical description of the maximum likelihood estimation can be found in the Online Appendix of Dal Bó and Fréchette (2011). Romero and Rosokha (2018) and Dal Bó and Fréchette (2017) directly elicit strategies and show that these correspond to a large extent to the estimated strategies.

[22] We also estimated more complex strategies for players in Sim and first movers in Seq, including a number of memory-two strategies (see Table F.8 of the SM for the results and Table F.9 for the strategy definitions). This exercise does not give us much additional insights though.

[23] Table F.6 in the SM reports the estimated strategy distribution for each treatment separately based on the last 20 supergames. Table F.7 in the SM reports results based on data from all supergames. Results are qualitatively similar.

share is in the range of the cooperation rates reported for the five treatments in which $\delta > \delta^*$. Second, also consistent with the reported cooperation rates is that in both Sim and Seq AD is overall used less frequently and (conditionally) cooperative strategies are used more frequently in the games with $\delta > \delta^*$ than in the game with $\delta < \delta^*$.

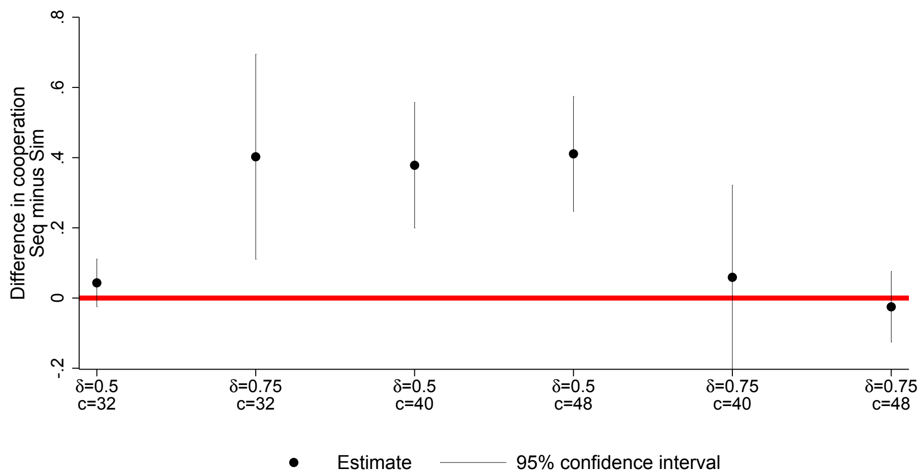
If we focus on the effect of sequentiality on strategy adoption, we see that cooperative strategies are generally used more frequently by first and second movers in Seq than by players in Sim. This finding does not come as a surprise for $\delta > \delta^*$, and is consistent with results reported on cooperation rates. However, for $\delta < \delta^*$ the finding is not trivial because the observed cooperation rate does not differ between Sim and Seq. It is consistent with the presence of social preferences, though. Remarkably, the most frequent strategy used by first movers in the game where $\delta < \delta^*$ is D-TFT (54.6% of the time) instead of AD (40.4% of the time). This is in contrast to Sim, where AD is more common than D-TFT (72.7% versus 27.3%).

Other new insights from the estimations are related to strategies used within the set of conditionally cooperative strategies. Comparing the set of conditionally cooperative strategies between Sim and Seq reveals that different types of such strategies are used. Overall, TFT is more prominent in Seq than in Sim, among both first and second movers. In Sim, GT and TFT are roughly equally popular for $\delta > \delta^*$ and D-TFT is most common for $\delta < \delta^*$. In Seq, first movers tend to prefer D-TFT over TFT if $\delta < \delta^*$ and TFT over D-TFT if $\delta > \delta^*$. Second movers tend to use GT more frequently than TFT if $\delta < \delta^*$ (24.7% versus 16.5%) and swap if $\delta > \delta^*$ (32.8% versus 56.2%).

7 Conclusion

If coordination on efficient outcomes fails, this is mostly due to individuals avoiding risk (Van Huyck, Battalio, and Beil, 1990, 1991). A similar logic applies with respect to cooperation in repeated games. Cooperation is more likely if it can be sustained in equilibrium and if it is relatively less risky to use a conditionally cooperative strategy, that is, if the set of beliefs that makes a conditionally cooperative strategy optimal is larger. This has been shown in the context of infinitely repeated simultaneous PDs (Roth and Murnighan, 1978; Blonski, Ockenfels, and Spagnolo, 2011; Dal Bó and Fréchette, 2011), finitely repeated PDs (Embrey, Fréchette, and Yuksel, 2018), repeated entry games (Calford and Oprea, 2017), and dynamic dilemma games (Vespa and Wilson, 2019). We use this insight to predict how sequentiality influences cooperation rates in infinitely repeated PDs. In a repeated sequential PD the second mover does not face strategic risk by conditionally cooperating in the stage game because she can avoid suffering the low sucker payoff. If foreseen by the first mover, this induces him to cooperate as well, making mutual cooperation more easily established than if players would move simultaneously. Our experiment shows that this prediction is borne out by the data. We find that cooperation rates after learning are around 40 percentage points higher if players move sequentially than if they move simultaneously, provided that cooperation can be supported in equilibrium and that the incentive to mutually cooperate is not too high. In the cases where cooperation is not supported in equilibrium or where it is supported but the strategic risk in the simultaneous PD is at its lowest, the cooperation rate is close to respectively zero and 100%, independent of sequentiality. Figure 4 summarizes our main result by showing the difference in cooperation rate as a function of the treatments ranked in terms of attractiveness of mutual cooperation.

Figure 4: Effect of sequentiality after learning



Notes: The figure shows the estimated difference in cooperation rate between Seq and Sim (including 95% confidence intervals) by treatment in the last 20 supergames. The treatments are ordered by attractiveness of mutual cooperation, as proxied by SizeBAD in Sim. Estimates and confidence intervals are based on probit regressions comparing Seq to Sim for each parameter configuration with standard errors clustered at the matching group level.

Our results have implications for policy. If a policy's goal is to achieve and sustain a high level of cooperation, it is optimal to have players deciding sequentially and to provide second movers with information about the decision of the first mover. Our results also have implications for the interpretation of behavior in PD games played in (quasi-)continuous time (see for example Friedman and Oprea, 2012; Bigoni, Casari, Skrzypacz, and Spagnolo, 2015). These games differ in at least three respects from discrete-time simultaneous PDs: (a) the frequency of the (albeit shorter) interactions is higher in each supergame, (b) players move *de facto* sequentially — they observe the partner's choice before making a choice, and (c) players choose the timing of their moves. Cooperation rates are typically very high and the reasons have not been entirely understood yet. Friedman and Oprea (2012) show that the frequency of interaction increases the cooperation rate in discrete-time PDs, but our experiment shows that sequentiality on its own may also lead to a substantial increase in cooperation. The sequential-move nature inherent to games played in (quasi-)continuous time may thus be one of the structural characteristics that leads to the higher cooperation rate. This squares well with Calford and Oprea (2017) who report data from an experiment in which strategic uncertainty is removed by freezing choices for a few seconds. They show that doing so increases cooperation. Strategically, a sequential PD is equivalent to a simultaneous PD where the choice of one of the players is frozen for one period.

Although appealing to strategic uncertainty is clearly crucial to understand the effect of sequentiality on cooperation, it fails to explain why the cooperation rate in sequential-move games is sensitive to c and δ even if the basin of attraction of always defect is zero. We have shown that the patterns can largely be rationalized by allowing for heterogeneity of players in terms of utilities à la Charness and Rabin (2002). The patterns are also consistent with predictions of Kartal and Müller (2018), who develop a model with heterogeneous players and private information. Although both theoretical frameworks focus on heterogeneity in terms of the strength of social preferences, social preferences are not key to the argument. Heterogeneity can also refer to risk preferences or proneness to mistakes as in a logit quantal response function. That said, empirically, the conditional cooperation rate of experienced second movers in sequential-move games seems more strongly related to a preference for an equal and efficient distribution of money over one that maximizes monetary payoff than to proxies for risk preferences or proneness to mistakes.[24]

[24]We do find though that, overall, conditional cooperation by second movers is positively related to the number of mistakes made in the control questions if cooperation cannot be supported in equilibrium, and not so if it can be supported in equilibrium. The latter result relates to Proto, Rustichini, and Sofianos

In a final section we report results of estimations of strategies adopted by the participants in our experiment. A first result is that by far the majority of the cooperative strategies involve conditional cooperation à la grim trigger or tit-for-tat. This provides a justification for our approach of simplifying the choices in a repeated game to a choice between always defect and conditional cooperation. One exception relates to strategy "defect and then tit-for-tat", which we discuss below in more detail. A second result is that strategies involving at least some conditional cooperation are more common under sequential decision-making than under simultaneous decision-making. Although this is to be expected for the games in which cooperation can be sustained in equilibrium, it also holds for the game in which cooperation is not sustainable in equilibrium, and it holds for first and second movers. This finding squares well with our analysis assuming social preferences which predicts a (weakly) higher cooperation rate with sequential moves even if $\delta < \delta^*$. A third result is that the distribution of conditionally cooperative strategies is different in the sequential- and simultaneous-move games. In particular, in the games where cooperation is sustainable in equilibrium, tit-for-tat is used much more frequently by first and second movers in sequential-move games than grim trigger (in more than 60% versus around 20% of the cases) whereas in the simultaneous-move games both strategies are almost as frequent (around 27% of the cases each). We speculate that second movers prefer tit-for-tat over grim trigger because it allows switching back to a cooperative mode of play without putting oneself in a vulnerable position. First movers seem to (learn to) foresee that many second movers play tit-for-tat, which makes them play tit-for-tat relatively frequently as well. Finally, the estimations show that a particularly popular strategy among first movers in the case in which cooperation cannot be sustained in equilibrium is the strategy to first defect and then switch to tit-for-tat (D-TFT), and to some extent also for players in the simultaneous-move version of the game. We speculate that this may have to do with the fact that D-TFT protects a player from suffering the sucker payoff if matched with a defecting partner and is at the same time successful for reaching mutual cooperation if the partner is lenient. D-TFT would do well for example if matched to a strategy that

(2018) who find that higher levels of cooperation are reached in groups of intelligent individuals than in groups of less intelligent individuals and that intelligent individuals use conditionally cooperative strategies rather than cooperating unconditionally in a setting where cooperation is sustainable in equilibrium.

starts with unconditional cooperation before switching to conditional cooperation. It would be interesting to carry out a deeper analysis of repeated-game strategies but for this purpose our games are too short.

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Supplementary material

A Experimental procedures

In all sessions, participants first took part in ten binary dictator games (DG). The dictator could either choose to keep 50 points for oneself and give 12 points to the recipient, or to keep c points and give c points to the recipient. Across the ten DGs c ranged from 30 to 48 points with increments of two points. All participants made choices in the role of dictator. They were explained that at the end of the session pairs would be randomly formed and roles would randomly assigned to determine the payment.

The experiment then proceeded to the main part. The Seq treatments covered seven sessions of 60 participants and the Sim treatments covered two sessions with 40 participants and two with 50 participants. All participants played 50 supergames.[25] We chose a large number of supergames per session because previous studies have shown the importance of learning (Dal Bó and Fréchette, 2011). At the beginning of the session participants were randomly assigned to matching groups of ten. Participants were not aware of the matching groups. At the beginning of each supergame pairs were randomly formed within the matching groups. Within the same session, participants in different matching groups faced different mutual cooperation payoffs in order to minimize possible session effects.

The level of understanding of the instructions was tested through a set of non-incentivized control questions about the PD's parameters (payoffs and continuation probability), and about the matching protocols within and across supergames. Participants were not time constrained and were allowed to proceed with the experiment only after they correctly answered all questions. We kept record of the number of times that a participant submitted the answers to the control questions with at least one mistake. Below we report an English translation of the control questions:

1. How many points do you earn in a round if both you and the other participant choose A?
2. How many points do you earn in a round if both you and the other participant choose B?
3. How many points do you earn in a round if you choose A and the other participant chooses B?
4. How many points do you earn in a round if you choose B and the other participant chooses A?
5. You are in round two of a match. What is the probability that the match ends after this round?
6. True or false? I will be paired with the same participant in all rounds of a match.
7. True or false? I will be paired with the same participant across all matches.

At the end of the session we conducted a short survey, collecting information on gender, origin, age, and educational background. We also asked participants to self-report how risk averse they are. In particular, we asked :"How much of a risk taker would you evaluate yourself on a scale from 1 to 6?"

[25] In one of the sessions the laboratory assistant accidentally implemented 51 supergames.

The final payment of a participant was determined by her earnings in one of the ten randomly drawn DGs plus the total earnings over all rounds of a randomly drawn supergame. Each point earned during the experiment was worth 0.1€. Participants received a show-up fee of 6€ in the treatments with $\delta = 0.5$ and of 7€ in the treatments with $\delta = 0.75$. The show-up fee was larger in the latter treatments because these sessions took longer.

B Translated instructions

B.1 Instructions simultaneous games, $\delta = 0.5$

General instructions

Welcome to the experiment.

All participants receive the same instructions. Please read them carefully.

Do not communicate with any of the other participants during the entire experiment and turn off your cell phone. If you have questions, raise your hand, and wait until the experimenter comes to you to answer your question in private.

You receive a show-up fee of €6. The amount of money you earn on top of this depends on decisions made by you and other participants. Earnings are expressed in points during the experiment. Points convert to Euros in the following way: 10 points = €1. You will be paid your earnings in cash at the end of the experiment. The experiment is anonymous. Your identity will not be revealed to other participants and the identity of others will not be revealed to you.

The experiment consists of two parts. For both parts, you will get a separate set of instructions. The instructions for Part 1 are on the next page. The instructions for Part 2 will be distributed after Part 1 has finished.

Instructions Part 1

There are two players: player 1 and player 2. The task of player 1 is to choose between UP or DOWN. Player 2 is a passive player.

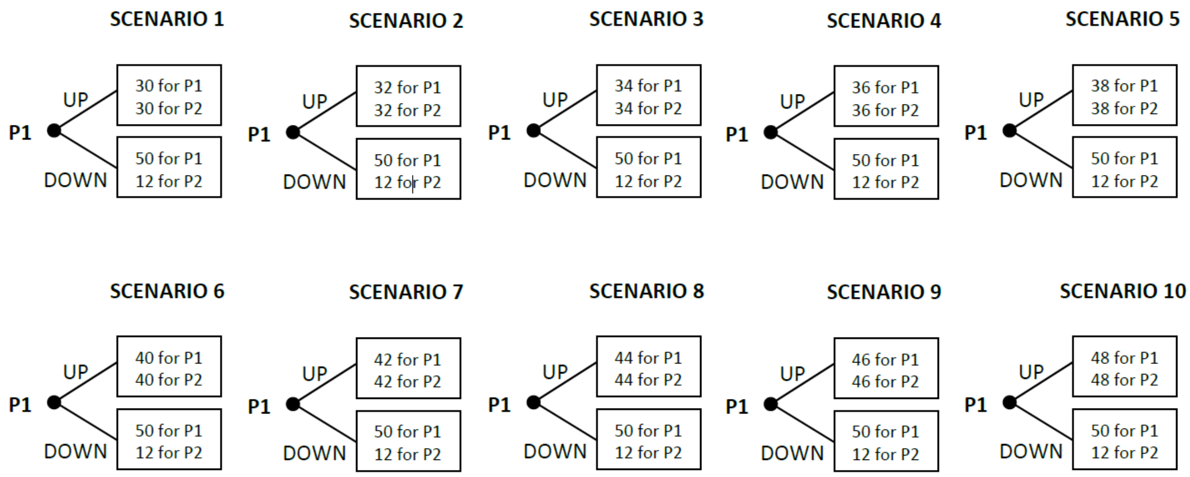
- If player 1 chooses UP, both players earn the same amount, which will be between 30 and 48 points depending on the scenario.
- If player 1 chooses DOWN, player 1 earns 50 points and player 2 earns 12 points.

In the experiment, there will be 10 scenarios. The figures below show the payoffs in points for both players in each of these 10 scenarios. P1 refers to player 2 and P2 to player 2.

For each scenario we ask you the following: if you have the role of player 1, what do you choose, UP or DOWN?

In order to calculate your earnings, the computer program randomly divides all participants into pairs of a player 1 and a player 2. You will be paid for the role of player 1 or player 2. At the point of decision-making, you don't know which role you have. Also, the computer program randomly selects 1 out of the 10 scenarios that will be used for payment. At the point of decision-making, you don't know which scenario is selected.

At the end of the experiment, you will be informed about the role for which you are paid, the randomly selected scenario and your earnings in Part 1.



Instructions Part 2

In Part 2 you will make decisions in several sequences of rounds. Each sequence of rounds is referred to as a **match**.

In each match, you will be paired with another participant for one or more rounds. Within a match, pairs remain the same. There will be 50 matches in total, and after each match you are randomly paired with another participant for a new match.

At the end of the experiment, one of the 50 matches will be randomly selected for payment by the computer program. Your payment depends on the total points you have earned in that match.

Choices and earnings

In each round of a match, you and the paired participant make a choice between option A and option B. Earnings in a round will be indicated on your computer screen in a table like the one below with Z>Y>X>W:

- If both of you choose A, you both earn Y points.
- If you choose A and the other chooses B, you earn W points and the other earns Z points.
- If you choose B and the other chooses A, you earn Z points and the other earns W points.
- If both of you choose B, you both earn X points.

The table is the same for all participants you will be paired with, and remains the same throughout Part 2.

Table: Earnings in points with Z>Y>X>W

Both choose A	Y	Y
You choose A and other chooses B	W	Z
You choose B and other chooses A	Z	W
Both choose B	X	X

At the end of each round, you will get to see the choice of the paired participant and your earnings in points in that round. You will also get to see the history of choices within the current match.

Number of rounds in a match

The number of rounds in a match is determined **randomly**. At the end of each round, there is a 50% probability that the match continues for at least another round. The computer virtually tosses a fair coin (50% probability of landing on heads and 50% probability of landing on tails) and the outcome of the coin toss will appear on your screen at the end of each round. If the outcome of the coin toss is heads, the match continues to a next round. If the outcome of the coin toss is tails, the match ends.

Control questions

Before decision-making in Part 2 starts, you will be asked to answer a number of control questions on the computer screen. Once everyone has answered all questions correctly, Part 2 starts.

B.2 Instructions sequential games, $\delta = 0.5$

General instruction and instructions for Part 1 are identical to those in section B.1.

Instructions Part 2

In Part 2 you will make decisions in several sequences of rounds. Each sequence of rounds is referred to as a **match**.
In each match, you will be paired with another participant for one or more rounds. Within a match, pairs remain the same. There will be 50 matches in total, and after each match you are randomly paired with another participant for a new match.
At the end of the experiment, one of the 50 matches will be randomly selected for payment by the computer program. Your payment depends on the total points you have earned in that match.

Choices and earnings

In each match you will make decisions in the role of player 1 or player 2. Before each match starts your role will be randomly selected by the computer program and indicated on the screen. It will remain the same throughout that match.
In each round, player 1 and player 2 make a choice between option A and option B.
If you are player 1, you make this choice unconditionally, so you simply choose between A and B.
If you are player 2, you can condition your choice on the choice of player 1. This means you will observe the choice of the other before making your choice between A and B.
Earnings in a round will be indicated on your computer screen in a table like the one below with Z>Y>X>W:

- If both of you choose A, you both earn Y points.
- If you choose A and the other chooses B, you earn W points and the other earns Z points.
- If you choose B and the other chooses A, you earn Z points and the other earns W points.
- If both of you choose B, you both earn X points.

The table is the same for all participants you will be paired with, and remains the same throughout Part 2.

Table: Earnings in points with Z>Y>X>W

Both choose A	Y	Y
You choose A and other chooses B	W	Z
You choose B and other chooses A	Z	W
Both choose B	X	X

At the end of each round, you will get to see your earnings in points in that round. Participants with the role of player 2 will get to see the choice of the paired player 1 in that round, and participants with the role of player 1 will get to see the choice of the paired player 2 in that round. You will also get to see the history of choices within the current match.

Number of rounds in a match

The number of rounds in a match is determined **randomly**. At the end of each round, there is a 50% probability that the match continues for at least another round. The computer virtually tosses a fair coin (50% probability of landing on heads and 50% probability of landing on tails) and the outcome of the coin toss will appear on your screen at the end of each round. If the outcome of the coin toss is heads, the match continues to a next round. If the outcome of the coin toss is tails, the match ends.

Control questions

Before decision-making in Part 2 starts, you will be asked to answer a number of control questions on the computer screen. Once everyone has answered all questions correctly, Part 2 starts.

C Supplement on theory

C.1 Standard theory of a repeated sequential PD

We illustrate that the threshold for mutual cooperation to be an equilibrium outcome is the same under sequential decision-making than under simultaneous decision-making by comparing the expected payoff of a grim trigger strategy (GT) to that of "always defect" (AD). GT is generally defined as follows: "choose C on the first move and continue to do so on future moves as long as both players choose C; if one of the players chooses D, then switch to D forever after" (see for example Dal Bó and Fréchette, 2011). This can be implemented as follows for the first mover in a sequential PD: "choose C in round 1 and continue to do so in round $t > 1$ as long as both players chose C in round $t-1$; if one of the players chose D in round $t-1$, choose D in t and forever after." For the second mover, a GT strategy is implemented as follows: "choose C (D) in round t if the first mover chooses C (D) in round t; choose D unconditionally in round t and forever after if one of the players chose D in round $t-1$".

Both players playing GT constitutes a subgame perfect equilibrium (SPE) if the rate at which players discount the future is sufficiently low, that is, if discount factor δ is sufficiently high (see Propositions 4 and 5 in Friedman, 1971). For the second mover the expected payoff of GT, given that the first mover plays GT, is higher than that of AD if:

$$\begin{aligned} c + \delta c + \delta^2 c + \dots &\geq t + \delta d + \delta^2 d + \dots \\ c + \frac{\delta}{1-\delta} c &\geq t + \frac{\delta}{1-\delta} d \\ \delta &\geq \frac{t-c}{t-d} \equiv \delta^*. \end{aligned}$$

For the first mover the expected payoff of GT is higher than AD, given that the second mover plays GT, if:

$$\begin{aligned} c + \delta c + \delta^2 c + \dots &\geq d + \delta d + \delta^2 d + \dots \\ \frac{c}{1-\delta} &\geq \frac{d}{1-\delta}, \end{aligned}$$

which holds by definition. The condition thus reduces to $\delta \geq \frac{t-c}{t-d} \equiv \delta^*$ (see also Wen, 2002, who proves a folk theorem for repeated sequential games in general).

C.2 Basin of attraction

We follow Dal Bó and Fréchette (2011) and simplify the repeated simultaneous PD to a game with two strategies, namely the always defect (AD) and the grim trigger (GT) strategy, where GT is defined as follows: "choose C in round 1 and continue to do so in round $t > 1$ as long as both players chose C in round $t-1$; if one of the players chose D in round $t-1$, choose D in t and forever after." The basin of attraction of AD is calculated as the maximum probability of the partner using a GT strategy that makes it optimal for a player to always defect. If we assume that p is the probability that the partner uses GT, then the expected payoff of GT is larger than that of using the AD strategy if:

$$\begin{aligned}
p(c+\delta c+\dots)+(1-p)(s+\delta d+\dots) &> p(t+\delta d+\dots)+(1-p)(d+\delta d+\dots)\\
p\left(c+\frac{\delta c}{1-\delta}\right)+(1-p)\left(s+\frac{\delta d}{1-\delta}\right) &> p\left(t+\frac{\delta d}{1-\delta}\right)+(1-p)\left(d+\frac{\delta d}{1-\delta}\right)\\
p &> \frac{d-s}{c+d-t-s+\frac{\delta(c-d)}{1-\delta}} \equiv \bar{p}.
\end{aligned}$$

It can easily be seen that if $\delta < \frac{t-c}{t-d} \equiv \delta^*$, $\bar{p} > 1$, which implies that AD is the optimal strategy then. If $\delta > \delta^*$, there exists a $0 < \bar{p} < 1$ so that GT is optimal for $p > \bar{p}$.

In order to use the concept of basin of attraction in the sequential PD, we also simplify the repeated sequential PD to a game with two strategies, namely AD and GT. We start with calculating the basin of attraction of AD for the second mover by calculating the maximum probability of the first mover using a GT strategy that makes it optimal for the second mover to always defect. If we assume that p_1 is the probability that the first mover uses GT, then the expected payoff of GT for the second mover is larger than that of using the AD strategy if:

$$\begin{aligned}
p_1(c+\delta c+\dots)+(1-p_1)(d+\delta d+\dots) &> p_1(t+\delta d+\dots)+(1-p_1)(d+\delta d+\dots)\\
c+\frac{\delta c}{1-\delta} &> t+\frac{\delta d}{1-\delta}\\
\delta &> \frac{t-c}{t-d} \equiv \delta^*.
\end{aligned}$$

The second mover will thus be "fully attracted" to AD if $\delta < \delta^*$ and to the GT strategy if $\delta > \delta^*$. The implication for the first mover is that he will also be "fully attracted" to AD if $\delta < \delta^*$ and to the GT strategy if $\delta > \delta^*$. The same calculations hold if instead of using a GT strategy, the second mover would use a TFT strategy or another strategy with limited punishment.

D Statistical tests of treatment effects on cooperation rates

Table D.1: Cooperation rate by treatment

			Round 1					All rounds				
			$c = 32$		$c = 40$		$c = 48$	$c = 32$		$c = 40$		$c = 48$
Supergame 1												
		Sim	33.3	$\lll$	70.0	$\approx$	73.3	35.0	$<$	55.0	$\ll$	73.3
			(6.0)		(8.9)		(6.0)	(8.9)		(5.2)		(6.0)
	$\delta = 0.5$		$\wr$		$\vee$		$\vee$	$\wr$		$\wr$		$\wr$
		Seq	43.3	$\approx$	51.7	$\approx$	56.7	40.0	$\approx$	48.8	$\approx$	61.3
			(6.4)		(5.7)		(7.2)	(5.8)		(4.3)		(7.6)
		Sim	43.3	$\approx$	53.3	$\approx$	66.7	19.1	$\ll$	35.3	$\lll$	51.6
			(3.0)		(6.0)		(7.9)	(6.4)		(2.7)		(5.5)
	$\delta = 0.75$		$\vee\vee$		$\wr$		$\wr$	$\wr$		$\wr$		$\wr$
		Seq	28.3	$\ll$	50.0	$\approx$	68.3	26.2	$\ll$	49.5	$\approx$	68.3
			(5.7)		(6.5)		(10.8)	(1.9)		(10.0)		(10.8)
Supergames 1 to 50												
		Sim	6.2	$\lll$	29.1	$\ll$	55.4	6.1	$\lll$	23.9	$\lll$	46.5
			(0.7)		(7.6)		(8.7)	(0.3)		(4.6)		(7.5)
	$\delta = 0.5$		$\wr$		$\wr$		$\wedge\wedge\wedge$	$\wr$		$\wedge\wedge\wedge$		$\wedge\wedge\wedge$
		Seq	10.0	$\lll$	44.1	$\lll$	83.0	8.9	$\lll$	41.9	$\lll$	81.6
			(3.0)		(5.6)		(5.4)	(2.6)		(4.9)		(5.2)
		Sim	22.3	$\lll$	72.4	$\ll$	91.9	14.7	$\lll$	59.0	$\ll$	81.3
			(10.2)		(10.7)		(3.3)	(6.4)		(7.6)		(4.7)
	$\delta = 0.75$		$\wedge\wedge$		$\wr$		$\wr$	$\wedge\wedge\wedge$		$\wr$		$\wr$
		Seq	57.5	$\ll$	77.5	$\approx$	86.0	47.0	$\lll$	69.4	$<$	81.5
			(9.0)		(3.8)		(4.0)	(6.8)		(4.8)		(4.1)
Supergames 31 to 50												
		Sim	2.7	$\lll$	15.8	$\lll$	51.0	2.6	$\lll$	12.8	$\lll$	43.5
			(1.8)		(3.9)		(8.1)	(1.4)		(1.1)		(5.0)
	$\delta = 0.5$		$\wr$		$\wedge\wedge\wedge$		$\wedge\wedge\wedge$	$\wr$		$\wedge\wedge\wedge$		$\wedge\wedge\wedge$
		Seq	7.0	$\lll$	53.7	$\lll$	92.1	6.3	$\lll$	48.5	$\lll$	88.2
			(3.0)		(8.2)		(2.8)	(2.3)		(6.5)		(3.7)
		Sim	24.8	$\lll$	78.5	$\approx$	95.5	16.8	$\lll$	66.4	$<$	86.5
			(3.6)		(6.9)		(4.3)	(8.0)		(11.8)		(4.9)
	$\delta = 0.75$		$\wedge\wedge$		$\wr$		$\wr$	$\wedge\wedge$		$\wr$		$\wr$
		Seq	65.1	$<$	84.4	$\approx$	93.0	46.9	$\ll$	74.1	$\ll$	89.1
			(3.6)		(6.9)		(4.3)	(7.8)		(6.5)		(4.0)
Supergame 50												
		Sim	3.3	$\ll$	16.7	$\lll$	50.0	2.5	$\ll$	16.0	$\ll$	46.0
			(3.0)		(3.0)		(13.7)	(2.6)		(2.2)		(14.0)
	$\delta = 0.5$		$\wr$		$\wedge\wedge\wedge$		$\wedge\wedge\wedge$	$\wr$		$\wedge\wedge\wedge$		$\wedge\wedge\wedge$
		Seq	3.3	$\lll$	56.7	$\lll$	93.3	3.6	$\lll$	40.8	$\lll$	89.7
			(2.0)		(10.1)		(3.2)	(0.8)		(5.0)		(5.0)
		Sim	20.0	$\lll$	80.0	$\approx$	93.3	11.4	$\lll$	80.0	$\approx$	87.5
			(8.9)		(13.7)		(6.0)	(4.6)		(10.8)		(10.6)
	$\delta = 0.75$		$\wedge\wedge$		$\wr$		$\wr$	$\wedge\wedge\wedge$		$\wr$		$\wr$
		Seq	61.7	$<$	85.0	$\approx$	93.3	45.7	$\ll$	72.6	$\approx$	87.9
			(14.2)		(5.4)		(4.7)	(10.5)		(7.8)		(5.2)

Notes: The unit of observation is a participant in a round. Differences between treatments are tested using probit regressions with standard errors (in parentheses) clustered at the matching group level. $<$, $\ll$, and $\lll$ refer to $p < 0.1$, $p < 0.05$. and $p < 0.01$, respectively.

Table D.2: Cooperation rate by treatment including DBF

		Round 1					All rounds				
		$c = 32$		$c = 40$		$c = 48$	$c = 32$		$c = 40$		$c = 48$
Supergame 1											
	Sim	33.8	⋘	60.0	≈	63.2	31.7	<	45.6	≈	52.3
		(3.6)		(6.9)		(4.3)	(4.5)		(5.7)		(9.6)
$\delta = 0.5$		≀		≀		≀	≀		≀		≀
	Seq	43.3	≈	51.7	≈	56.7	40.0	≈	48.8	≈	61.3
		(6.4)		(5.7)		(7.2)	(5.8)		(4.3)		(7.6)
	Sim	37.8	≈	44.1	<	60.8	20.7	⋘	32.0	⋘	53.7
		(3.1)		(4.9)		(3.1)	(2.9)		(3.0)		(6.8)
$\delta = 0.75$		≀		≀		≀	≀		∧		≀
	Seq	28.3	≪	50.0	≈	68.3	26.2	≪	49.5	≈	68.3
		(5.7)		(6.5)		(10.8)	(1.9)		(10.0)		(10.8)
Supergames 1 to 50											
	Sim	8.8	⋘	22.3	⋘	43.5	8.1	⋘	19.6	⋘	38.5
		(1.6)		(4.5)		(5.8)	(1.8)		(2.7)		(4.4)
$\delta = 0.5$		≀		⋀⋀⋀		⋀⋀⋀	≀		⋀⋀⋀		⋀⋀⋀
	Seq	10.0	⋘	44.1	⋘	83.0	8.9	⋘	41.9	⋘	81.6
		(3.0)		(5.6)		(5.4)	(2.6)		(4.9)		(5.2)
	Sim	23.9	⋘	67.1	⋘	88.6	17.6	⋘	58.9	⋘	78.8
		(5.3)		(9.2)		(2.5)	(3.4)		(6.1)		(3.3)
$\delta = 0.75$		⋀⋀⋀		≀		≀	⋀⋀⋀		≀		≀
	Seq	57.5	≪	77.5	≈	86.0	47.0	⋘	69.4	<	81.5
		(9.0)		(3.8)		(4.0)	(6.8)		(4.8)		(4.1)
Supergames 31 to 50											
	Sim	4.4	⋘	17.1	⋘	41.4	3.9	⋘	16.3	⋘	36.9
		(1.5)		(3.2)		(6.6)	(1.5)		(2.5)		(4.6)
$\delta = 0.5$		≀		⋀⋀⋀		⋀⋀⋀	≀		⋀⋀⋀		⋀⋀⋀
	Seq	7.0	⋘	53.7	⋘	92.1	6.3	⋘	48.5	⋘	88.2
		(3.0)		(8.2)		(2.8)	(2.3)		(6.5)		(3.7)
	Sim	24.5	⋘	71.0	≪	96.1	16.2	⋘	65.3	≪	88.3
		(9.9)		(11.5)		(3.0)	(7.0)		(8.9)		(4.2)
$\delta = 0.75$		⋀⋀		≀		≀	⋀⋀⋀		≀		≀
	Seq	65.1	<	84.4	≈	93.0	46.9	≪	74.1	≪	89.1
		(10.3)		(5.1)		(3.7)	(7.8)		(6.5)		(4.0)
Supergame 50											
	Sim	5.4	⋘	20.0	⋘	40.8	5.1	⋘	20.0	⋘	41.7
		(2.4)		(2.4)		(7.8)	(2.9)		(1.6)		(6.1)
$\delta = 0.5$		≀		⋀⋀⋀		⋀⋀⋀	≀		⋀⋀⋀		⋀⋀⋀
	Seq	3.3	⋘	56.7	⋘	93.3	3.6	⋘	40.8	⋘	89.7
		(2.0)		(10.1)		(3.2)	(0.8)		(5.0)		(4.9)
	Sim	20.0	⋘	80.0	≈	93.3	11.4	⋘	80.0	≈	87.5
		(8.9)		(13.7)		(6.0)	(4.6)		(10.8)		(10.6)
$\delta = 0.75$		⋀⋀		≀		≀	⋀⋀⋀		≀		≀
	Seq	61.7	<	85.0	≈	93.3	45.7	≪	72.6	≈	87.9
		(14.2)		(5.4)		(4.7)	(10.5)		(7.8)		(5.2)

Notes: Data from Sim include data from the first up to 50 supergames played in the experiment of DBF. Differences between treatments are tested using probit regressions with standard errors (in parentheses) clustered at the matching group level. $<$, $\ll$, and $\lll$ refer to $p < 0.1$, $p < 0.05$. and $p < 0.01$, respectively.

Table D.3: Effect of $\delta = 0.75$ versus $\delta = 0.5$ on cooperation rate

	Round 1			All rounds		
	$c = 32$	$c = 40$	$c = 48$	$c = 32$	$c = 40$	$c = 48$
Supergame 1						
Sim	$\approx$	$\approx$	$\approx$	$\approx$	$\lll$	$\ll$
Seq	$<$	$\approx$	$\approx$	$\ll$	$\approx$	$\approx$
Supergames 1 to 50						
Sim	$\gg$	$\ggg$	$\ggg$	$>$	$\ggg$	$\ggg$
Seq	$\ggg$	$\ggg$	$\approx$	$\ggg$	$\ggg$	$\approx$
Supergames 31 to 50						
Sim	$\ggg$	$\ggg$	$\ggg$	$\gg$	$\ggg$	$\ggg$
Seq	$\ggg$	$\ggg$	$\approx$	$\ggg$	$\ggg$	$\approx$
Supergame 50						
Sim	$>$	$\ggg$	$\ggg$	$\approx$	$\ggg$	$\gg$
Seq	$\ggg$	$\gg$	$\approx$	$\ggg$	$\ggg$	$\approx$

Notes: Differences between treatments are tested using probit regressions with standard errors clustered at the matching group level. $<$, $\ll$, and $\lll$ refer to $p < 0.1$, $p < 0.05$. and $p < 0.01$, respectively.

Table D.4: Effect of $\delta = 0.75$ versus $\delta = 0.5$ on cooperation rate including data from DBF

	Round 1			All rounds		
	$c = 32$	$c = 40$	$c = 48$	$c = 32$	$c = 40$	$c = 48$
Supergame 1						
Sim	$\approx$	$<$	$\approx$	$\ll$	$\ll$	$\approx$
Seq	$<$	$\approx$	$\approx$	$\ll$	$\approx$	$\approx$
Supergames 1 to 50						
Sim	$\ggg$	$\ggg$	$\ggg$	$\ggg$	$\ggg$	$\ggg$
Seq	$\ggg$	$\ggg$	$\approx$	$\ggg$	$\ggg$	$\approx$
Supergames 31 to 50						
Sim	$\ggg$	$\ggg$	$\ggg$	$>$	$\ggg$	$\ggg$
Seq	$\ggg$	$\ggg$	$\approx$	$\ggg$	$\ggg$	$\approx$
Supergame 50						
Sim	$\gg$	$\ggg$	$\ggg$	$\approx$	$\ggg$	$\ggg$
Seq	$\ggg$	$\gg$	$\approx$	$\ggg$	$\ggg$	$\approx$

Notes: Sim includes data from the first 50 supergames played in the experiment of DBF. Differences between treatments are tested using probit regressions with standard errors clustered at the matching group level. $<$, $\ll$, and $\lll$ refer to $p < 0.1$, $p < 0.05$. and $p < 0.01$, respectively.

Table D.5: Cooperation rates in Seq by role and treatment

			Round 1					All rounds				
			$c = 32$		$c = 40$		$c = 48$	$c = 32$		$c = 40$		$c = 48$
Supergame 1												
	P1	$\delta = 0.5$	53.3	≈	66.7	≈	56.7	47.5	≈	60.0	≈	62.5
			(8.0)		(9.4)		(5.9)	(7.0)		(7.4)		(6.6)
			≀		≀		≀	∨∨		≀		≀
		$\delta = 0.75$	40.0	≈	60.0	≈	80.0	30.5	≪	54.3	≈	80.0
			(8.5)		(8.5)		(13.0)	(2.3)		(9.4)		(13.0)
	P2	$\delta = 0.5$	56.3	≈	45.0	<	76.5	57.9	≈	50.0	<	80.0
			(6.3)		(9.0)		(13.2)	(3.6)		(9.2)		(11.1)
			∨		≀		≀	≀		≀		≀
		$\delta = 0.75$	25.0	<	55.6	≈	70.8	50.0	≈	71.9	≈	70.8
			(13.5)		(5.7)		(12.3)	(11.1)		(10.2)		(12.3)
Supergames 1 to 50												
	P1	$\delta = 0.5$	13.2	⋘	52.4	⋘	87.2	12.2	⋘	47.7	⋘	84.8
			(3.6)		(5.2)		(5.0)	(3.2)		(4.9)		(4.6)
			∧∧∧		∧∧∧		≀	∧∧∧		∧∧∧		≀
		$\delta = 0.75$	63.1	≪	83.1	≈	89.7	50.0	⋘	72.3	<	83.5
			(8.6)		(3.2)		(3.3)	(7.1)		(4.6)		(3.9)
	P2	$\delta = 0.5$	39.9	≪	64.1	⋘	88.9	37.2	⋘	71.6	⋘	90.9
			(9.0)		(5.2)		(3.2)	(6.9)		(3.7)		(2.8)
			∧∧∧		∧∧∧		≀	∧∧∧		∧∧∧		≀
		$\delta = 0.75$	78.0	≈	85.2	≈	90.6	81.2	⋘	90.9	≈	93.9
			(5.2)		(2.6)		(2.6)	(1.8)		(1.6)		(1.4)
Supergames 31 to 50												
	P1	$\delta = 0.5$	9.5	⋘	61.8	⋘	95.3	9.1	⋘	53.9	⋘	90.6
			(3.7)		(8.2)		(2.3)	(3.0)		(6.7)		(3.0)
			∧∧∧		∧∧∧		≀	∧∧∧		∧∧		≀
		$\delta = 0.75$	69.8	≪	89.0	≈	95.0	49.7	≪	76.3	≪	90.8
			(10.1)		(4.0)		(3.2)	(8.2)		(6.3)		(3.7)
	P2	$\delta = 0.5$	43.9	⋘	72.5	⋘	93.2	35.8	⋘	78.4	⋘	94.0
			(11.1)		(4.1)		(2.6)	(7.6)		(2.5)		(2.3)
			∧∧∧		∧∧∧		≀	∧∧∧		∧∧∧		≀
		$\delta = 0.75$	83.3	≈	89.3	≈	95.4	82.4	⋘	93.3	≪	95.6
			(4.5)		(3.2)		(1.7)	(1.4)		(1.2)		(1.4)
Supergame 50												
	P1	$\delta = 0.5$	6.7	⋘	66.7	⋘	100.0	5.6	⋘	42.8	⋘	91.1
			(4.0)		(13.3)		(-)	(0.9)		(5.7)		(4.6)
			∧∧∧		∧∧		∨∨∨	∨∨		≀		≀
		$\delta = 0.75$	63.3	≪	93.3	≈	96.7	47.4	≪	74.4	<	90.8
			(15.9)		(4.0)		(3.2)	(10.7)		(7.3)		(4.5)
	P2	$\delta = 0.5$	0.0	⋘	65.0	⋘	86.7	30.0	⋘	87.0	⋘	96.3
			(-)		(8.7)		(6.4)	(15.7)		(2.8)		(2.7)
			∧∧∧		∧∧		≀	≀		≀		≀
		$\delta = 0.75$	89.5	≈	82.1	≈	93.1	85.9	<	93.0	≈	93.6
			(4.9)		(6.5)		(4.3)	(2.2)		(2.6)		(2.3)

Notes: For first movers (P1) cooperation rates are reported and for second movers (P2) conditional cooperation rates are reported. Differences between treatments are tested using probit regressions with standard errors (in parentheses) clustered at the matching group level. In round 1 of supergame 50 standard errors could not be computed for P1 in $\delta = 0.5, c = 48$ nor for P2 in $\delta = 0.75, c = 32$ because of perfect fit. $<$, $\ll$, and $\lll$ refer to $p < 0.1$, $p < 0.05$. and $p < 0.01$, respectively.

E Known End Game

We report information about our additional treatments (henceforth, KnownEnd treatments) investigating how uncertainty about the future affects cooperation. Different than in Sim and Seq treatments, participants in KnownEnd treatments are informed, at the beginning of each round, if that round is a continuation round or if is the last round of the supergame. Interestingly, the possibility to condition strategies on this additional information does not affect the threshold δ^*. Consider the following "augmented" GT strategy: if the current round is a continuation round cooperate as long as there are no defections, if a defection occurs switch to perpetual defection; if the current round is the last round defect. Since the ex-ante probability for a round to be a continuation round is δ, the equilibrium payoff from the "augmented" GT strategy if round 1 is a continuation round is:

$$c + \delta c + (1-\delta)d + \delta\left[\delta c + (1-\delta)d\right] + \delta^2\left[\delta c + (1-\delta)d\right] + \ldots = c + \frac{\delta}{1-\delta}c$$

A deviation in round 1 from this strategy yields the following payoff:

$$t + d + \delta d + \delta^2 d + \ldots = t + \frac{\delta}{1-\delta}d$$

A player will hence stick to GT if

$$\delta > \frac{t-c}{t-d} = \delta^*.$$

While δ^* is the same as in Sim and Seq under the "augmented" GT strategy, players might be more likely to adopt a cooperative strategy in KnownEnd because in every continuation round they know with *certainty* that there is at least one additional round to play. This feature arguably reduces the intertemporal risk characterizing cooperative strategies.

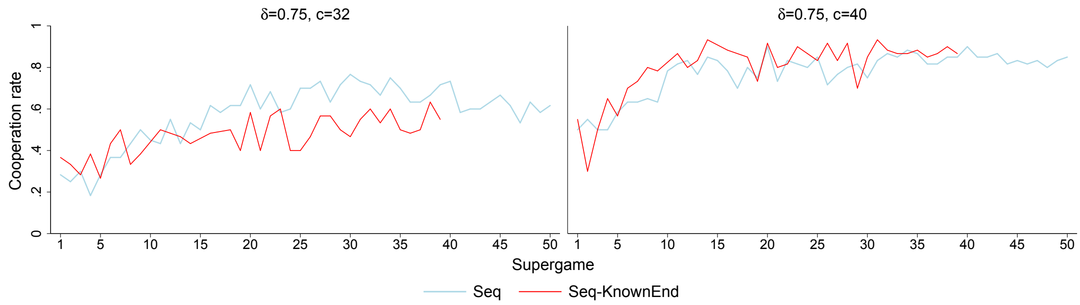
For the KnownEnd treatment, we focus on sequential decision-making where strategic uncertainty is also ruled out. Moreover we set $\delta = 0.75$ in order to avoid incurring in too many supergames that begin and end in round 1.[26] Finally, we discard the treatment $\delta = 0.75, c = 48$, since cooperation rates are already very close to 100% in Sim and Seq. The experimental protocol for the KnownEnd sessions follows closely that of the Sim and Seq sessions. However, since participants were slightly slower in reaching decisions in KnownEnd, we implemented 40 supergames per session instead of 50. Everything else was kept the same. All KnownEnd session were implemented at LINEEX lab in Valencia in November 2018.

Figures E.5 and E.6 summarize the main results for the KnownEnd treatments. In none of the treatments we observe major differences between KnownEnd and Seq, both at an aggregate level (Figure E.5) and when organizing data by role (Figure E.6).[27]

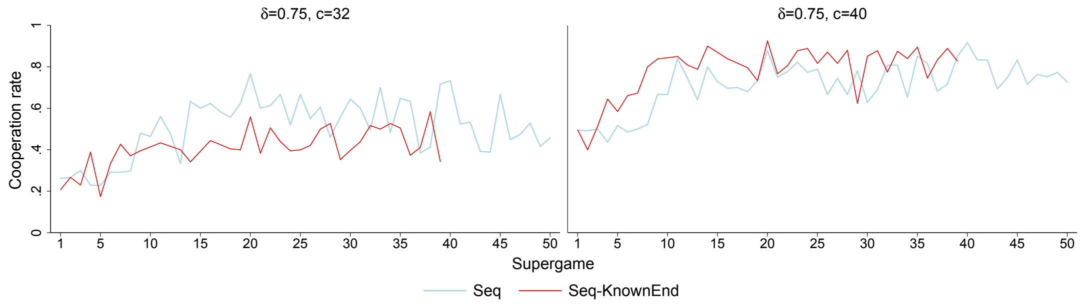
[26] One-round supergames in KnownEnd are essentially one-shot PDs.
[27] Statistical test results are available upon request.

Figure E.5: Evolution of cooperation rate by treatment – Seq vs. KnownEnd

(a) Round 1



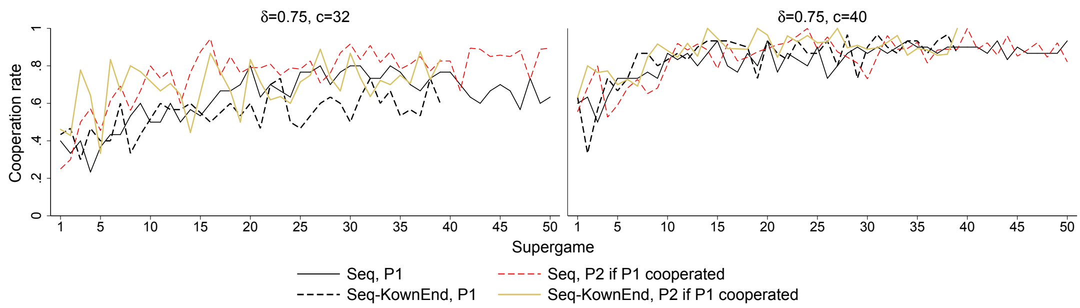
(b) All rounds



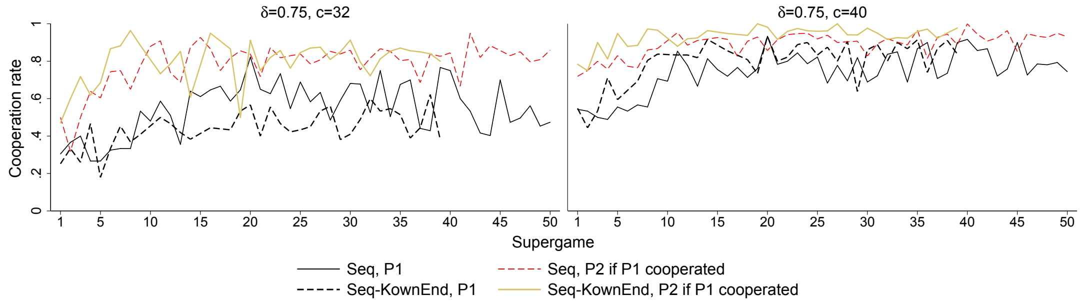
Notes: The figure shows cooperation rates across supergames by treatment. In the KnownEnd treatments only non-last rounds are included. The unit of observation is a participant's decision in a round.

Figure E.6: Evolution of cooperation rate by treatment and role – Seq vs. KnownEnd

(a) Round 1



(b) All rounds



Notes: The figure shows cooperation rates across supergames by treatment. In the KnownEnd treatments only non-last rounds are included. The unit of observation is a participant's choice in a round.

F Supplementary tables

Table F.6: Estimated repeated-game strategies by treatment in supergames 31-50

(a) Sim

	$\delta = 0.5$			$\delta = 0.75$		
	$c = 32$	$c = 40$	$c = 48$	$c = 32$	$c = 40$	$c = 48$
AD	0.727	0.723	0.357	0.477	0.100	0.033
	(0.000)	(0.000)	(0.000)	(0.004)	(0.067)	(0.205)
AC	0.000	0.000	0.033	0.000	0.036	0.097
	(0.381)	(0.500)	(0.219)	(0.438)	(0.208)	(0.206)
GT	0.000	0.000	0.467	0.099	0.442	0.625
	(0.381)	(0.500)	(0.001)	(0.080)	(0.000)	(0.000)
TFT	0.000	0.099	0.000	0.146	0.322	0.245
	(0.381)	(0.027)	(0.325)	(0.040)	(0.015)	(0.036)
D-TFT	0.273	0.177	0.143	0.278	0.100	0.000
γ	0.262	0.437	0.445	0.364	0.318	0.267
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Coop. strat.	0.273	0.277	0.643	0.523	0.900	0.967

(b) Seq, P1

	$\delta = 0.5$			$\delta = 0.75$		
	$c = 32$	$c = 40$	$c = 48$	$c = 32$	$c = 40$	$c = 48$
AD	0.404	0.110	0.000	0.110	0.066	0.033
	(0.046)	(0.141)	(0.500)	(0.145)	(0.207)	(0.242)
AC	0.015	0.002	0.141	0.015	0.097	0.106
	(0.332)	(0.483)	(0.265)	(0.117)	(0.146)	(0.143)
GT	0.001	0.000	0.443	0.277	0.104	0.194
	(0.471)	(0.500)	(0.124)	(0.013)	(0.156)	(0.251)
TFT	0.034	0.634	0.399	0.457	0.700	0.666
	(0.204)	(0.000)	(0.134)	(0.001)	(0.000)	(0.023)
D-TFT	0.546	0.254	0.017	0.141	0.034	0.000
γ	0.350	0.370	0.289	0.362	0.280	0.238
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Coop. strat.	0.596	0.890	1.000	0.890	0.934	0.967

(c) Seq, P2

	$\delta = 0.5$			$\delta = 0.75$		
	$c = 32$	$c = 40$	$c = 48$	$c = 32$	$c = 40$	$c = 48$
AD	0.588	0.245	0.042	0.157	0.083	0.033
	(0.000)	(0.000)	(0.163)	(0.010)	(0.115)	(0.151)
AC	0.000	0.000	0.026	0.000	0.000	0.000
	(0.477)	(0.476)	(0.344)	(0.478)	(0.500)	(0.495)
GT	0.247	0.129	0.207	0.442	0.287	0.533
	(0.057)	(0.166)	(0.234)	(0.002)	(0.007)	(0.036)
TFT	0.165	0.626	0.726	0.401	0.629	0.434
γ	0.234	0.364	0.319	0.439	0.312	0.294
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Coop. strat.	0.412	0.755	0.958	0.843	0.917	0.967

Notes: Estimates from maximum likelihood based on all rounds of all supergames. p-values are in parentheses. The share of cooperative strategies (coop. strat.) is equal to 1 minus the share of AD.

Table F.7: Estimated repeated-game strategies over all supergames

	$\delta < \delta^*$			$\delta > \delta^*$		
	Sim	Seq, P1	Seq, P2	Sim	Seq, P1	Seq, P2
AD	0.695	0.285	0.640	0.302	0.075	0.123
	(0.000)	(0.050)	(0.000)	(0.034)	(0.153)	(0.123)
AC	0.000	0.017	0.000	0.012	0.025	0.000
	(0.258)	(0.320)	(0.469)	(0.306)	(0.313)	(0.493)
GT	0.000	0.017	0.283	0.288	0.165	0.220
	(0.258)	(0.193)	(0.002)	(0.019)	(0.205)	(0.041)
TFT	0.000	0.017	0.077	0.251	0.615	0.657
	(0.258)	(0.192)		(0.033)	(0.002)	
D-TFT	0.305	0.665	–	0.146	0.121	–
γ	0.356	0.421	0.289	0.417	0.400	0.391
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Coop. strat.	0.305	0.715	0.360	0.698	0.925	0.877

Notes: Estimates from maximum likelihood based on all rounds of all supergames. p-values are in parentheses. The share of cooperative strategies (coop. strat.) is equal to 1 minus the share of AD.

Table F.8: Full set of estimated repeated-game strategies

	$\delta < \delta^*$		$\delta > \delta^*$	
	Sim	Seq, P1	Sim	Seq, P1
AD	0.551	0.284	0.282	0.071
	(0.000)	(0.063)	(0.038)	(0.159)
AC	0.000	0.017	0.007	0.008
	(0.215)	(0.301)	(0.387)	(0.417)
GT	0.000	0.011	0.250	0.155
	(0.215)	(0.202)	(0.042)	(0.162)
TFT	0.000	0.011	0.196	0.551
	(0.215)	(0.208)	(0.050)	(0.000)
T2	0.000	0.000	0.001	0.018
	(0.215)	(0.500)	(0.475)	(0.406)
TF2T	0.000	0.000	0.033	0.070
	(0.215)	(0.471)	(0.230)	(0.177)
2TFT	0.000	0.011	0.051	0.000
	(0.215)	(0.200)	(0.232)	(0.500)
LGT2	0.000	0.000	0.014	0.000
	(0.215)	(0.471)	(0.341)	(0.500)
D-TFT	0.187	0.645	0.080	0.072
	(0.014)	(0.000)	(0.124)	(0.196)
D-TF2T	0.000	0.010	0.013	0.015
	(0.215)	(0.287)	(0.312)	(0.321)
D-2TFT	0.262	0.000	0.067	0.039
	(0.015)	(0.500)	(0.214)	(0.248)
D-LGT2	0.000	0.011	0.007	0.000
γ	0.353	0.417	0.409	0.394
	(0.000)	(0.000)	(0.000)	(0.000)
Coop. strat.	0.449	0.716	0.718	0.929

Notes: Estimates from maximum likelihood based on all rounds of all supergames. p-values are in parentheses. The share of cooperative strategies (coop. strat.) is equal to 1 minus the share of AD. The description of the additional strategies is in Table F.9.

Table F.9: Description of additional repeated-game strategies

Strategy	Abbreviation	Description
Tit-for-2 Tat	TF2T	Play C unless partner played D in both of the last two rounds
2 tit-for-tat	2TFT	Play C unless partner played D in either of the last two rounds
Lenient Grim 2	LGT2	Play C until two consecutive rounds occur in which either player played D, then play D forever
Defective tit-for-tat	D-TFT	Play D in the first round, then play TFT
Defective Tit-for-2 Tat	D-TF2T	Play D in the first round, then play TF2T
Defective 2 tit-for-tat	D-2TFT	Play D in the first round, then play 2TFT
Defective Lenient Grim 2	D-LGT2	Play D in the first round, then play LGT2

Note: Definitions are mostly based on Fudenberg, Rand, and Dreber (2012).

Table F.10: Robustness checks of the correlates of cooperation in round 1 of all supergames

Dep. var.:	Sim			Seq, P1			Seq, P2		
Cooperate (yes=1)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Equal distribution	0.083			0.079**			0.077**		
	(0.121)			(0.012)			(0.017)		
Risk taking		0.026			0.029*			0.021	
		(0.271)			(0.051)			(0.122)	
Mistakes in quiz			-0.015			0.022***			0.050***
			(0.263)			(0.001)			(0.006)
$\delta > \delta^*$	0.438***	0.455***	0.459***	0.589***	0.609***	0.628***	0.391***	0.412***	0.459***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$\delta > \delta^* \times$ Mistakes in quiz			0.008			-0.023***			-0.062***
			(0.649)			(0.009)			(0.001)
Male	0.061	0.059	0.058	0.094***	0.088***	0.094***	0.062*	0.056*	0.058*
	(0.203)	(0.209)	(0.207)	(0.007)	(0.010)	(0.007)	(0.053)	(0.069)	(0.065)
Supergame number	-0.001	-0.001	-0.001	0.004***	0.004***	0.004***	0.004***	0.004***	0.004***
	(0.340)	(0.340)	(0.340)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Length of past supergame	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.002	0.002
	(0.466)	(0.468)	(0.467)	(0.307)	(0.269)	(0.331)	(0.216)	(0.257)	(0.249)
Constant	0.044	-0.002	0.092**	-0.034	-0.107*	-0.017	0.210***	0.166*	0.210***
	(0.286)	(0.980)	(0.011)	(0.386)	(0.088)	(0.692)	(0.004)	(0.052)	(0.001)
Observations	9000	9000	9000	9000	9000	9000	5831	5831	5831
Log pseudolikelihood	-4055.651	-4069.140	-4089.301	-3890.546	-3894.427	-3920.432	-2218.619	-2228.686	-2224.564

Notes: Estimates from multilevel mixed-effects linear regressions including random effects at the matching group level and standard errors adjusted for clustering at the matching group level. The unit of observation is a choice of participant in round 1 in columns (1) and (2); in column (3) we only consider conditional cooperation choices. p-values are in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table F.11: Robustness checks of the correlates of cooperation in round 1 of supergames 31-50

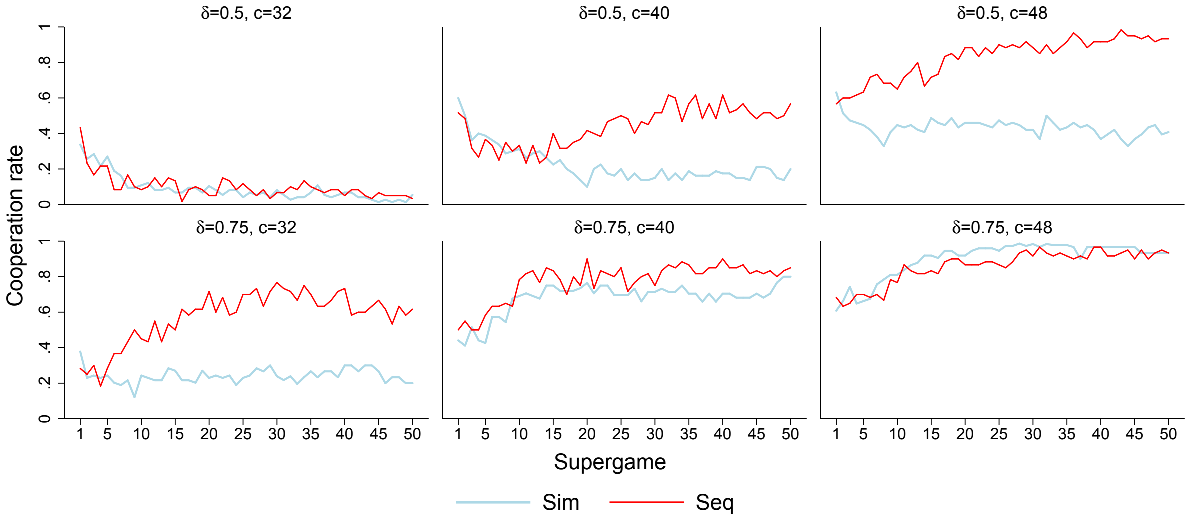
Dep. var.:	Sim			Seq, P1			Seq, P2		
Cooperate (yes=1)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Equal distribution	0.101**			0.075**			0.081**		
	(0.042)			(0.031)			(0.032)		
Risk taking		0.039			0.027			0.026*	
		(0.113)			(0.115)			(0.094)	
Mistakes in quiz			-0.015			0.014			0.032
			(0.271)			(0.380)			(0.720)
$\delta > \delta^*$	0.459***	0.478***	0.482***	0.701***	0.718***	0.736***	0.452***	0.478***	0.502***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$\delta > \delta^* \times$ Mistakes in quiz			0.011			-0.018			-0.041
			(0.531)			(0.329)			(0.643)
Male	0.057	0.054	0.054	0.086**	0.081**	0.085**	0.053	0.047	0.049
	(0.235)	(0.269)	(0.247)	(0.020)	(0.027)	(0.021)	(0.104)	(0.136)	(0.128)
Supergame number	-0.002	-0.002	-0.002	-0.001	-0.001	-0.001	-0.002**	-0.002**	-0.002**
	(0.114)	(0.114)	(0.114)	(0.285)	(0.321)	(0.288)	(0.017)	(0.010)	(0.017)
Length of past supergame	0.000	0.000	0.000	-0.000	-0.000	-0.000	0.001	0.001	0.001
	(0.881)	(0.889)	(0.883)	(0.878)	(0.920)	(0.797)	(0.564)	(0.636)	(0.544)
Constant	0.057	-0.024	0.112*	0.088	0.019	0.109	0.403***	0.341***	0.420***
	(0.414)	(0.790)	(0.087)	(0.170)	(0.808)	(0.128)	(0.000)	(0.002)	(0.000)
Observations	3600	3600	3600	3600	3600	3600	2523	2523	2523
Log pseudolikelihood	-1287.980	-1287.115	-1314.678	-1015.391	-1017.965	-1030.075	-659.957	-663.711	-668.771

Notes: Estimates from multilevel mixed-effects linear regressions including random effects at the matching group level and standard errors adjusted for clustering at the matching group level. The unit of observation is a choice of participant in round 1 in columns (1) and (2); in column (3) we only consider conditional cooperation choices. p-values are in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

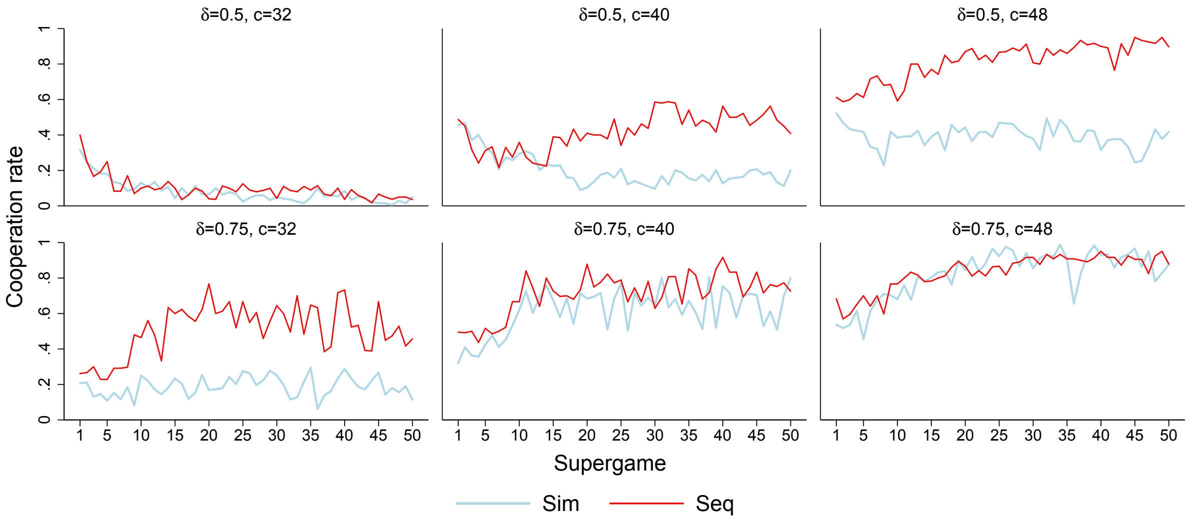
G Supplementary figures

Figure G.1: Evolution of cooperation rates by treatment including data from DBF

(a) Round 1



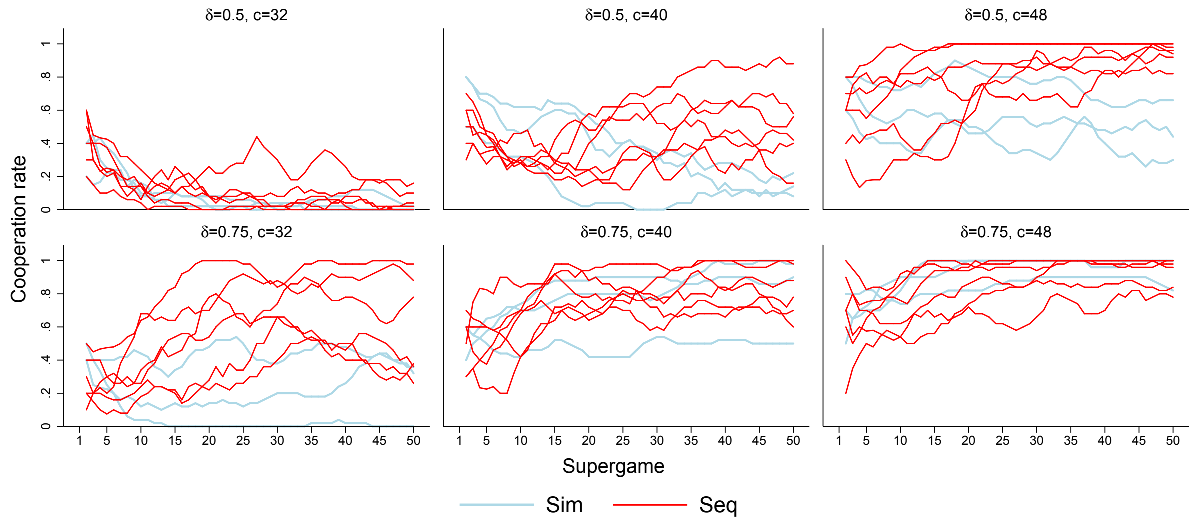
(b) All rounds



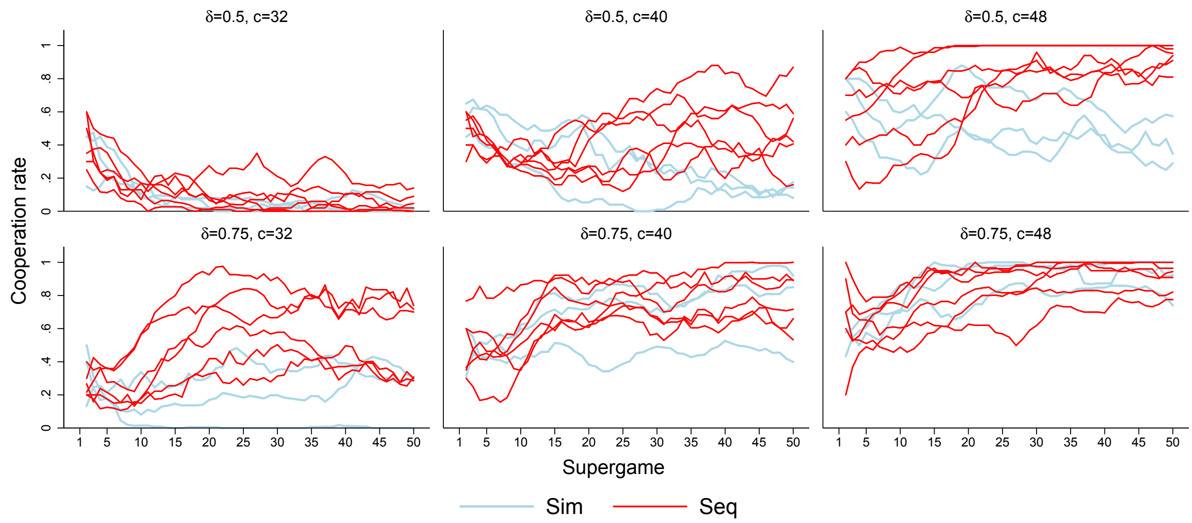
Notes: The figure shows cooperation rates across supergames by treatment. The unit of observation is a participant's decision in a round. Sim includes data from the first 50 supergames played in the experiment of DBF.

Figure G.2: Evolution of cooperation rate by treatment by matching group

(a) Round 1



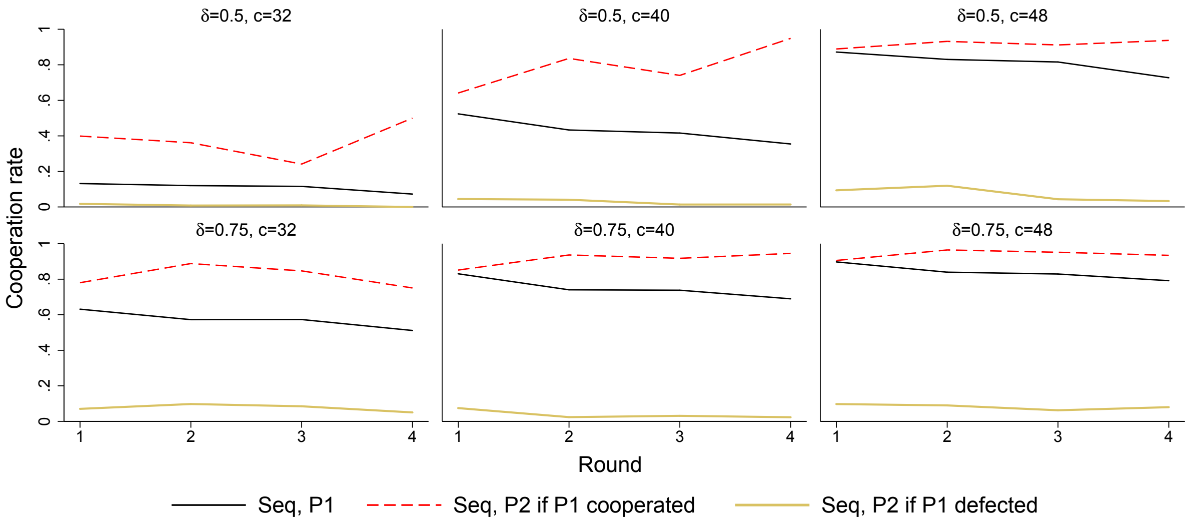
(b) All rounds



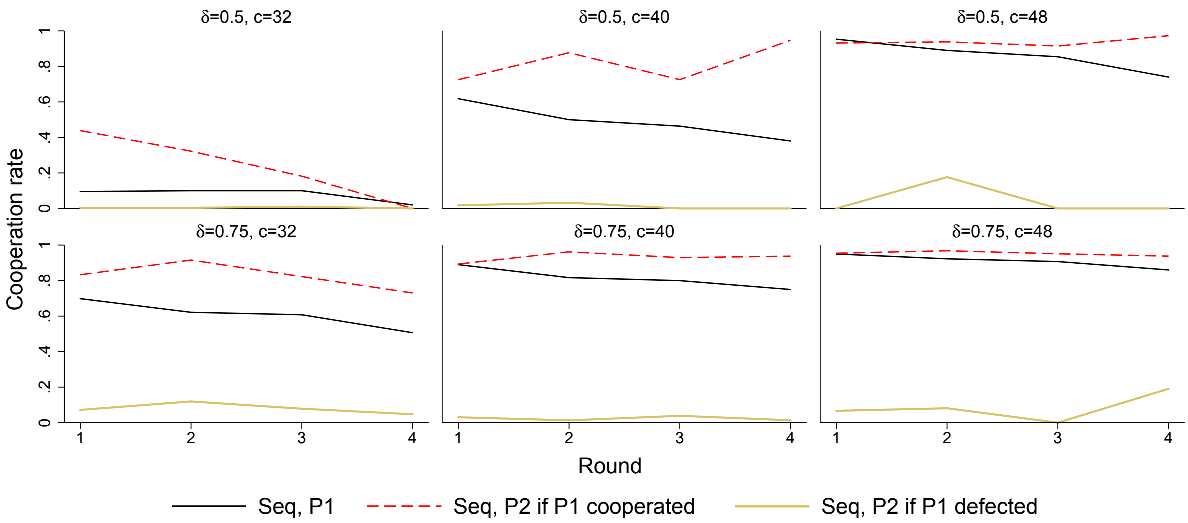
Notes: The figure shows five-supergame moving averages of cooperation rate by supergame and by treatment. Each line depicts a matching group. The unit of observation is a participant's decision in a round.

Figure G.3: Cooperation percentage within supergames (Seq only)

(a) Supergames 1 to 50



(b) Supergames 31 to 50



Notes: The figure shows cooperation rates across supergames by treatment. The unit of observation is a participant's decision in a round.

Figure G.4: The reduced supergame with social preferences

(a) Sim

	GT	AD
GT	$c + \frac{\delta}{1-\delta}c$ $c + \frac{\delta}{1-\delta}c$	$t + \frac{\delta}{1-\delta}d - \rho_2(t-s)$ $s + \frac{\delta}{1-\delta}d$
AD	$s + \frac{\delta}{1-\delta}d$ $t + \frac{\delta}{1-\delta}d - \rho_1(t-s)$	$d + \frac{\delta}{1-\delta}d$ $d + \frac{\delta}{1-\delta}d$

(b) Seq

	GT	AD
GT	$c + \frac{\delta}{1-\delta}c$ $c + \frac{\delta}{1-\delta}c$	$t + \frac{\delta}{1-\delta}d - \rho_2(t-s)$ $s + \frac{\delta}{1-\delta}d$
AD	$d + \frac{\delta}{1-\delta}d$ $d + \frac{\delta}{1-\delta}d$	$d + \frac{\delta}{1-\delta}d$ $d + \frac{\delta}{1-\delta}d$

Notes: Reduced version of the repeated PD where players choose between strategies AD (always defect) and GT (grim trigger), and where player i is characterized by utility function $U_i = (1-\rho_i)\pi_i + \rho_i\pi_j$ if $\pi_i \geq \pi_j$ and $U_i = \pi_i$ if $\pi_i < \pi_j$. Utilities of the column (row) player are below (above) the diagonals. The row (column) player in Seq is the first (second) mover.