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Abstract
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Keywords
Social dilemma experiments, Isomorphic invariance, Public goods game, Prisoners' dilemma game, Voluntary cooperation.

JEL Codes
C71, C92, D70, D90

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Abstract
In this study, we test whether purely behavioral aspects affect voluntary cooperativeness in Prisoner's Dilemma and Public Good Games, thereby questioning their isomorphic invariance. The experiment compares games whose identical payoffs are described as of the Prisoners' Dilemma or as of linear Public Good. Social dilemma frames are compared between subjects whereas 2- or 3-person games are compared within subjects. We either confront participants with the 2-person before the 3-person game or in reverse order, always without feedback information between rounds. The analysis rejects isomorphic invariance and shows less average cooperativeness, especially more likely free riding, in the case of the Public Good type.

Key words: Social dilemma experiments, Isomorphic invariance, Public goods game, Prisoners' dilemma game, Voluntary cooperation.

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1 Introduction

Isomorphic invariance is an independence requirement which forbids arbitrariness in determining perfectly rational decision making and game playing, although it has been early on shown that behavioral changes are produced by strategically irrelevant aspects for a given game type. So for the Prisoner's Dilemma game Pruitt (1967, 1970) has shown that presenting payoffs via a bimatrix as composed payoffs from own and others' choices affects voluntary cooperativeness. Also naming of the games and actions has been shown to matter both in Prisoner's Dilemma (e.g., Liberman et al., 2004; Zhong et al., 2007; Ellingsen et al., 2012) and Public Good games (e.g., Elliott et al., 1998; Andreoni, 1995; Park, 2000; Dufwenberg et al., 2011; Khadjavi and Lange, 2015).

Of course, experimenters can never be sure which game, if it is at all a well defined game, they implement experimentally. What one has induced experimentally is usually just a normal form game informing about the choice sets, the material payoffs of the various players and, in case of stochastic games, the probabilities of random events. Comprehension by participants is enhanced by trial rounds or controlled by letting participants answer control questions.[1] But when the game form is well understood, participants may import additional motives like intrinsic motivation, for instance, to cooperate (see Gerlach and Jaeger, 2016, who review possible determinants of such effects). Experimentally one may limit such influences via "clean" or neutral framing what, however, has been shown to cause just another framing effect (Engel and Rand, 2014; Eriksson and Strimling, 2014). This questions whether findings not only for a given game type, but also across social dilemma types, like the Public Good and Prisoners' Dilemma type, isomorphic invariance can be confirmed or is even less likely.

Experimentally so far attention has been devoted to comparing levels of voluntary cooperativeness for isomorphically invariant Common Pool Resources and Public Good games by identifying a possible give-take effect (see Cartwright and Ramalingam, 2019 for a recent review). Instead we try to add to the literature by extending the behavioral comparison of isomorphically invariant social dilemma games across such game types, in particular of the Prisoners' Dilemma, PD, or (linear) Public Good, PG type. In case of rejecting isomorphic invariance we furthermore explore which aspects could question it. To do this we implement 2- and 3- player versions of each game type and vary their sequence of the two games. Section 2 provides more detailed descriptions of the experimental games and states our main research questions; results are presented in Section 3, followed by conclusions in Section 4.

[1]Indeed, misperception due to a specific game-frame can drive the difference in Cooperativeness detected across frames as it has been shown for the "give-take" frame(Fosgaard et al., 2017).

2 Experimental Design and Research Questions

In this study we extend the test of the behavioral validity of isomorphic invariance across PD- and PG-games. At the best of our knowledge, there is no previous comprehensive experimental test of the behavioral invariance across these two social dilemma games. Still, Goetze (1994) has provided a compelling review of the most common features of their experimental implementation: while PD matrices just present the own payoffs resulting from cooperative or non-cooperative actions, payoffs in PG games are presented as resulting from subtracting individual contributions from one's endowment and adding what all gain from collective action; also, "defect" and "not contributing" are a typical jargon difference detected in the two games and, although payoff equivalent, "defect" may suggest failures to take some positive action, while "not contributing" denotes inaction leading to differences in behaviour. Regarding intermediate choice levels most PD-experiments have avoided them via dichotomous choices between cooperating and defecting. By our research we aim to control the many aspects differing in the most common experimental implementations of PG and PD type. We therefore have to retest the null hypothesis that the level of cooperativeness elicited does not vary across the two types considering a limited number of differences. If rejecting isomorphic invariance we will discuss which differences, like details in explaining the payoffs via bimatrices or in words, may explain the different effects across game types and player numbers (see Section 2.1). The experiment involves two consecutive rounds of one game type, framed either as PD or PG. Hence, social dilemmas are compared between subjects. This between subjects comparison is the focus of our experimental analysis as it allows for testing isomorphic invariance *(Research Question 1)*. We further investigate whether findings depend on the number of players: for each game type we let participants interact in groups of 2 and 3 players. Subjects who have interacted in a group of 2, respectively 3, in round 1, interact in a group of 3, respectively 2, in round 2. The order of playing the 2- and 3- person type is varied across sessions, i.e., 2- and 3- person games are compared within subjects. Outcome information is only provided after the second game. Altogether the decision data distinguish:

$n \in \{2, 3\}$, the number of players;

$j \in \{PD, PG\}$, the frame; and

$t \in \{1st, 2nd\}$, the round of play.

Overall, we implement four different experimental conditions across sessions: $j = PD$ & $n = 2$ in $t = 1$; $j = PD$ & $n = 3$ in $t = 1$; $j = PG$ & $n = 2$ in $t = 1$; $j = PG$ & $n = 3$ in $t = 1$.[2] These

[2]Note that in the 2- and 3- person versions participants face different numbers of available choices: $n = 2$ results in a 4×4 payoff table, whereas $n = 3$ the latter is $3 \times 3 \times 3$; $n = 3$ combines the larger number of players with fewer available options in order to reduce complexity differences across n-conditions.

variations may help to answer some more exploratory behavioral questions (*(Research Question 2)* is the effect of the player number frame dependent? *(Research Question 3)* Does familiarity with experimental setting, via confronting the game type with a different number of players before, affect cooperativeness?

2.1 Isomorphic Invariance and Game Frame

Our experimental setup guarantees isomorphic invariance: payoff matrices provided in the PD- and PG-games are identical for each n-condition; the payoff matrix for each condition is presented to the subjects in the round instructions and remains available while they are making their choices. We now provide a simple representation of the theoretical framework for our experiment which illustrates the isomorphic invariance between the PD and PG frames. Player i's payoff is

$$u_i = 1 - c_i + \alpha C.$$

The individual choice c_i is the fraction of the unit endowment ($e = 1$) that player i chooses to contribute in PG, while in PD c_i is the share of the full Cooperativeness strategy $C(= 1)$. Similarly, C is the total contribution (overall share of endowments) in PG and the number of cooperators (share of C strategy) in PD. As previously mentioned, while the experimental implementations of the PG usually allow for intermediate levels of contribution, PD implementations have been mostly experimentally implemented as a dichotomous choice of cooperating or defecting. Still, experimental implementations of Prisoner's dilemmas as a non-binary choice game have been performed (for instance, Goerg and Walkowitz, 2010 and Goerg et al., 2020 implement it as a continuous choice game). In our experiment, we allow for intermediate levels of contribution in PG as well as to choose the degree of Cooperativeness in PD. The fractions of the C strategy (endowment) that they can choose are $\frac{1}{3}$ and $\frac{2}{3}$ when $n = 2$ and $\frac{1}{2}$ when n=3,[3] in addition to the full Cooperativeness (maximal contribution) and defection (free-riding) strategies. The payoffs in the matrices are determined according to the following parameters: the initial endowment of points for contributing in PG is 240, which corresponds to the points earned in PD if everyone defects. The other payoffs are calculated according to the formula provided in this section for a value of α equal to 0.9 when $n = 2$ and to 0.6 when $n = 3$.[4] The payoff matrices for each $n-$condition are presented in Appendix B.

While the payoff matrix presented in each game-frame is identical due to isomorphic invariance, the task is presented differently in the two game frames. In Table 2, we present an extract from the instructions for the condition $n = 2$ that exemplifies the difference between the two game frames.

[3] Note that the two conditions may differ in the level of complexity, as $n = 2$ results in a 4×4 payoff table, whereas $n = 3$ the latter is $3 \times 3 \times 3$.

[4] We control for efficiency incentives by varying the MPCR, $alpha$, such that $\alpha_{n=3} = \frac{2}{3}\alpha_{n=2}$

PD	PG
In this round you will interact with one other participant. You and the other participant can choose among four options: two options are denoted as option o and option a. The other two options, available to each of you, are the intermediate option M_1, on the basis of which 1/3 of option o and 2/3 of option a are used, and the intermediate option M_2, on the basis of which 1/3 of option a and 2/3 of option o are used. [...]	In this round you will interact with one other participant. Each of you is endowed with 240 tokens. You and the other participant have four choice options specifying how many of these tokens each of you invests in a joint project from which both you both gain equally (i.e., how much each of you gains from the joint project depends only on the sum of both investments in the joint project). [...]
For example, if both of you choose option o, respectively a, you will obtain 240, respectively 432. You obtain 456 when you choose o and the other a, and 216 when you choose a and the other o. If you both choose M_1, respectively M_2, each of you obtains 304, respectively 368.	For example, if both of you choose to invest 0, respectively 240 tokens, each of you obtains 240, respectively 432. You obtain 456 when you invest 0 tokens and the other 240, and 216 when you invest 240 tokens and the other 0. If you both choose to invest 80, respectively 160 tokens, each of you obtains 304, respectively 368.

Table 2: Framing of round-specific instructions $n = 2$.

The verbal presentation differs in the presentation of the task across game type; in particular, in PG frame we refer to a token endowment which can be used to contribute to a common project. As noted by Goetze (1994), the PG type often mentions nonexcludable, i.e., public, good ("the common project") which is more implicit in PD. On the one hand, more explicitly referring to the "common project" might highlight that contributing is efficiency enhancing and then increase cooperation. On the other hand, referring to initial token endowments in PG may suggest being entitled to it (see Hoffman and Spitzer, 1985) and people might then feel less compelled to contribute. In the same vein, receiving tokens at the beginning of the round might create an endowment effect negatively affecting their level of cooperation as PG's verbal description highlights wealth changes in payoffs due to contribution; instead, the PD's presentation of the payoffs seems in terms of final wealth rather than as changes of wealth.[5] Finally, our verbal instructions limit the influence of jargon like "defect" and "not contributing" as we refer to contribute in PG, but we do not contrast it with the term "defection" in PD.

[5]This "Payoff wealth" argument is mentioned by Goetze (1994) who illustrates frequent differences in presenting PG games, compared to PD games.

2.2 Experimental Procedure

General instructions are presented before round 1, while specific instructions for each task are shown only before the corresponding round. The general instructions inform subjects that they will play more than one round, without specifying the exact number of rounds, that they will never interact with the same subject(s),[6] and that one round will be randomly drawn for payment. The general instructions also specify the formula for transforming points P, earned in that round, in the probabilities of earning either 4 or 14 euros, so that each participant earns in the experiment either 4 or 14 euros in addition to the show-up fee of 6 euros. The specific instructions inform subjects about the number of players and the game, including its payoff matrix, to be played in that round. Before deciding in a given round, subjects answered two control questions and could proceed only when answering them correctly, except when two minutes had elapsed. In this case, subjects were provided with feedback about the correct answer after the two minutes. In each rou nd subjects select one of their available choices and state their non-incentivized beliefs about the choice behavior of the other group member(s). After the experiment participants completed a non-incentivized questionnaire eliciting demographics, self-reported risk attitude (Dohmen et al., 2011), personality traits (Rammstedt and John, 2007) as well as a six-item cognitive reflection test (Primi et al., 2016). The experiment was run in February 2022 using the Luiss Cesare Lab and involved 192 participants in 8 sessions (48 subjects in each of the four experimental conditions). Sessions lasted, on average, 45 minutes. The average payment of 14.84 euro includes the participation fee of 6 euro. The English version of the Instructions can be found in Appendix B.

The experiment was programmed in oTree (Chen et al., 2016) and involved only students of Luiss University, recruited via ORSEE (Greiner, 2015).

3 Results

We first provide the results for our main research question (R.1), i.e., whether framing affects Cooperativeness. We then focus specifically on testing the hypotheses about the effect of the number of players (R.2) and of the round of play (R.3) on Cooperativeness and checking whether the effects are frame-dependent.

In the following analysis, we normalise individual Cooperativeness: zero and one correspond to dominant freeriding respectively to the fully cooperative choice.

[6] Player groups of 2 and 3 are formed from matching groups of six participants to determine the final payment.

3.1 Cooperativeness

Figure 1 illustrates and Table 3 reports average Cooperativeness across game-frames, rounds, and group sizes. Average Cooperativeness tends to be higher in PD than in PG, although the overall difference is, with 0.42 for PD and 0.35 for PG, not statistically significant. More specifically, how the game-frame affects Cooperativeness depends on n $(= 3)$ and round of play: the difference in Cooperativeness in PD and PG is significant in the second round of play (0.43 in PD versus 0.35 in PG) and mildly significant when only two players interact in the second round (0.46 in PD versus 0.30 in PG) or are interacting in both rounds (0.48 in PD versus 0.38 in PG). Cooperativeness is (insignificantly) larger in PG than in PD only when three players interact in the first round (0.35 in PD versus 0.39 in PG).

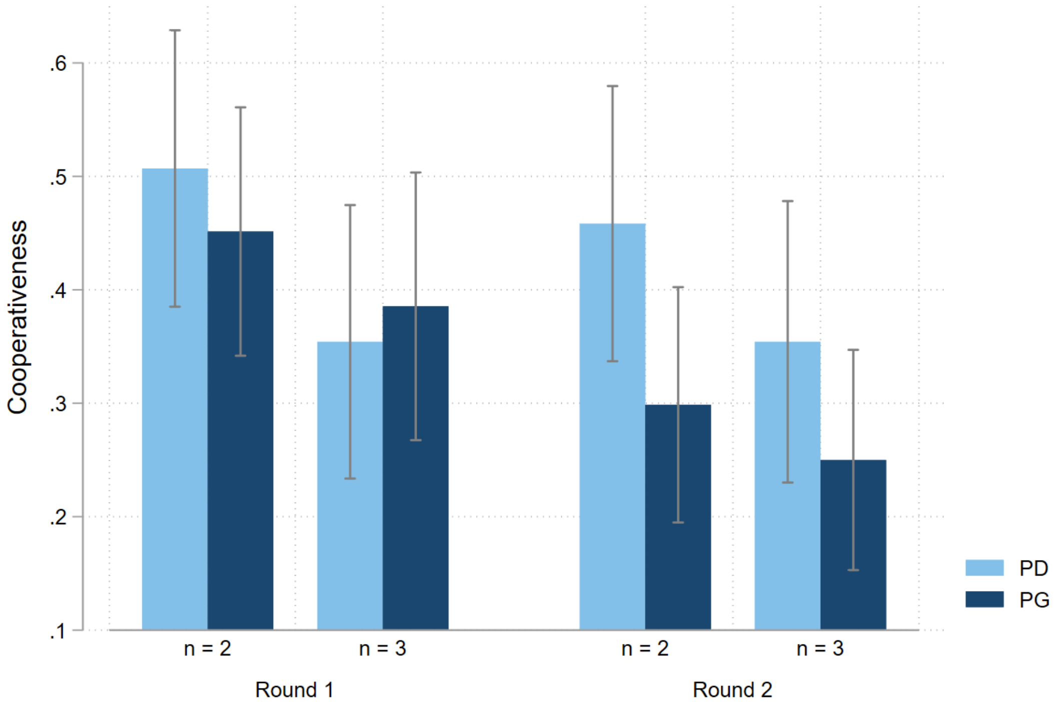

Figure 1: Average cooperativeness across game-frames, rounds, and player numbers.

Table 3: Frame effect on Cooperativeness

		mean PD	mean PG	t test p-value
round 1	$n = 2$	0.507 (0.429) [48]	0.451 (0.386) [48]	0.564
	$n = 3$	0.354 (0.425) [48]	0.385 (0.416) [48]	0.665
	all together †	0.431 (0.432) [96]	0.418 (0.4) [96]	0.959
round 2	$n = 2$	0.458 (0.427) [48]	0.299 (0.365) [48]	**0.071**
	$n = 3$	0.354 (0.437) [48]	0.250 (0.342) [48]	0.324
	all together †	0.406 (0.433) [96]	0.274 (0.353) [96]	**0.049**
all rounds	$n = 2$	0.483 (0.427) [96]	0.375 (0.382) [96]	**0.095**
	$n = 3$	0.354 (0.429) [96]	0.318 (0.385) [96]	0.694
	all together †	0.418 (0.431) [192]	0.346 (0.383) [192]	0.157

Notes: p-values refer to t tests of the hypothesis that average cooperativeness does not differ in the two groups. Standard deviations are in parentheses. Number of observations are in brackets.

† These tests encompass two choices per subject.

How Cooperativeness depends on round of play and the number of players according to Table 3 suggests controlling for these variables via regression analysis. The first column of Table 4 confirms a significant and negative effect of the PG-frame on Cooperativeness. Moreover, it also reveals significant effects of both rounds of play and number of players: subjects cooperate significantly less in $n = 3$ and in the second round. According to the second and third columns of Table 4 these overall effects are mainly due to the game-frame: the effect of round is (in)significant when only considering PG (PD); while the effect of $n = 3$ is (in)significant when only considering PD (PG).[7]

[7] To check whether the two game frames and the number of players (and choices) do not entail a different cognitive burden for participants, we run additional regressions using response time as a dependent variable. Table 8 in Appendix A confirms that the game frame and the number of players (and choices) do not significantly affect either the time (in seconds) needed by participants to choose their cooperativeness level or the total time (in seconds) required to choose both their cooperativeness level and their beliefs about other(s) cooperativeness. Quite expectedly, subjects in round 2 need a significantly smaller amount of time to reach a decision, and the same holds for male participants. Additionally, we have incorporated Table 7 into Appendix A, where it is shown that there are no significant statistical disparities in the self-reported difficulty expressed by the participants across the two game frames. This reinforces the finding that the perceived difficulty remained consistent throughout the study.

Table 4: Overall determinants of Cooperativeness

	All frames (1)	PD (2)	PG (3)
PG	-0.110**		
	(0.050)		
Round 2	-0.084**	-0.024	-0.144***
	(0.037)	(0.057)	(0.045)
$n = 3$	-0.093**	-0.128**	-0.057
	(0.037)	(0.057)	(0.045)
Male	0.021	0.115	-0.011
	(0.056)	(0.079)	(0.080)
Age	-0.003	-0.018	0.004
	(0.011)	(0.015)	(0.023)
Risk lover	0.118*	0.127	0.078
	(0.066)	(0.087)	(0.091)
Economics	-0.028	-0.033	-0.065
	(0.050)	(0.069)	(0.082)
CRT	✓	✓	✓
Personality traits	✓	✓	✓
Observations	384	192	192

Notes: Dependent variable. *Cooperativeness*: variable ranging between 0 and 1. Regressors. *PG*: 1 if PG and 0 if PD. *Round 2*: 1 if round 2 and 0 otherwise; *n=3*: 1 if group size is 3 and 0 if 2. *Individual Controls*: male, age, dummy for self-reported risk attitude, dummy for studying economics, cognitive reflection test (CRT), and personality traits. Specifications are Tobit regressions with clustered standard errors at subject level reported in parentheses.
Significance of coefficients: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

3.2 Dominance

To disentangle how the game-frame affects the frequencies of dominant choices (i.e., $c_i = 0$) and Cooperativeness (i.e., $c_i > 0$) Table 5 presents a Hurdle regression analysis. The first column shows the effects of covariates on the probability of a positive choice, i.e., the probability of abstaining from complete free-riding (contributing zero in both rounds).[8] We find that PG lets subjects significantly more likely to free-ride, while more risk prone subjects tend to make positive choices. The second column shows the effects on the extent of Cooperativeness assuming that choices are positive: Cooperativeness is negatively affected by the PG-frame and positively by self-reported risk tolerance, although the latter effect is weakly significant only.

[8] In the first hurdle we include as individual controls only variables not changing across rounds.

Table 5: Disentangling the effect of framing on dominant choice and positive cooperativeness.

	First Hurdle (1)	Second Hurdle (2)
PG	-0.109**	-0.128***
	(0.048)	(0.048)
$n = 3$		0.044
		(0.036)
Round 2		-0.036
		(0.035)
Male	0.027	-0.033
	(0.052)	(0.051)
Age	0.001	0.005
	(0.01)	(0.009)
Risk love	0.121**	0.096*
	(0.063)	(0.058)
Economics	-0.04	-0.002
	(0.049)	(0.047)
CRT	✓	✓
Personality traits	✓	✓
Observations	384	384

Notes: Regression (1) and (2) are the first and second hurdle of a double hurdle model with clustered standard errors at subject level in the second equation. The dependent variables in (1) and (2) are respectively a dummy variable equal to 1 when cooperativeness is positive, and the level of cooperativeness when cooperativeness is strictly positive. Regressors. *PG*: 1 if PG and 0 if PD. *Round 2*: 1 if round 2 and 0 otherwise; *n=3*: 1 if group size is 3 and 0 if 2. *Individual Controls*: male, age, dummy for self-reported risk attitude, dummy for studying economics, cognitive reflection test (CRT), and personality traits.
Significance of coefficients: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

3.3 Beliefs

How do choices depend on beliefs concerning the cooperativeness of one's co-player(s)? As expected, average beliefs are highly correlated with Cooperativeness (overall correlation: 0.4391, $p < 0.001$). To account for opportunism, let *delta* denote the difference between such (average) belief and cooperativeness at individual level when $n = 2$ ($n = 3$). Figure 2 illustrates the average *delta* levels across game-frame, round, and group size. Unsurprisingly, the differences are always positive: subjects self-servingly cooperate, on average, less than expected for others. Furthermore, when $n = 2$ is played first, *delta* for PD is higher than for PG in both rounds ($p = 0.017$ for round 1 and $p = 0.01$ for round 2), while the opposite is true when $n = 3$ is played in round 1 (although not significantly).[9]

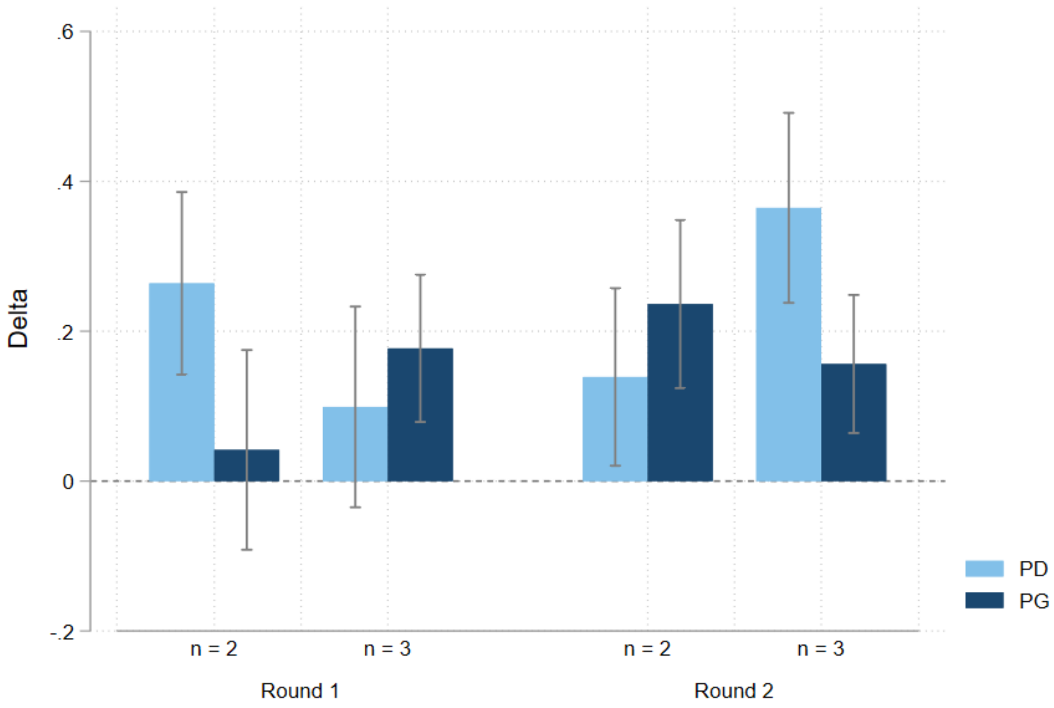

Figure 2: *Delta* across game-frame, rounds, and group size

[9]Note that, given our experimental design, samples in the extreme columns are the same by game-frame, namely subjects who face $n = 2$ in round 1 and $n = 3$ in round 2. The same applies to the two intermediate columns, namely subjects facing $n = 3$ in round 1 and $n = 2$ in round 2.

Table 6: Overall determinants of Beliefs

	All frames (1)	PD (2)	PG (3)
PG	-0.131***		
	(0.043)		
Round 2	-0.006	0.046	-0.057
	(0.034)	(0.049)	(0.046)
$n = 3$	-0.064*	-0.098**	-0.029
	(0.034)	(0.049)	(0.046)
Male	0.069	0.120*	0.050
	(0.046)	(0.070)	(0.060)
Age	-0.028***	-0.040***	-0.037**
	(0.009)	(0.013)	(0.017)
Risk lover	0.016	-0.063	-0.019
	(0.059)	(0.089)	(0.072)
Economics	-0.063	-0.109**	-0.057
	(0.042)	(0.052)	(0.054)
CRT	✓	✓	✓
Personality traits	✓	✓	✓
Observations	384	192	192

Notes: Dependent variable. *(Average) Belief*: variable ranging between 0 and 1. Regressors. *PG*: 1 if PG and 0 if PD. *Round 2*: 1 if round 2 and 0 otherwise; *n=3*: 1 if group size is 3 and 0 if 2. *Individual Controls*: male, age, dummy for self-reported risk attitude, dummy for studying economics, cognitive reflection test (CRT), and personality traits. Specifications are Tobit regressions with clustered standard errors at subject level reported in parentheses.
Significance of coefficients: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Column (1) in Table 6 investigates the effects of the game-frame on (average) beliefs regarding co-players' Cooperativeness. In line with our previous findings, we confirm not only that players cooperate less in PG than in PD, but also expect others to do the same. Moreover, (average) beliefs are negatively and mildly affected by $n = 3$. Columns (2) and (3) report the effects of covariates, separately for PD- and PG-frames. Results show only significant effects of the PD-frame. In particular, $n = 3$ and being enrolled in an Economics major have a negative and significant effect on (average) beliefs. At the same time, males mildly tend to have more optimistic beliefs about co-players' Cooperativeness.

4 Conclusions

In this experimental analysis we show that the choice to cooperate and how much to cooperate depend on whether the collective action is framed as a PD or a PG game, although our setting ensures isomorphic invariance across these social-dilemma games. In particular, our results show that the PG-frame significantly reduces average cooperativeness, also when controlling for familiarity and group size, which affects the strategy sets and their efficiency, e.g. the $MPCR$ in PG. One possible explanation for this result is that, exclusively in the PG-frame, subjects receive tokens at the beginning of the round that might create an endowment effect negatively affecting their level of cooperativeness. Indeed, in spite of isomorphic invariance, implicitly alluding to payoffs as resulting from "payoff wealth" to which one may feel entitled, is more typical for the PG type. Moreover, our findings show that familiarity and group size effects are frame dependent: while familiarity with the setting negatively affects cooperation in PG but not in PD, group size negatively affects cooperation in PD but not in PG. Overall, this warns us against generalizing findings for one Social Dilemma-frame to others, e.g., when trying to predict free-riding or intrinsic efficiency concerns. Since our results regarding the number of players and the number of rounds were only tested on games with two or three players and on two rounds respectively, future research could be focused on examining these two factors across a larger number of rounds and a greater variety of players. Finally, although our design limits frequent differences in presenting these two social dilemma types in the experimental literature as contrasting "defect" in PD with "not contributing" in PG and dichotomous choice in PD *versus* continuous choices in PG, these aspects deserve further investigation.

Declaration of Competing Interest: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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A Extra results

A.1 Balance Table

Table 7: Balance Table

Variable	PD	PG	Pairwise t-test Mean difference
Male	0.531 (0.051)	0.510 (0.051)	0.021
Age	21.219 (0.233)	21.115 (0.196)	0.104
Risk lover	0.813 (0.040)	0.760 (0.044)	0.052
Economics	0.698 (0.047)	0.729 (0.046)	-0.031
CRT	3.104 (0.192)	3.177 (0.183)	-0.073
Difficulty	0.875 (0.034)	0.875 (0.034)	0.000
Time choice round 1	94.000 (6.654)	84.604 (7.533)	9.396
Time choice round 2	77.094 (6.933)	64.615 (6.478)	12.479
Number of observations	96	96	192

Notes: *Balance table.* The values displayed for t-tests are the differences in the means across the groups. Standard errors in parentheses. Variables. male, age, dummy for self-reported risk attitude, dummy for studying economics, cognitive reflection test (CRT), dummy for self-reported difficulty, seconds to choose cooperativeness level in round 1 and in round 2.

Significance of coefficients: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

A.2 Time Analysis

Table 8: Response Times

	(1)	(2)
PG	-7.387 (10.453)	-6.376 (10.535)
Round 2	-18.448*** (5.276)	-17.089*** (5.340)
$n = 3$	6.896 (5.276)	6.734 (5.340)
Male	-29.625*** (9.810)	-31.007*** (9.914)
Age	-0.443 (2.277)	-0.077 (2.238)
Risk lover	-0.340 (11.605)	-1.422 (11.683)
Economics	-3.343 (11.023)	-1.125 (11.003)
CRT	✓	✓
Personality traits	✓	✓
Observations	384	384

Notes: Dependent variables. In (1), *seconds to choose cooperativeness level.* In (2), *seconds to choose cooperativeness level and beliefs.* Regressors. *PG*: 1 if PG and 0 if PD. *Round 2*: 1 if round 2 and 0 otherwise; *n=3*: 1 if group size is 3 and 0 if 2. *Individual Controls*: male, age, dummy for self-reported risk attitude, dummy for studying economics, cognitive reflection test (CRT), and personality traits. Specifications are OLS regressions with clustered standard errors at subject level reported in parentheses.

Significance of coefficients: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

B Instructions

General Instructions

Welcome to this experiment.

In this experiment you can earn either 4 or 14 euro in addition to your show-up fee of 6 euro. Whether you earn 4 or 14 euros depends on P, the payoff that you will gain from the experiment. Whatever your payoff P will be, your probability of earning either 4 or 14 euro will be positive and smaller than 100%. You will win 14 euro with probability

$$(P - 100) \times \frac{100}{500}\%,$$

and 4 euro with the complementary probability

$$100\% - (P - 100) \times \frac{100}{500}\%.$$

Your payoff P in each round depends on your choices and the choices of other participant(s) with whom you are interacting. Only one round will be randomly selected by the computer for you payment. All participants are paid in this way, i.e., all participants earn 4 or 14 euro according to their own payoff P.

In each round, you will interact with randomly chosen participants whose identity we will not reveal to you. In Round 1 you will interact with one other participant ($n = 2$) [two other participants ($n = 3$)]. In round 1, you can choose among four (if n=2) [among three (if $n = 3$)] choice options. You will not interact with the same other participant(s) in more than one round. We now explain how choices determine payoffs P of the interacting participants. You will be informed about your own payoff P of the playoff-relevant round only after the last round.

Prisoners' Dilemma, $n = 2$

Round 1: [In this round you will interact with one other participant. You and the other participant can choose among four options:]

Round 2: [In this second round you will interact only with one other participant. Differently from round 1, you and the other participant can now choose among four options:]

two options are denoted as option o and option a. The other two options, available to each of you, are the intermediate option M_1, on the basis of which 1/3 of option o and 2/3 of option a are used, and the intermediate option M_2, on the basis of which 1/3 of option a and 2/3 of option o are used.

Your and the other player's results, expressed in terms of payoff P, are listed in the following table, for each of the $2 \times 2 \times 4 = 16$ possible combinations of your individual choices.

For example, if both of you choose option o, respectively a, you will obtain 240, respectively 432. You obtain 456 when you choose o and the other a, and 216 when you choose a and the other o. If you both choose M_1, respectively M_2, each of you obtains 304, respectively 368.

At the moment of the decision you may resort to this table, which will be shown on the screen. Moreover, in the same screen, by clicking on the INSTRUCTIONS icon at the top right, you can read again the instructions of the round.

Your choice is	The other's choice is	Your payoff P is	The other's payoff P is
o	o	240	240
	M_1 (1/3 of o and 2/3 of a)	312	232
	M_2 (2/3 of o and 1/3 of a)	384	224
	a	456	216
M_1 (1/3 of o and 2/3 of a)	o	232	312
	M_1 (1/3 of o and 2/3 of a)	304	304
	M_2 (2/3 of o and 1/3 of a)	376	296
	a	448	288
M_2 (2/3 of o and 1/3 of a)	o	224	384
	M_1 (1/3 of o and 2/3 of a)	296	376
	M_2 (2/3 of o and 1/3 of a)	368	368
	a	440	360
a	o	216	456
	M_1 (1/3 of o and 2/3 of a)	288	448
	M_2 (2/3 of o and 1/3 of a)	360	440
	a	432	432

Prisoners' Dilemma, $n = 3$

Round 1: [In this round you will interact with two other participants. You and the other participants can choose among three options:]

Round 2: [In this second round you will interact with two other participants. Differently from round 1, you and the other participants can choose among three options:]

two options are denoted as option o and option a. The other option, available to each of you, is the intermediate option M, on the basis of which 1/2 of option o and 1/2 of option a are used.

Your and the other players' results, expressed in terms of payoff P, are listed in the following table, for each of the $3 \times 3 \times 3 = 27$ possible combinations of your individual choices.

For example, if all three of you choose option o, respectively a, you will obtain 240, respectively 432. You obtain 528 when you choose o and both others a, and 144 when you choose a and both others o. You obtain 384 when you and another choose o and the third a and 288 when you and another choose a and the third o. If you all choose M, each of you obtains 336.

At the moment of the decision you may resort to this table, which will be shown on the screen. Moreover, in the same screen, by clicking on the INSTRUCTIONS icon at the top right, you can read again the instructions of the round.

Your choice is	The others' choices are	Your payoff P is	The others' payoff P are
o	Both play o	240	Both earn 240
	One plays o, the other plays M (1/2 of o and 1/2 of a)	312	One earns 312, the other 192
	One plays o, the other plays a	384	One earns 384, the other 144
	Both play M (1/2 of o and 1/2 of a)	384	Both earn 264
	One plays M (1/2 of o and 1/2 of a), the other plays a	456	One earns 336, the other 216
	Both play a	528	Both earn 288
M (1/2 of o and 1/2 of a)	Both play o	192	Both earn 312
	One plays o, the other plays M (1/2 of o and 1/2 of a)	264	One earns 384, the other 264
	One plays o, the other plays a	336	One earns 456, the other 216
	Both play M (1/2 of o and 1/2 of a)	336	Both earn 336
	One plays M (1/2 of o and 1/2 of a), the other plays a	408	One earns 408, the other 288
	Both play a	480	Both earn 360
a	Both play o	144	Both earn 384
	One plays o, the other plays M (1/2 of o and 1/2 of a)	216	One earns 456, the other 336
	One plays o, the other plays a	288	One earns 528, the other 288
	Both play M (1/2 of o and 1/2 of a)	288	Both earn 408
	One plays M (1/2 of o and 1/2 of a), the other plays a	360	One earns 480, the other 360
	Both play a	432	Both earn 432

Public Good, $n = 2$

Round 1: [In this round you will interact with one other participant. Each of you is endowed with 240 tokens. You and the other participants have four choice options specifying how many of these tokens each of you invests in a joint project from which both you both gain equally (i.e., how much each of you gains from the joint project depends only on the sum of both investments in the joint project).]

Round 2: [In this second round you will interact only with one other participant. Each of you is endowed with 240 tokens. Differently from round 1, you and the other participants have four choice options specifying how many of these tokens each of you invests in a joint project from which both you both gain equally (i.e., how much each of you gains from the joint project depends only on the sum of both investments in the joint project).]

Your payoff P is given by the sum of tokens that you choose not to invest in the common project plus what each of you obtains from the overall investment in the common project.

You and the other participant have the same four choice options concerning the investment in the joint project: two options are 0 and 240, according to which respectively no or all available tokens are invested. The other options are the intermediate options 80 and 160, according to which respectively 1/3 and 2/3 of the endowment of tokens is invested.

Your and the other player's results, expressed in terms of payoff P, are listed in the following table, for each of the $2 \times 2 \times 4 = 16$ possible combinations of your individual choices.

For example, if both of you choose to invest 0, respectively 240 tokens, each of you obtains 240, respectively 432. You obtain 456 when you invest 0 tokens and the other 240, and 216 when you invest 240 tokens and the other 0. If you both choose to invest 80, respectively 160 tokens, each of you obtains 304, respectively 368.

At the moment of the decision you may resort to this table, which will be shown on the screen. Moreover, in the same screen, by clicking on the INSTRUCTIONS icon at the top right, you can read again the instructions of the round.

Your choice is	The other's choice is	Your payoff P is	The other's payoff P is
0	0	240	240
	80	312	232
	160	384	224
	240	456	216
80	0	232	312
	80	304	304
	160	376	296
	240	448	288
160	0	224	384
	80	296	376
	160	368	368
	240	440	360
240	0	216	456
	80	288	448
	160	360	440
	240	432	432

Public Good, $n = 3$

Round 1: [In this round you will interact with two other participants. Each of you is endowed with 240 tokens. You and the other participants have three choice options specifying how many of these tokens each of you invests in a joint project from which both you both gain equally (i.e., how much each of you gains from the joint project depends only on the sum of both investments in the joint project).]

Round 2: [In this second round you will interact with two other participants. Each of you is endowed with 240 tokens. Differently from round 1, you and the other participants have three choice options specifying how many of these tokens each of you invests in a joint project from which both you both gain equally (i.e., how much each of you gains from the joint project depends only on the sum of both investments in the joint project).]

Your payoff P is given by the sum of tokens that you choose not to invest in the common project plus what each of you obtains from the overall investment in the common project.

You and the other participants have the same three choice options concerning the investment in the joint project: two options are 0 and 240, according to which respectively no or all available tokens are invested. The other options is the intermediate options 120, according to which 1/2 of the endowment of tokens is invested.

Your and the other players' results, expressed in terms of payoff P, are listed in the following table, for each of the $3 \times 3 \times 3 = 27$ possible combinations of your individual choices.

For example, if all three of you choose to invest 0, respectively 240 tokens, you will obtain 240, respectively 432. You obtain 528 when you invest 0 tokens and both others 240, and 144 when you invest 240 tokens and both others invest 0. You obtain 384 when you and another choose to invest 0 and the third invests 240, and 288 when you and another choose to invest 240 tokens and the third 0. If you all choose to invest 120 tokens, each of you obtains 336.

At the moment of the decision you may resort to this table, which will be shown on the screen. Moreover, in the same screen, by clicking on the INSTRUCTIONS icon at the top right, you can read again the instructions of the round.

Your choice is	The others' choices are	Your payoff P is	The others' payoff P are
0	Both play 0	240	Both earn 240
	One plays 0, the other plays 120	312	One earns 312, the other 192
	One plays 0, the other plays 240	384	One earns 384, the other 144
	Both play 120	384	Both earn 264
	One plays 120, the other plays 240	456	One earns 336, the other 216
	Both play 240	528	Both earn 288
120	Both play *o*	192	Both earn 312
	One plays 0, the other plays 120	264	One earns 384, the other 264
	One plays 0, the other plays 240	336	One earns 456, the other 216
	Both play 120	336	Both earn 336
	One plays 120, the other plays 240	408	One earns 408, the other 288
	Both play 240	480	Both earn 360
240	Both play 0	144	Both earn 384
	One plays 0, the other plays 120	216	One earns 456, the other 336
	One plays 0, the other plays 240	288	One earns 528, the other 288
	Both play 120	288	Both earn 408
	One plays 120, the other plays 240	360	One earns 480, the other 360
	Both play 240	432	Both earn 432