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Research paper

Inequality, social norms and cooperation: Strategy choice in the infinitely socially iterated prisoner's dilemma☆

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ABSTRACT

Societies today face important challenges related to cooperation, which is needed among individuals who interact at a nonregular frequency. In this context, cooperation can be sustained if social norms push in this direction. We design an online experiment in which participants make strategic choices in an infinitely socially iterated prisoner's dilemma. We examine the effects of inequality on social norms of cooperation and how norm compliance, in turn, affects cooperation. Inequality exists when two participants defect and cooperation gives equal payoffs in one treatment or keeps the unequal payoffs in the other. The results show that inequality weakens social norms by limiting first- and second-order normative beliefs about cooperation as well as descriptive beliefs about the other participants' cooperation. Inequality reduces the likelihood of cooperation mainly driven by the change in social norms. Overall, the mere existence of inequality causes these changes, not specific behaviors, depending on the participants' type.

1. Introduction

The role of inequality in power, status, income, or wealth on long-term economic efficiency has often been discussed (Stiglitz, 2015). Recent evidence supports the conclusion that inequality leads to an inefficient allocation of resources and lower investment and innovation that undermine economic growth (Aghion and Williamson, 1998; Ostry et al., 2014; Piketty, 2013; World Bank, 2005). Furthermore, it is suggested that inequality leads to the erosion of social cohesion, which undermines social norms of cooperation in the long run (Putnam, 2000; United Nations Development Programme, 2013). Social norms are informal rules of behavior in groups and societies that individuals conform to if they believe that most people conform to them and believe that most people believe that people ought to conform to them (Bicchieri, 2006). On the one hand, inequality may alter such beliefs and undermine the existence of the norm. As an example, trustees' reciprocity is commonly observed in a trust game, but this behavior disappears when inequality is introduced. Trustors, anticipating this correctly, adapt their beliefs, which in turn removes the otherwise established norm of reciprocity (Xiao and Bicchieri, 2010). On the other hand, a weakened norm may render sustaining cooperation more difficult. In social dilemma, the ability to communicate between individuals allows for the elicitation of social norms that change individuals' beliefs about others' actions and expectations. However, without the sharing of a common norm, cooperation is much more difficult to sustain (Bicchieri, 2016; Ostrom, 2009). Inequality also plays a role in cooperation issues

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because individuals dislike inequality (Bolton and Ockenfels, 2000; Fehr and Schmidt, 1999), and because inequality prevents equilibrium selection for coordination (Feldhaus et al., 2020; López-Pérez et al., 2015).

The current paper focuses on the question of cooperation in social dilemmas. It aims to address whether inequality in players' endowments diminishes the predominance of the social norm of cooperation and, through this mechanism, whether such inequality reduces cooperation. The question is also whether the expected decrease in cooperation is due to reduced incentives for players with low endowment or the mere presence of inequality. Over the course of a lifetime and for an indefinite period, people often interact with many others at a nonregular frequency and, nevertheless, contribute to the same shared common good. This is the case, for instance, for inhabitants of a neighborhood who contribute to the well-being of the neighborhood, for colleagues from the same firm or department who contribute to the global profit by contributing to various smaller projects, or more generally, for citizens of a country who contribute to national revenues and well-being. In many societal situations, individuals interact repeatedly with other people but not necessarily with the same person. To explore these scenarios, we examine infinitely iterated prisoner's dilemma where individuals in a large group are randomly paired each period and decide whether to cooperate or not. Throughout the paper, we refer to this game as an infinitely socially iterated prisoner's dilemma.

In such a context, cooperation can be sustained if there is a social norm to cooperate, pushing all actors to contribute to the shared common good (Fehr and Schurtenberger, 2018).[1] This social norm is a belief-based mechanism of cooperation that raises different moral concerns such as equity and fairness. Compliance with the social norm depends on the perception of its existence and relevance, while non-compliance may incur direct costs in the form of punishment and ostracism, or indirect costs in the form of moral disapproval and peer pressure.[2] Bicchieri (2006) explains that "a norm can be represented as an equilibrium in the sense that each player maximizes her expected utility if she takes the actions of the other players as given, and the players' beliefs are correct".[3] Social norms can be used as a method for equilibrium selection that may differ between groups or societies (Burke and Young, 2011). The perception of a social norm of cooperation can serve as equilibrium selection in social dilemma with different equilibria depending on whether individual or collective interest is followed (Bicchieri, 2006). However, actors are not all equal, and this questions the relevance of power of the social norm and, thus, the level of cooperation that can be expected.

The economic literature on finite cooperation games shows that inequality negatively impacts cooperation (Ahn et al., 2007; Anderson et al., 2008; Beckenkamp et al., 2007; Buckley and Croson, 2006; Cherry et al., 2005; Fischbacher et al., 2014; Sheposh and Gallo, 1973; Zelmer, 2003).[4] Inequality also reduces the efficiency of instruments such as punishment and communication (Gangadharan et al., 2017; Koch et al., 2021; Nikiforakis et al., 2012; Reuben and Riedl, 2013). Recent research underscores the complexity surrounding the detrimental impact of inequality on cooperation, including questions such as the origins of inequality, i.e. due to performance, endowment, or returns from cooperating and their interdependencies (Gächter et al., 2017b; Hauser et al., 2019), as well as examining the visibility of wealth (Nishi et al., 2015). Besides, the role of inequality on long-term cooperation has been rather underinvestigated. Whereas it has been shown that long-term cooperation can be sustained in infinitely repeated games with stranger matching in the case of repeated interactions of the same pair (Dal Bó and Fréchette, 2011, 2018; Duffy and Ochs, 2009) as well as in anonymous settings (Camera and Casari, 2009; Camera et al., 2012), only two recent articles study the role of inequality in this context. Camera et al. (2020) explore inequality in terms of ex-post payoffs in donor-recipient games. Since the roles of players are randomly assigned between periods, theory suggests that inequality should not influence behavior, as it is payoff-irrelevant. However, they observe that inequality undermines efficient cooperation. This study provides initial insights into the role of inequality in long-term cooperation but only considers unilateral cooperation without accounting for strategic uncertainty regarding others' cooperation, as is the case in social dilemmas, and does not alter monetary incentives to cooperate. In our paper, we examine changes in monetary payoffs when inequality is introduced. Bland et al. (2023) also investigate infinitely repeated prisoner's dilemma games with different incentives under conditions of inequality. They find that the decrease in cooperation in the presence of inequality is due to induced changes in incentives at the aggregate level and fairness considerations at the individual level. Our paper complements this emerging literature by examining the social norm of cooperation and cooperation in a large group where pairs of players are formed under a stranger-matching protocol with no repeated interactions of the same pairs. Additionally, our design allows us to disentangle the pure effect of inequality from changes in incentives to cooperate.

In this paper, we empirically examine the effects of endowment inequality on social norms of cooperation and how norm compliance, in turn, affects cooperation in infinitely socially iterated prisoner's dilemma games. We conducted an online experiment using the strategy method where participants had to decide to cooperate or not in several periods. A fairly large group of participants made choices for repeated interactions in pairs with a stranger-matching protocol, which reflects interactions of people in societies as a succession of interactions in small groups without individual reputation effects. The stranger-matching protocol allows us to capture the repeated but non-regular nature of interactions between individuals in reality. Theoretically, based on the folk

[1] Using the elicitation method of the social norms as appropriate behaviors introduced by Krupka and Weber (2013), it has been found that social norms explain a large series of phenomena such as reciprocity (Gächter et al., 2013; Nikiforakis et al., 2014), fair sharing (Gächter et al., 2017a), promise keeping (Krupka et al., 2017), lying (d'Adda et al., 2017), ethical conduct of financial advisers (Burks and Krupka, 2012), corruption (Banerjee, 2016), discrimination (Barr et al., 2018), and gendered occupational choices (Gangadharan et al., 2016). See also Fallucchi and Nosenzo (2022) for a discussion of the robustness of the Krupka–Weber elicitation method of social norms when other points are made salient for the coordination of the group. They find that the method is indeed robust, particularly when beliefs about the appropriate behavior are clear. More recently, d'Adda et al. (2020) explain all behaviors in a dictator game with personal values and the perception of social norms.

[2] Another approach proposed by Kandori (1992) relies on providing proper incentives to adhere to the norm, utilizing sanctions that affect the entire community, thereby inducing a drop in cooperation across all members through a grim trigger strategy, rather than relying on individual sanctions.

[3] See also Cialdini et al. (1990).

[4] Chan et al. (1996) and Visser and Burns (2015) are rare evidence showing that inequality increases cooperation.

theorem, cooperation can be sustained over time with anonymous random matching (Deb et al., 2016, 2020; Ellison, 1994; Kandori, 1992). Two participants cooperating or two participants defecting are both subgame perfect Nash equilibrium outcomes. The stranger-matching protocol makes beliefs about the cooperation of the entire group become critical to strategy-making.

Achieving cooperation generates additional benefits to be shared among participants. An equal share of these benefits is obvious when the participants have the same amount available to invest in cooperation. When they are, instead, unequal, the distribution of the benefits is questionable: the benefits may either be equally shared or distributed proportionally according to their available investment. These two distribution rules imply different motives, which can lead to a conflict of simultaneous moral concerns. Thus, we compare settings that differ by endowment inequality when the two participants defect or the two cooperate. In two treatments, the participants are equal; either all have a high endowment ('high type') or all have a low endowment ('low type'). In two other treatments, the participants are unequal, with an equal share of high and low type participants. In one treatment, the benefits from cooperation are equally shared between the participants, whereas in the other treatment, the benefits are proportionally distributed. Incentives to cooperate, as well as the temptation to defect, are altered. The comparisons between treatments allow for the identification of the impact of inequality on norms of cooperation and strategies in the infinitely socially iterated prisoner's dilemma game.

The results show that the large majority of participants believe that the decision that should be chosen and that will be chosen is cooperation. Inequality weakens the social norm by decreasing these expectations of cooperation. For both unequal treatments, the mere presence of inequality changes first- and second-order normative beliefs, as well as descriptive beliefs, regardless of the type of the participant and the type of her expected playmate. In turn, the social norm impacts the decision to cooperate with higher beliefs, leading to a greater likelihood of choosing cooperation. The strategy to always cooperate in the long run is less chosen, while the always-defect strategy is instead chosen more in unequal treatments compared to equal treatments. Interestingly, the type, high or low, of participant does not affect choices. It is the mere existence of inequality that causes the changes, not the specific behaviors depending on the participants' type.

Our contribution to the literature is twofold. First, we study the impact of inequality on long-term cooperation in a controlled framework. On the one hand, in most previous studies, the introduction of inequality distorts the trade-off between equality and efficiency that introduces normative conflict, changes incentives to cooperate and biases the evaluation of the role of inequality (Gangadharan et al., 2017). Our study aims to identify the pure effect of inequality on cooperation prohibiting changes in trade-off between equality and efficiency. On the other hand, inequality and cooperation have mainly been studied in finite games, while long-term strategies of cooperation can only be studied in infinite games. Our study aims to fill this gap. Second, we directly elicit social norms perception with normative and descriptive beliefs. Our study aims to explain whether inequality changes the perception of social norms as well as whether strategies are affected by social norm perception.

The rest of the paper is organized as follows. Section 2 presents the experiment. Section 3 shows the results. Section 4 discusses the results and concludes.

2. The experiment

The experiment groups participants by 50 to play an infinitely socially iterated prisoner's dilemma game with participants being randomly matched in pairs at each period and where decisions are elicited with the strategy method.[5] The number of interactions is finite but uncertain, representing indefinitely repeated interactions.[6] At the end of each period, a random draw decides whether a new period starts or not with a continuation probability equal to 0.95. Continuation probability and the size of the group are common knowledge. Participants were unable to identify the other player in their pair. In this section, we detail the game, the different treatments that the participants play in a between-subjects design, the stages of the experiment, the procedures, and theoretical predictions.

2.1. The game

The infinitely socially iterated prisoner's dilemma game consist of two possible actions: cooperate (C) or defect (D).

Payoffs. The gains of player i are calculated based on her voluntary contributions, g_i, and on her playmate j's, g_j, to a public good that has a return of $a = 1.6$. Individual contributions are supposed to be either 0 (D) or the player's entire endowment (C), i.e., $g_i \in \{0, E_i\}$ and $g_j \in \{0, E_j\}$. Cooperation from the two players generates benefits. The distribution of these benefits can be either egalitarian, i.e., player i's gains are $\Pi_i = E_i - g_i + 0.8(g_i + g_j)$, or proportional to the players' endowments, i.e., player i's gains are $\Pi_i = E_i - g_i + 0.8(g_i + \frac{E_i}{E_j} g_j)$. In these two settings, cooperation does not increase relative inequality, which avoids any normative conflict between efficiency and equality (Gangadharan et al., 2017).

The payoffs depend on the two players' actions. When the distribution of the benefits of cooperation is egalitarian, payoffs are as follows (see Table 1).

When the distribution of the benefits of cooperation is proportional, payoffs are as follows (see Table 2).

[5] Another approach in the literature focuses on infinitely repeated prisoner's dilemma with successive supergames, where repeated interactions occur between the same pair of participants (Dal Bó and Fréchette, 2011, 2018; Duffy and Ochs, 2009; Galbiati et al., 2019). This approach creates norms for each supergame based on the reputation of the participants. In contrast, our approach allows us to focus on the norm of the larger group and avoids any reputational or direct reciprocity effects that characterize interactions in an extended society.

[6] We use the random termination period first introduced by Roth and Murnighan (1978). See Dal Bó and Fréchette (2018) for a survey of experiments using infinitely repeated games to study cooperation in this context and a discussion of the methods used to induce infinitely repeated games in the laboratory.

Table 1
Egalitarian distribution of the benefits of cooperation.

		Player j	
		Cooperate	Defect
Player i	Cooperate	$0.8(E_i + E_j)$; $0.8(E_i + E_j)$	$0.8E_i$; $E_j + 0.8E_i$
	Defect	$E_i + 0.8E_j$; $0.8E_j$	E_i ; E_j

Table 2
Proportional distribution of the benefits of cooperation.

		Player j	
		Cooperate	Defect
Player i	Cooperate	$1.6E_i$; $1.6E_j$	$0.8E_i$; $1.8E_j$
	Defect	$1.8E_i$; $0.8E_j$	E_i ; E_j

When endowments are equal, the payoffs are the same in the egalitarian and proportional distribution of cooperation. However, when endowments are unequal, the two types of distribution lead to different payoffs.

Equilibria. In an infinitely iterated prisoner's dilemma game, sufficiently high probability of continuation, δ, enables the existence of multiple subgame perfect equilibria. We focus here on the two equilibria discussed in the literature. On the one hand, all players defecting in all periods is an equilibrium because their individual interest that drives them to best respond to defection by choosing defection as well. On the other hand, for sufficiently high δ, if the player assumes that her playmate is adopting the grim-trigger strategy, i.e., the cooperative strategy providing the strongest punishment when observing defection, she best responds by playing the grim-trigger strategy as well (Camera and Casari, 2009; Camera et al., 2012; Dal Bó and Fréchette, 2018; Ellison, 1994; Kandori, 1992). We calculate the threshold of the probability of continuation that makes cooperation an equilibrium action, δ^{SPE}, accounting for the random-matching structure of interactions and find that it is identical for all players when endowments are equal or when they are unequal with a proportional distribution of the benefits of cooperation. However, δ^{SPE} differs depending on the relative endowments of the players in the egalitarian distribution: δ^{SPE} is higher for high type players and lower for low type players.

The choice of cooperation not only depends on whether cooperation is an equilibrium action (Dal Bó and Fréchette, 2018). Indeed, a player may worry about her low payoff when cooperating while her playmate chooses to defect, which is not included in the calculation of δ^{SPE}. Assuming the always-defect strategy and a cooperative strategy such as grim-trigger in the infinitely repeated prisoner's dilemma game, Blonski and Spagnolo (2015) and Dal Bó and Fréchette (2018) define cooperation as risk dominant in the sense of Harsanyi and Selten (1988) if the grim-trigger strategy is risk dominant, i.e., the best response to the strategy of the other player is to randomize with equal probability between always-defect and grim-trigger. Cooperation is part of a risk-dominant equilibrium if the player's payoff when she chooses the grim-trigger strategy is higher than her payoff when she chooses the always-defect strategy, which is the case for a sufficiently high continuation probability. We calculate the threshold for cooperation to be part of a risk-dominant equilibrium, δ^{RD}, accounting for the random-matching structure of interactions and find that it is identical for all players when endowments are equal or unequal with a proportional distribution of the benefits of cooperation. However, as for δ^{SPE}, δ^{RD} differs depending on the relative endowments of the players in the egalitarian distribution: δ^{RD} is higher for high type players and lower for low type players. Details of calculations are provided in Appendix A.[7]

In the experiment, regardless of the situation, the continuation probability is always 0.95. The high level of this probability and the parameters in the experiment ensure that $\delta > \delta^{SPE}$ and $\delta > \delta^{RD}$, allowing both defection and cooperation to be equilibrium actions.[8]

2.2. Treatments

We conducted four treatments: two equal treatments where all 50 players had the same endowment that was either high or low, and two treatments where half of the 50 players had the high endowment and the other half had the low endowment. The treatments are between subjects, which means that each participant takes part in only one treatment.

2.2.1. Equal treatments

In the equal treatments, we assume $E_i = E_j$. We consider two levels of endowment: the two players in the pair have either low endowment, i.e., $E_i = E_j = E_l = 10$ (*Equal-L treatment*), or high endowment, i.e., $E_i = E_j = E_h = 20$ (*Equal-H treatment*).

Equal-L. The 50 participants have the low endowment $E_l = 10$. Applying the players' gains defined in the previous section, the payoff matrix is as follows (see Table 3).

Equal-H. The 50 participants have the high endowment $E_h = 20$. The payoff matrix is as follows (see Table 4).

[7] See also Camera and Casari (2009) for the calculation of δ^{SPE} with a stranger-matching protocol in a infinitely iterated prisoner's dilemma.

[8] Based on Dal Bó and Fréchette (2018), which emphasizes that the distance to the $\delta > \delta^{SPE}$ and $\delta > \delta^{RD}$ thresholds matters in equilibrium selection, it is possible that high-type players are less likely to cooperate than low-type players when the players in the pair have different endowments in the Unequal-Egalitarian treatment. Nonetheless, the high continuation probability in the experiment still guarantees that both defection and cooperation are equilibrium actions.

Table 3
Payoffs in the Equal-L treatment.

		Player j	
		Cooperate	Defect
Player i	Cooperate	16 ; 16	8 ; 18
	Defect	18 ; 8	10 ; 10

Table 4
Payoffs in the Equal-H treatment.

		Player j	
		Cooperate	Defect
Player i	Cooperate	32 ; 32	16 ; 36
	Defect	36 ; 16	20 ; 20

Table 5
Payoffs in the Unequal-Egalitarian treatment.

		Player j	
		Cooperate	Defect
Player i	Cooperate	24 ; 24	16 ; 26
	Defect	28 ; 8	20 ; 10

Table 6
Payoffs in the Unequal-Proportional treatment.

		Player j	
		Cooperate	Defect
Player i	Cooperate	32 ; 16	16 ; 18
	Defect	36 ; 8	20 ; 10

2.2.2. Unequal treatments

Inequality is introduced assuming that 25 players are low type with endowment $E_l = 10$ and 25 other players are high type with endowment $E_h = 20$. The matching in pairs can either be among players with the same endowment or with unequal endowments. If endowments of the players in the pair are equal, the payoff matrices are the same as in the equal treatments. Below, we present the payoff matrices if endowments are unequal.

Unequal-Egalitarian (UE). When player i in the pair is high type, i.e., she receives $E_h = 20$, and player j is low type, i.e., she receives $E_l = 10$, the payoffs matrix is as follows (see Table 5).

Unequal-Proportional (UP). When player i in the pair is high type, i.e., $E_h = 20$, and player j is low type, i.e., $E_l = 10$, the payoff matrix is as follows (see Table 6).

2.3. Stages

The experiment consists of three stages: in the first stage, the participants learn the overall setup of the experiment; in the second stage, participants' perception of the social norm of cooperation is elicited; in the third stage, participants' decisions to cooperate or defect in the infinitely socially iterated prisoner's dilemma are measured.

First stage: Presentation of the overall setup. At the start of the experiment, participants are informed that they will be making decisions across multiple periods in a game, where they will be randomly paired with another participant from their group at each period. They are also informed that the number of periods is not predetermined but is instead randomly chosen, with a 95% probability of starting a new period at the end of each one. Each possible pairing of types is accompanied by a prisoner's dilemma payoff matrix, which is shown to participants. Only one payoff matrix is presented in the equal treatments whereas four different payoff matrices are presented in the unequal treatments. In the unequal treatments, participants also learn their type that can be high or low. Throughout the remainder of the experiment, participants make their decisions knowing their type. By removing the veil of ignorance, we aim to investigate how individuals' awareness of their relative position affects their behavior in the context of inequality.

Second stage: Elicitation of the social norm of cooperation. Participants begin by answering questions about their beliefs to elicit their perception of the social norm. The social norm elicitation comprises three components: first-order normative beliefs, second-order

normative beliefs, and descriptive beliefs (Bicchieri, 2006). These beliefs pertain to the decisions of other participants in the group, whether to cooperate or defect, in the game as it is presented at this stage, i.e., the infinitely socially iterated prisoner's dilemma with all possible payoff matrices. Beliefs regarding decisions and expectations of other participants in the group is then understood in this framework. The first-order normative beliefs are evaluated by asking the participants what decision (cooperate or defect), in their opinion, participants should make. The second-order normative beliefs assess participants' estimates of the proportion of participants in their group they think would indicate that participants should choose to cooperate. The descriptive beliefs are measured by asking the participants what proportion of participants in their group they think would choose to cooperate in period 1.[9] Responses of the two latter questions are scaled with 0.1 intervals. In unequal treatments, the number of questions for each dimension is doubled for each potential type of the other participant. First-order normative beliefs are not incentivized due to the absence of an objective truth against which correctness can be measured. The second-order normative beliefs and the descriptive beliefs enable participants to earn an additional 50 ECUs for each correct prediction of the respective aggregated beliefs of the group with an acceptable error rate of 10%. Importantly, participants receive no feedback, either on correct answers or on the accuracy of their beliefs. They only learn their earnings at the very end of the experiment.

Third stage: Elicitation of decisions and strategies in the game. Once the belief elicitation stage has been completed, the participants play the infinitely socially iterated prisoner's dilemma game with the strategy method. At each period of the game, the participants are randomly matched with another participant in the group. In both equal and unequal treatments, the participants with whom the participant is randomly paired are all of the same type.[10] The participants learn the type of the participants with whom they will be paired before choosing their decisions and strategies in the game. The participants make different strategy choices in the prisoner's dilemma game, and the matching is done ex-post following (Dal Bó and Fréchette, 2019), who validated the method with dynamic experimental data.[11] This procedure allows us to directly address strategy choices instead of simulating strategies from observed actions (Camera et al., 2012; Dal Bó and Fréchette, 2011; Engle-Warnick et al., 2004; Engle-Warnick and Slonim, 2006). The strategy method offers the possibility of acting as if participants had access to perfect information about their game history, i.e., at the time of their decision, they know the decision their playmate in the previous period has chosen.

In period 1, the participant has to choose between cooperating and defecting. In period 2, she has to choose a decision conditional on the decision of the other participant she was paired with in period 1, i.e., to cooperate or defect if the previous playmate had chosen to cooperate in period 1 and cooperate or defect if the previous playmate had chosen to defect in period 1. After period 2, strategies are elicited. First, we elicit the *memory-one strategy* that corresponds to choosing to cooperate or defect after the choices of the two playmates in the previous period, i.e., cooperate or defect if, in the previous period, the participant chose to cooperate or defect and her previous playmate chose to cooperate or defect. Second, we elicit more complex strategies that participants choose among a *menu of strategies*. From this menu, we identify the following main strategies: always-cooperate, always-defect, tit-for-tat, and grim-trigger (see Appendix C, which indicates how strategies are grouped). Always-cooperate, tit-for-tat, and grim-trigger are cooperation strategies, while always-defect is a defection strategy. One of these two strategies' elicitation method was randomly selected for implementation for the ex-post computation of payoffs.

2.4. Procedures

The experiment was conducted online during 2021. In total, 500 US-located participants were recruited through Amazon Mechanical Turk to participate in the experiment. Each participant could log in alone and progress at her own pace, the matching being completed ex-post. At the end of the experiment, we conducted a socio-demographic questionnaire eliciting gender, age, and educational degree and elicited IQ and *a priori* trust in others to control that our sample is balanced between treatments on standard socio-demographic variables and IQ and trust in others that may affect beliefs and behavior in the experiment. 35.6% were women; 21% were younger than 30 years old, 56% between 30 and 45 years old, 19.8% were between 45 and 60 years old and 3.2% above 60; 19.4% had a degree lower than a bachelor's degree, 61.4% had a bachelor's degree and 19.2% had a master's degree. In the three-item IQ test (Oechssler et al., 2009), 38.8% of the participants gave a correct answer to the three questions, 16.6% to two questions, 16.4% to one question and 28.2% gave no correct answer.[12] Participants also had to answer a question about trust toward other people ("Generally, would you say that most people are trustworthy or that you can never be too careful with people?") and 56.4% indicated that "most people are trustworthy". The distribution of these variables is not different between the treatments (rank-sum Mann–Whitney tests: $p > 0.1$). In the econometric analysis, we controlled for the aforementioned individual characteristics.

Each participant participated in a single treatment: 50 participants in Equal-L, 50 in Equal-H, 200 in Unequal-Egalitarian, and 200 in Unequal-Proportional. In each unequal treatment, 50 participants received endowment E_l and were matched with participants with endowment E_l as well, 50 participants received endowment E_h and were matched with participants with endowment E_h as well, 50 participants received endowment E_l and were matched with participants with endowment E_h, and 50 participants received endowment E_h and were matched with participants with endowment E_l.

[9] See Bicchieri and Xiao (2009) for the first use of this elicitation method.

[10] The pairing with other participants of the same type allows the participant to consider only one payoff matrix and then requires less cognitive effort from the participant. Because we use the strategy method, other participants of the same type also allows the participant to limit the number of cases to consider and focus on a specific pairing.

[11] Another way to elicit strategies in the infinitely repeated prisoner's dilemma game is provided in Romero and Rosokha (2018).

[12] The questions are given in the instructions in Appendix B.

Instructions were formulated in a neutral way (see instructions in Appendix B). The experiment was performed with oTree (Chen et al., 2016). The experiment lasted for approximately 5 min. Once all participants in a treatment had completed the experiment, we formed groups of 50 participants to implement their strategic decisions and, thus, calculate the payoffs. We randomly drew the number of periods using the continuation rate of 0.95 for each group. The total gains of the participants were the sum of their gains in all periods of the prisoner's dilemma game. The amounts in the payoff matrices were in ECUs. The participants earned additional earnings based on the elicitation of their beliefs. The exchange rate was 200 ECUs = $1. The ex-post implementation was performed in Python with Jupyter. The average earnings were approximately $5.

2.5. Theoretical predictions

In any prisoner's dilemma game, the action to defect is a possible outcome of an equilibrium strategy. Additionally, the strategy to cooperate is an equilibrium and part of a risk-dominant equilibrium in all equal and unequal treatments for both high- and low-type players. Strategies then should not be different between the treatments. Nevertheless, the perceived social norm, N, may help the players select one of the two equilibria (Burke and Young, 2011). We suppose $N \in \{0,1\}$, with $N = 0$ if the social norm is to defect and $N = 1$ if it is to cooperate. Following d'Adda et al. (2020), the social norm is expressed as $N = r + \alpha(E(r) - r) + \beta(E(g) - r)$, where $r \in \{0,1\}$ is the player's first-order normative belief, $E(r) \in \{0, 0.1, \dots, 1\}$ is her second-order normative belief and $E(g) \in \{0, 0.1, \dots, 1\}$ is her descriptive belief. The coefficients α and β are the weights the player attributes to her second-order normative beliefs and descriptive beliefs, respectively, with $\alpha, \beta > 0$ and $\alpha + \beta < 1$. Previous experimental work suggests that inequality decreases the social norm of cooperation (Reuben and Riedl, 2013; Fischbacher et al., 2014; Xiao and Bicchieri, 2010). The first hypothesis we test is the following:

Hypothesis 1. The social norm, based on first-order and second-order normative beliefs and descriptive beliefs, is lower in the unequal treatments than in the equal treatments.

When individuals believe that cooperation is a social norm, they are more likely to cooperate, even without external sanctions (Bicchieri, 2006). Normative and descriptive beliefs for cooperation reinforce individuals' own cooperative behavior. The second hypothesis we test is the following:

Hypothesis 2. The likelihood of choosing a cooperative strategy increases with the social norm of cooperation.

If the social norm is lower in the unequal treatments than in the equal treatments, the cooperative strategy would be less likely to be chosen in the unequal treatments than in the equal treatments. Additionally, the weight the player attributes to the social norm may differ between unequal and equal treatments. If it is lower in the unequal treatments than in the equal treatments, the cooperative strategy would be even less chosen in the former than in the latter.

Although the thresholds of the continuation rate are lower than 0.95 in any situation of the experiment, we may observe different decisions in the Unequal-Egalitarian treatment because the levels of δ thresholds are different than in Equal-L, Equal-H, or Unequal-Proportional: δ thresholds are lower (higher) for low-type (high-type) players. The δ thresholds are identical in Unequal-Proportional, Equal-L, and Equal-H. Differences between Unequal-Proportional and Equal treatments would reflect the pure effect of inequality, keeping identical incentives for cooperation.

3. Results

In this section, we answer two questions: (i) How does inequality change the participants' beliefs and the social norm? (ii) How do inequality and changes in beliefs influence the participant's strategy choices?

3.1. Social norms

First-order normative beliefs represent the participant's personal values regarding the action that she thinks should be made in the game. This value is the individual reference of the social norm (d'Adda et al., 2020). In the equal treatments, 78% of the participants think that the decision that should be made is to cooperate, whereas the frequency decreases to approximately 63% in the Unequal-Egalitarian treatment and 58% in the Unequal-Proportional treatment (see Table 12 in Appendix for detailed statistics by type).

Second-order normative beliefs represent the participant's beliefs about the other participants' opinion regarding the action that should be made. These beliefs range between 0 when the participant believes that 0% of the other participants think that the decision that should be made is to cooperate and 1 when she believes that 100% of the other participants think that the decision that should be made is to cooperate. Steps are of 0.1. On average, in the equal treatments, the participants believe that 74% of the participants think that the decision that should be made is to cooperate. This share decreases to 63% and 60% in the Unequal-Egalitarian and Unequal-Proportional treatments, respectively (see Tables 13 and 14 in appendix). The distribution of second-order beliefs is represented in Fig. 1.

Descriptive beliefs provide the participant's beliefs about the decision that other participants will make. These beliefs range between 0 when the participant believes that 0% of the other participants will choose to cooperate and 1 when she believes that 100% of the other participants will cooperate. The steps are of 0.1. In the equal treatments, participants believe that, on average,

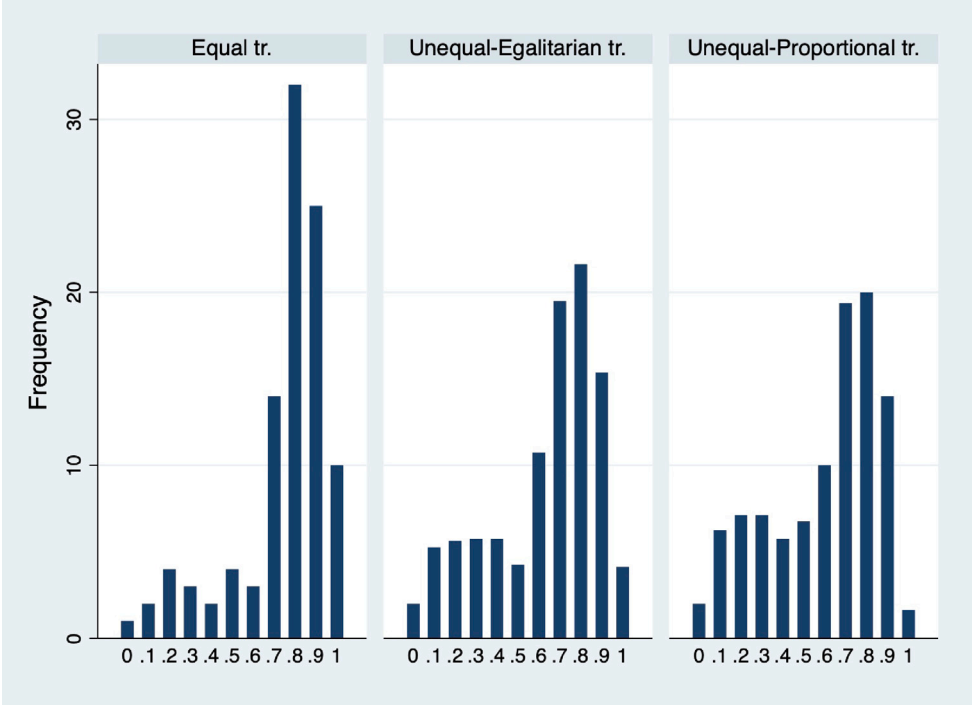

Fig. 1. Distribution of second-order normative beliefs.

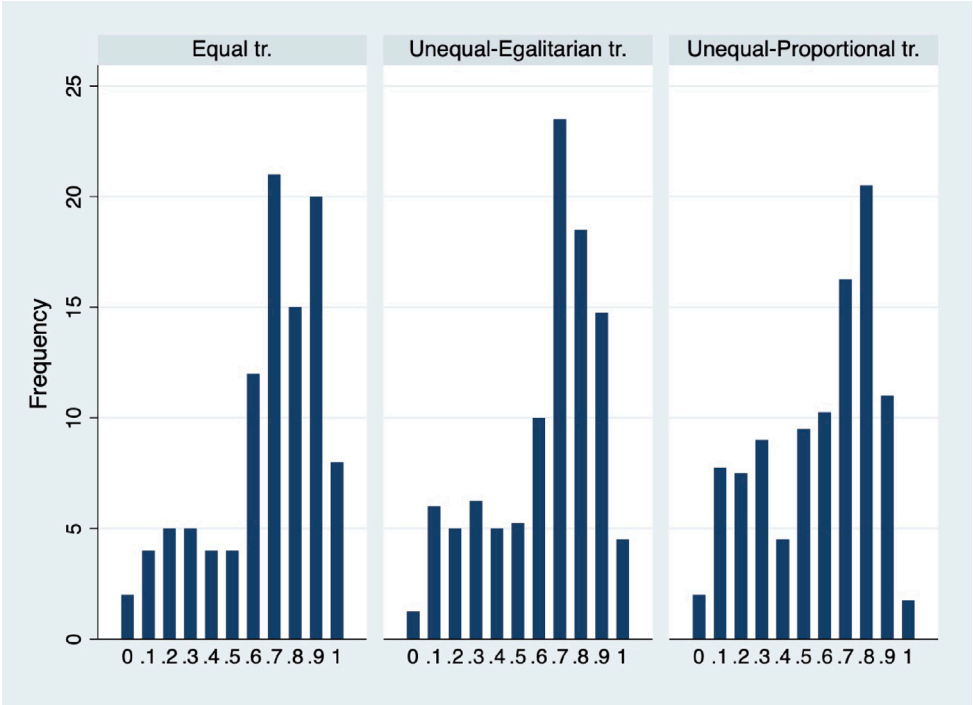

Fig. 2. Distribution of descriptive beliefs.

66% of the participants will decide to cooperate instead of defect. In the unequal treatments, this share is approximately 63% in the Unequal-Egalitarian treatment and 57% in the Unequal-Proportional treatment (see Table 15 in appendix). The distribution of descriptive beliefs is represented in Fig. 2.

Table 7
Beliefs, by treatment.

	First-order normative beliefs		Second-order normative beliefs		Descriptive beliefs	
	(1)	(2)	(3)	(4)	(5)	(6)
UE	−0.169***	−0.186**	−0.107***	−0.064*	−0.028	−0.029
	(0.059)	(0.085)	(0.027)	(0.038)	(0.030)	(0.040)
UP	−0.218***	−0.128	−0.141***	−0.074**	−0.085***	−0.076*
	(0.059)	(0.086)	(0.026)	(0.037)	(0.030)	(0.041)
UE ×Heterogeneous		−0.020		−0.012		−0.017
		(0.046)		(0.014)		(0.018)
UP ×Heterogeneous		−0.174***		−0.046***		−0.023
		(0.048)		(0.016)		(0.023)
High type	0.028	−0.002	−0.017	0.059	−0.007	−0.018
	(0.031)	(0.107)	(0.019)	(0.046)	(0.020)	(0.053)
UE ×High type		0.060		−0.073		0.019
		(0.117)		(0.054)		(0.061)
UP ×High type		0.006		−0.088*		−0.004
		(0.115)		(0.052)		(0.060)
Intercept			0.811***	0.773***	0.721***	0.726***
			(0.040)	(0.045)	(0.044)	(0.04)
N	900	900	1700	1700	900	900
Clusters	500	500	500	500	500	500
pseudo R^2	0.029	0.042	0.047	0.052	0.043	0.044

Standard errors, clustered at the individual level, in parentheses. Models (1) and (2) are logit models, reporting average marginal effects; Models (3) to (6) are OLS models. *N* is 900 for first-order normative and descriptive beliefs because these variables are based on answers to one question for the 100 participants in the equal treatments and on two questions for the 200 participants in the unequal treatments. *N* is 1700 for second-order normative beliefs because this variable is based on answers to one question for the 100 participants in the equal treatments and on four questions for the 200 participants in the unequal treatments.
* $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

We now test whether these beliefs differ between the treatments. We account for the type of the participant as well as for the fact that the participant gives her beliefs regarding the same type as herself (homogeneous) or the other type (heterogeneous). Table 7 provides the results.

Inequality weakens the social norm of cooperation with a decrease in first- and second-order normative beliefs in the two unequal treatments as well as descriptive beliefs in the Unequal-Proportional treatment. When the benefits of cooperation are proportionally shared between the participants, incentives to cooperate are kept exactly constant when inequality is introduced compared to equality in endowments. Changes in beliefs in this treatment are then uniquely driven by inequality in endowments. The type of the participant has no significant impact on her beliefs, regardless of the treatment. This gives result 1.

Result 1. The existence of inequality weakens the social norm of cooperation by decreasing first- and second-order normative beliefs and descriptive beliefs, regardless of the type of participant.

When the benefits of cooperation are equally shared between the participants, the change in incentives compensate the existence of inequality for descriptive beliefs that are not lower than in the equal treatments. Interestingly, we observe that normative beliefs for heterogeneous matching are significantly lower in the Unequal-Proportional treatment than in the equal treatments. The presence of inequality thus changes participants' beliefs that are unrelated to changes in incentives to cooperate. The perception of social norms of cooperation is weakened in the presence of inequality.

3.2. Decisions and strategies

Inequality weakens the social norm of cooperation. We now analyze whether inequality or changes in the social norm affect decisions and strategies of cooperation.

3.2.1. Decisions in periods 1 and 2

In period 1, 74% of the participants decide to cooperate in the equal treatments. This share is 67% and 65% in the unequal treatments, the Unequal-Egalitarian treatment and the Unequal-Proportional treatment, respectively (see Table 16 in the appendix for detailed statistics). In period 2, in equal treatments, 70% of the participants cooperate if the playmate has cooperated in period 1 and 63% cooperate if the playmate defected. These rates are 62% and 56% in the Unequal-Egalitarian treatment and 59% and 50% in the Unequal-Proportional treatment (see Table 17 in the appendix for detailed statistics).

Table 8
Decisions in periods 1 and 2.

	Decision in period 1		Decision in period 2		
	(1)	(2)	(3)	(4)	(5)
UE	−0.078	−0.041	−0.079	−0.059	−0.048
	(0.057)	(0.055)	(0.049)	(0.049)	(0.048)
UP	−0.090	−0.035	−0.120**	−0.084*	−0.076
	(0.057)	(0.054)	(0.048)	(0.048)	(0.048)
High type	0.022	0.023	0.014	0.012	0.006
	(0.041)	(0.038)	(0.036)	(0.034)	(0.032)
r		0.617***		0.400***	0.204***
		(0.081)		(0.079)	(0.075)
$E(r) - r$		0.138		−0.012	−0.055
		(0.107)		(0.106)	(0.100)
$E(g) - r$		0.370***		0.314***	0.198**
		(0.094)		(0.093)	(0.088)
Playmate cooperated in period 1			0.072***	0.072***	0.072***
			(0.025)	(0.025)	(0.025)
Participant cooperated in period 1					0.267***
					(0.031)
N	500	500	1000	1000	1000
Clusters	500	500	500	500	500
pseudo R^2	0.045	0.143	0.024	0.061	0.113

Standard errors, clustered at the individual level, in parentheses. Logit models, reporting average marginal effects. N is 500 for decision in period 1 because this variable is based on one decision. N is 1000 for decision in period 2 because this variable is based on two decisions with the strategy method.
* $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

Table 8 presents the impact of the treatments and of the social norm on the decisions in periods 1 and 2. In period 2, the decision of the playmate in the previous period, as well as the participant's decision in period 1, are also estimated.[13]

We do not observe a direct effect of inequality on the decision to cooperate in periods 1 or 2 as soon as we take into account individuals' beliefs. Instead, we find that first-order normative beliefs and descriptive beliefs positively impact the decision to cooperate. The impact of inequality on cooperation does not appear to be direct but is instead mediated by individuals' beliefs. Second-order normative beliefs have no significant impact. In period 2, the decision to cooperate strongly depends on past behaviors, from her previous playmate and from herself. The existence of inequality decreases the likelihood of cooperation only through a change in beliefs. In addition, the intensity of the effect of the social norm on the decisions is not related to inequality.[14]

3.2.2. Strategies

Memory-one strategies imply four decisions from the participants based on choices in the previous period: whether the participant and her playmate chose to cooperate or to defect. In equal treatments, when the participant chose to cooperate in the previous period, 88% of the participants cooperate if the previous playmate also cooperated and 46% cooperate if the previous playmate defected. When the participant chose to defect in the previous period, 70% of the participants cooperate if the previous playmate cooperated and 50% cooperate if the previous playmate also defected. These shares of cooperation are 81%, 43%, 57%, and 43% in the Unequal-Egalitarian treatment and 79%, 49%, 50% and 43% in the Unequal-Proportional treatment, respectively (see Table 18 in the appendix).

Table 9 presents the marginal effects of the estimation of the participant's likelihood of cooperating depending on the hypothetical decision of herself and her playmate in the previous period. Model (1) does not include normative or descriptive expectations, whereas Model (2) does.

We find that the likelihood of choosing to cooperate is significantly lower when there is inequality. The previous choice to cooperate of the playmate, regardless of whether the participant did or did not cooperate, increases this likelihood. The increase is stronger when the previous choice of the participant was also to cooperate. Interestingly, additional regressions show that the impact of past cooperation by the previous playmate is significantly lower in the Unequal-Proportional treatment; that is, observing cooperation from others plays a lower role in the Unequal-Proportional treatment than in equal treatments. When beliefs related to the social norm are introduced, dummies for unequal treatments are no longer significant, while first-order normative beliefs and descriptive beliefs significantly explain the likelihood of cooperating. The effect of beliefs is not different between the treatments. Result 2 is as follows.

[13] We also conducted regressions with crossed effects between heterogeneity and the unequal treatments and between the type of the participant and the treatments. We find no significant effect, and we do not report the coefficients in the table.
[14] We do not report this result in the table as it is insignificant.

Table 9
Memory-one strategies.

	Model (1)	Model (2)
UE	−0.075**	−0.053*
	(0.032)	(0.031)
UP	−0.080**	−0.047
	(0.032)	(0.031)
High type	−0.001	−0.005
	(0.024)	(0.023)
r		0.335***
		(0.060)
$E(r) - r$		0.042
		(0.063)
$E(g) - r$		0.196***
		(0.055)
Participant cooperated in previous period	0.011	0.011
	(0.024)	(0.024)
Playmate cooperated in previous period	0.111***	0.111***
	(0.026)	(0.026)
Participant cooperated ×Playmate cooperated	0.259***	0.259***
in previous period	(0.0364)	(0.0364)
N	2000	2000
Clusters	500	500
pseudo R^2	0.079	0.104

Standard errors, clustered at the individual level, in parentheses. Logit models, reporting average marginal effects. N is 2000 because memory-one strategies are based on four decisions with the strategy method.
* $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

Result 2. The existence of inequality decreases the likelihood of the decision to cooperate because of a change in the social norm, regardless of the type of participant.

Four main strategies are elicited from the menu of strategies: always-cooperate, always-defect, grim-trigger and tit-for-tat. On average, in the equal treatments, always-cooperate is chosen by 51% of the participants, always-defect by 11%, grim-trigger by 23% and tit-for-tat by 15%. In the unequal treatments, these shares are 34%, 24%, 23%, and 20% in the Unequal-Egalitarian treatment and 33%, 24%, 21%, and 23% in the Unequal-Proportional treatment, respectively.

The results show a lower share of participants who choose to always-cooperate and a higher share who choose to always-defect in the unequal treatments than in the equal treatments. Table 10 gives marginal effects of multinomial logit models that compare the effects of treatments, type of participant, beliefs and previous behavior on the participant's likelihood of adopting each strategy.

Constant strategies that are independent from other players' decisions, such as choosing to always cooperate or always defect, depend on inequality: inequality decreases the likelihood of choosing to always cooperate but increases the likelihood of choosing to always defect. First-order normative beliefs and the participant's cooperation in period 1 are found to negatively influence the choice to always defect and positively influence the choice to always cooperate. Descriptive beliefs also negatively influence the choice to always defect. The impact of the treatment is still significant once controlling for beliefs and the participant's past decision in period 1. This leads to result 3.

Result 3. The existence of inequality decreases the likelihood of choosing to always cooperate and increases the likelihood of choosing to always defect due to, in part, a change in the social norm, regardless of the type of participant.

Strategies that are directly linked to the participant's playmate behavior do not depend on inequality and are not related to the participants' decisions in period 1. First-order normative beliefs negatively influence the choice of the tit-for-tat strategy, while descriptive beliefs positively influence the choice of the grim-trigger strategy. Interestingly, first-order normative beliefs do not influence the choice of grim-trigger strategy and descriptive beliefs do not affect the choice of the tit-for-tat strategy. The identification of the sort of beliefs that are relevant while choosing specific strategies seems an interesting question for future research.

Inequality changes normative and descriptive beliefs, weakening the social norm of cooperation. Such changes reduce the decision to cooperate and the choice of the always-cooperate strategy while increasing the choice of the always-defect strategy. The intensity of the impact of the social norm does not appear to impact behavior differently in equal and unequal frameworks.

4. Discussion and conclusion

Cooperation in moving social interactions is essential to face the main challenges of societies today, such as the reduction of greenhouse gas emissions or water conservation, and to improve general well-being. Interactions with many others at a nonregular frequency make the situation complex to study and render the role of social norms central. An important stake in this context is

Table 10
Menu of strategies.

	Always-defect			Always-cooperate		
	Model (1)	Model (2)	Model (3)	Model (1)	Model (2)	Model (3)
UE	0.16***	0.14***	0.13***	−0.16***	−0.13***	−0.12***
	(0.029)	(0.028)	(0.027)	(0.028)	(0.028)	(0.027)
UP	0.14***	0.12***	0.11***	−0.17***	−0.12***	−0.12***
	(0.029)	(0.028)	(0.027)	(0.028)	(0.028)	(0.027)
High type	−0.029	−0.025	−0.023	0.036*	0.027	0.023
	(0.018)	(0.017)	(0.017)	(0.021)	(0.021)	(0.021)
r		−0.31***	−0.16**		0.43***	0.31***
		(0.051)	(0.053)		(0.51)	(0.53)
$E(r) - r$		0.049	0.086*		0.14**	0.12*
		(0.047)	(0.045)		(0.63)	(0.62)
$E(g) - r$		−0.24***	−0.15***		0.14**	0.065
		(0.055)	(0.055)		(0.43)	(0.42)
Participant coop.			−0.19***			0.16***
in period 1			(0.016)			(0.024)
	Grim-trigger			Tit-for-tat		
	Model (1)	Model (2)	Model (3)	Model (1)	Model (2)	Model (3)
UE	0.022	0.014	0.014	−0.013	−0.026	−0.027
	(0.019)	(0.019)	(0.019)	(0.029)	(0.029)	(0.029)
UP	−0.030	−0.031	−0.031	0.055**	0.037	0.037
	(0.020)	(0.021)	(0.020)	(0.028)	(0.028)	(0.028)
High type	−0.046***	−0.044***	−0.043***	0.039*	0.042**	0.044**
	(0.015)	(0.015)	(0.014)	(0.020)	(0.020)	(0.020)
r		0.028	0.015		−0.15***	−0.16***
		(0.033)	(0.035)		(0.047)	(0.049)
$E(r) - r$		−0.086**	−0.091**		−0.11*	−0.11**
		(0.043)	(0.043)		(0.058)	(0.058)
$E(g) - r$		0.13***	0.12***		−0.030	−0.035
		(0.040)	(0.040)		(0.052)	(0.053)
Participant coop.			0.011			0.014
in period 1			(0.016)			(0.023)
N				500	500	500
pseudo R^2				0.0387	0.0740	0.0982

Standard errors in parentheses. Multinomial logit models, reporting average marginal effects.
* $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

the consideration of inequality. Indeed, many people benefit from the same common good but do not have the same possibilities to contribute to it. The experiment we conducted tackles the role of inequality in infinitely socially iterated interactions to identify its impact on cooperation. We elicit the participants' beliefs about social norms and their decision to cooperate or not in an infinitely socially iterated prisoner's dilemma that either gives equal payoffs or unequal payoffs to the participants for cooperation, with or without endowment inequality among participants.

The results show that the existence of inequality weakens the social norm of cooperation by decreasing first- and second-order normative beliefs as well as descriptive beliefs. Such changes in first-order normative beliefs and descriptive beliefs lessen the likelihood of choosing to cooperate. The long-term strategy of always cooperating is also more likely for higher first-order normative expectations. Always defecting is more chosen for lower levels of first-order normative beliefs and descriptive beliefs. According to the results of the experiment, while the incentives for cooperation are not changed, the existence of inequality is detrimental to cooperation because of a weakened social norm. Interestingly, the level of the participants' endowment does not appear to influence either beliefs or behaviors. We do not observe a different influence of the social norm depending on whether inequality exists. It is the very existence of inequality that leads to changes in the choice of whether to cooperate.

An opposite effect could have been expected if the participants feel inequity aversion (Bolton and Ockenfels, 2000; Fehr and Schmidt, 1999). The payoffs in the unequal treatments have been determined to ensure that cooperation would not lead to any conflicting norms (Gangadharan et al., 2017). Therefore, some participants might be willing to cooperate to avoid inequality. However, this is not what is observed in the experiment: the detrimental effect of inequality on the social norm of cooperation appears to be much stronger than the wish to reduce inequality by cooperating.

The results of the experiment emphasize the importance of transparency in the normative behavior to adopt and the adoption of this behavior by other people. Indeed, a main driver of less cooperation in the presence of inequality is the change in beliefs. Transparency about the social norm should be disseminated to limit the negative effects of inequality on cooperation. The question of the sustainability of the common good in the presence of inequality needs to be further investigated (Baland et al., 2007). Future research should address interactions between the participants in a dynamic setting and ask for the role of various instruments in this context.

Declaration of competing interest

We declare no conflict of interest with the *Journal of Economic Behavior and Organization*.

Appendix A. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.jebo.2024.106819.

Data availability

Data will be made available on request.

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