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Cooperation in public goods games: Enhancing effects of group identity and competition

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Abstract

A lot of economic and social situations can be described as contests in which agents need to distribute scare resources. Individual behavior plays an important role within these situations, while identity strongly impacts on behavior. This paper asks how group identity impacts the provision of a public good in a contest situation with different prize sharing rules. We show that group identity significantly increases contributions. Moreover, it turns out that identity affects how subjects react to different prize sharing rules. Our findings contribute to an increased understanding of the nature of group identity and its impact on economic behavior.

Key words: group identity, contest, public goods game, multi-level interaction, experiment
JEL codes:

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1. Introduction

In and outside economics exists a broad number of situations which can be described as contests in which agents need to use scarce resources like time, effort and money to affect the probability of winning a prize e.g. in political (win an election), economic (patents) and social environments (friends, university place) (Dechenaux et al., 2015). In this process individuals behavior plays an important role. But, beside a strong focus on contests in the theoretical literature, the empirical investigation of different contests is still limited (Dechenaux et al., 2015). On the other hand, identity strongly influences the behavior of individuals (Akerlof and Kranton, 2000, 2010). In line with this, recent research indicates that group identity increases the amount of how much weight is put on the welfare of other in-group members (Eckel and Grossman, 2005; Chen and Li, 2009). Identity gained increasing attention on the micro as well as on the macro level in the last years. Over the last decades countries are increasingly confronted with social as well as ethnic diversity (Jivraj and Simpson, 2015). Various facets of identity, for example discrimination tendencies have a huge impact on e.g. labor markets (Chen and Mengel, 2016). In contrast, on a micro level organizations are confronted with diverse teams, which might be a boosting factor for creativity and innovation, although diverse backgrounds might also be a stifling factor. Conflicts within and competition between groups are ubiquitous in everyday life (Chowdhury et al., 2016). Overall, a broad literature has emerged in recent years, studying the social roots, underlying cognitive aspects, as well as the economic outcomes of identity (Chen and Mengel, 2016).

To our best knowledge, it has not been investigated how identity affects contest situations. In the present paper, we explore experimentally how (artificial) group identity influences the willingness of individuals to cooperate in a standard public goods game extended by a contest situation (multi-level interaction). Our public goods game with the contest situation is based on Gunnthorsdottir and Rapoport (2006) and we complement it by introducing artificial group identity according to Eckel and Grossman (2005). We use partners matching, with the game lasting 10 periods. We employ four treatments (low and high identity with egalitarian and proportional profit sharing), each played 10 times, where we randomly assign subjects into two groups (à 4 persons). Within each group, individuals are engaged in a standard public goods game while competing for an exogenous and commonly known prize[1]. Groups increase their probability of winning the prize by investing more in their public goods. In the baseline experiment, the groups engage in the game, although no information about the group composition is revealed. In the high identity treatments, we use a puzzle task before the experiment starts and color tags to create artificial group identity in the lab. Moreover, we vary the monetary incentives of the contest (Gunnthorsdottir and Rapoport, 2006) by applying two prize-sharing mechanisms, either equally or proportionally according to individuals' contributions, among all members of the winning group. The rules are communicated before the individual decisions start.

Our results indicate a significant and positive effect of increased group identity on individuals' willingness to cooperate in a public goods game in a competitive setting. The proportional

[1] In reality, intra-group conflicts rarely appear as isolated incidences but are mostly accompanied by inter-group competition, i.e. a team or a company as in-group competes for an exogenous good with other teams or companies as out-groups (contest).

profit sharing rule leads to higher investments in low identity treatments. [2] The results for the prize-sharing mechanism are reverse in the high identity treatment, there the highest level of cooperation can be observed under the egalitarian profit-sharing rule. Moreover, we find that the number of full cooperators is significantly higher in the high identity treatment. The remainder of the paper is structured as follows. Section 2 gives a short overview of the literature background, section 3 introduces the theoretical framework, before section 4 describes the experimental design. Section 5 presents our results and the discussion and section 6 concludes.

2. Literature background

2.1. Determinants of contributions to a public good

Public goods games have a long tradition (e.g. Ledyard, 1995). Since the interests of subgroups and individuals do not necessarily coincide, groups cannot be modeled as unitary actors. Individuals' behavior in groups is characterized simultaneously by cooperation and competition. They are confronted with contradictory incentives for either defecting to maximize their own payoff or cooperating to maximize the group's payoff. In economic standard theory individuals' contributions to public goods fall short of optimal amounts, since free-riding is the dominant strategy, especially in anonymous situations (Fischbacher et al., 2001). Players want to raise their monetary outcome with preferably low risk and low uncertainty (Fischbacher and Gächter, 2010; Fischbacher et al., 2001).

Various studies show that individuals in fact do not behave according to the standard model (Mullainathan and Thaler, 2000; Camerer and Loewenstein, 2004; Chaudhuri, 2011), given that they do not regard their decision in isolation but rather take social motives into consideration. It is shown that contributions are influenced by various factors, such as group size (Isaac et al., 1994), marginal per capita return (MPCR) (Ashley et al., 2010; Zelmer, 2003), gender (for an overview, see e.g. Croson and Gneezy, 2009) or partners matching (Keser and Van Winden, 2000). Moreover, low levels of fear and greed also positively influence the willingness to cooperate (Ahn et al., 2001). Nonetheless, cooperation cannot be guaranteed, as most decisions are made under uncertainty and individuals' decisions and reactions are difficult to forecast. Cooperation is not based on confusion or errors (Keser, 1996), but rather on kindness - e.g. altruism or warm-glow (Andreoni, 1995) - strategic considerations such as conditional cooperation (Fischbacher et al., 2001), as well as by in-group attachment (Chen and Li, 2009), self-centered inequity aversion (Fehr and Schmidt, 1999), social preferences of positive reciprocity (Fehr and Fischbacher, 2002) or fairness preferences (Fehr and Schmidt, 1999; Bolton and Ockenfels, 2000). Further explanations for within-group cooperation are e.g. the minimal group paradigm (Chen and Chen, 2011; Li et al., 2011; Chen and Li, 2009; Tajfel et al., 1971) and common fate (Brewer and Kramer, 1986; Wiltermuth and Heath, 2009). Recent research analyzes also the role of identity (Eckel and Grossman, 2005).

[2] Our findings in the no-identity treatment are consistent with those of Gunnthorsdottir and Rapoport (2006), who show that the proportional prize-sharing rule outperforms the egalitarian one.

2.2. Identity

Previous research indicates that identity[3] , a person's sense of self (Akerlof and Kranton, 2000), has a strong impact on economic outcomes and affects individual behavior and decision-making (Chen and Li, 2009; Akerlof and Kranton, 2010), which makes it a relevant factor in the provision of public goods (Ashforth and Mael, 1989; Akerlof, 2002; Akerlof and Kranton, 2005; Ashforth et al., 2011). A broad literature has emerged in recent years, studying the social roots, underlying cognitive aspects, as well as the economic outcomes of identity (Chen and Mengel, 2016).

A positive effect of group identity on the level of cooperation is shown for single-level interactions (Solow and Kirkwood, 2002; Eckel and Grossman, 2005; Chen and Li, 2009). For example, Eckel and Grossman (2005) analyze how and whether identity mitigates shirking and free-riding behavior in a team production setting, showing that actions designed to enhance team identification significantly increase cooperative behavior. This is in line with early work. Already Gaertner et al. (1993) show that it is possible to create a common group identity through the simple manipulation of, prima facie, irrelevant variables, leading group members to perceive themselves in their group as a we, resulting in the elimination of negative factors rooted in in-group heterogeneity.

In recent years various studies analyzed identity showing that e.g. a "real identity" reduces free-riding (Chowdhury et al., 2016) and workers competition (Kato and Shu, 2016). Kato and Shu (2016) analyze the interplay of social identity and worker competition in a Chinese textile firm, with exogenously formed social groups and real productivity data in a real economic setting, providing empirical evidence that social identity has a significant impact on competition and affects the interaction of workers. Workers only compete against those with a different social identity but not against their in-group co-workers, while identity also influences the incentives promoting competition. Furthermore, holding different social identities reduces truth-telling (Rong et al., 2016) and identity-homogeneous groups are more likely to reveal less negative reciprocity in case of deviating behavior of group members (Bicskei et al., 2016), while a strong identity increases cooperation in the absence of punishment (Weng and Carlsson, 2015). Further studies e.g investigate discrimination, showing that this behavior varies depending on the type of identity (for a meta-analysis, see, e.g. Lane, 2016).

2.3. Contests and multi-level interactions in public goods games

A broad literature about contests emerged in the last decades (Konrad, 2009) but the number of articles investigating empirically individual behavior in different contest situations is still limited and only emerged within the last decade (Dechenaux et al., 2015). Some studies focus e.g. on group performance and communication in combination with egalitarian profit sharing (Sheremeta and Zhang, 2010; Cason et al., 2012), rent-seeking contests (Katz et al., 1990; Ahn et al., 2011) or the effects of proportional prize sharing (Kugler et al., 2010; Gunnthorsdottir and Rapoport, 2006).

Focusing on public goods games shows that recent experiments started to extend the literature about single-level interactions in public goods games by introducing multi-level inter-

[3]The concept itself has a long tradition and its roots in psychology. Individuals' social identity is based on categorization (Tajfel, 1974; Turner, 1975; Tajfel, 1978, 1982), identification (in-group; out-group) (Stets and Burke, 2000; Tajfel, 1974) and comparison (Tajfel, 1974, 1978).

actions (contests). The interaction between several groups for winning an exogenous prize changes individuals' incentive structure, as free-riding might no longer be the dominant strategy. In a single-level dilemma, outperforming the others can be achieved by free-riding. But having a between-group conflict (contest situation) forces the rational self-interested individual to cooperate with her group members to win the conflict (Bornstein and Erev, 1994)[4]. Accordingly, the willingness to cooperate within a group also depends on the nature of the higher-level conflict (e.g. the contest as well as the incentive structure of the prize sharing mechanism). The findings of recent experiments indicate a positive effect of intergroup competition (Tan and Bolle, 2007; Burton-Chellew et al., 2010; Kugler et al., 2010) as well as pseudo-competition (Burton-Chellew and West, 2012) on the willingness to cooperate within groups. Intragroup conflicts embedded in an intergroup competition reduce free riding (Gunnthorsdottir and Rapoport, 2006).

3. Theoretical Framework

Following Gunnthorsdottir and Rapoport (2006), we introduce a market with n groups ($n \geq 2$) competing for an exogenous prize $S > 0$. Let m_k be the number of symmetric players in group k with $k = \{1, ..., n\}$ and $m_k = \{2, ..., K\}$. In sum, there are $\sum_{k=1}^{n} m_k = N$ symmetric players in the market. Each player i, with $i = \{1, ..., N\}$, receives an endowment $e > 0$, which can be invested either in a public good or kept for oneself. We assume the strategy space to be continuous, implying that individual i, can contribute any share of her endowment e to the public good. We denote an individual's contribution to her group's public good by x_{ik} ($0 \leq x_{ik} \leq e$), the group's total contribution by X_k ($X_k = \sum_{i=1}^{m_k} x_{ik}$) and the overall contributions in the market of all N players by X ($X = \sum_{i=1}^{N} X_k$).
Given the usual within-group conflict in standard public goods games between investing or keeping one's endowment, individuals' dominant strategy is to free-ride on other members, which reduces overall equilibrium contributions to zero. However, by introducing an exogenous prize, for which groups compete, individuals' incentive structure changes. This stems from the probability of winning being determined by group members' ability to cooperate, i.e. to generate a greater public good in comparison to other groups. Depending on prize value and how it will be distributed, it is no longer a dominant strategy to restrain from investing (Gunnthorsdottir and Rapoport, 2006).
Besides their pecuniary interests, individuals perceive themselves as parts of collectives i.e. groups rather than solely as independent entities. We argue that individuals decision-making for investing in public goods is crucially affected by their group identity, i.e. their attachment to groups. Accordingly, we will extend our framework by incorporating individuals' valuation for cooperation with in-group members into their payoff welfare function.

The within-group conflict

[4] Between-group competition and within-group cooperation is also broadly discussed in social-psychology. Early work by (Sherif et al., 1961) indicates that an antagonistic relation between groups boost solidarity within groups. Overall, with positive dependencies between groups, i.e. a goal can only be reached jointly, cooperative forms of social interaction occur, while with negative dependencies between groups, i.e. the goal of one group can only be reached at the cost of the other group, competitive forms of social interaction occur.

In accordance with the public goods literature (Zelmer, 2003; Ledyard, 1995), let x_{ik} be the share of endowment invested by player i of group k in the public good. The contributions from all members constitute a group's public good. The share of endowment not invested converts directly to an individual's payoff. Within each group, the investments in the public good are uniformly multiplied by the factor $t > 1$ and equally distributed among all members. We determine $g_k = te$ as the maximum payoff that each member can receive from the public good in group k, if all of its members invest their full endowment, i.e. if $X_k = m_k e$. However, we define the actual payoff in group k from their public good by $g_k \frac{X_k}{m_k e} = \frac{tX_k}{m_k}$. This payoff equals zero, if everybody restrains from investing, i.e. $X_k = 0$. Since $t > 1$, members' full contribution would lead to the highest joint welfare. However, we exclude the trivial case when it would be a dominant strategy for individuals to invest their full endowment and thus we assume $t < m_k$. In sum, an individual's payoff from the within-group conflict is given by

$$\pi_{ik}^{in-group} = (e - x_{ik}) + \frac{tX_k}{m_k}. \tag{1}$$

The between-group conflict

Like Gunnthorsdottir and Rapoport (2006), we introduce an exogenous prize S for which all n groups compete. This extends the standard public goods game by between-group competition. The probability for a group of winning the prize, thereby, depends on the value of their own public good relative to the values of all other groups' public goods. By introducing a contest success function, groups can never be sure to win the prize even if their contribution outperforms all others'. This models real-life circumstances more appropriately, since there never appears to be certainty to succeed in competition, even if one's expenditures stand out (Gunnthorsdottir and Rapoport, 2006). Let the probability of group k winning the prize be given by

$$\Theta_k = \frac{X_k}{X}. \tag{2}$$

If group k wins the prize, it will be distributed among members according to the profit-sharing function f_k given by

$$f_k = \frac{x_{ik}^c}{\sum_{i=1}^{m_k} x_{ik}^c}, \tag{3}$$

with $0 \leq c \leq \infty$. Notice that parameter c determines the type of profit-sharing rule. For example, if $c = 0$, all members of the winning group k receive an equal share of the prize, $\frac{S}{m_k}$, which denotes a completely egalitarian profit-sharing. By contrast, if $c = 1$, each member of the winning group receives a share of the prize proportional to her individual investment to the public good, $\frac{x_{ik}}{X_k}$, which denotes a completely proportional profit-sharing. An individual's payoff from the between-group competition is given by

$$\pi_{ik}^{between-group} = \Theta_k S f_k = \left(\frac{X_k}{X}\right) S \left(\frac{x_{ik}^c}{\sum_{i=1}^{m_k} x_{ik}^c}\right). \tag{4}$$

Payoff structure

An individual's overall expected payoff depends on the outcome from both the within-group, as well as the between-group conflict. By combining equation (1) and (4), we derive the expected payoff for individual i as a member of group k, given by

$$\pi_{ik} = (e - x_{ik}) + \frac{tX_k}{m_k} + \left(\frac{X_k}{X}\right) S\left(\frac{x_{ik}^c}{\sum_{i=1}^{m_k} x_{ik}^c}\right). \tag{5}$$

Equilibria without group identity

In our set-up, individuals are confronted with diverging investment motives. On the one hand, they have an incentive to keep their endowment for themselves, since this has a higher expected payoff than investing in the public good, given the within-group conflict. On the other hand, investments increase their probability of winning the prize in the between-group conflict.

Lemma 1: *In the unique Nash-equilibrium with symmetric players without group identity, individuals invest* $x_{ik}^* = S\left(\frac{n-1+cn(m_k-1)}{[nm_k]^2(1-\frac{t}{m_k})}\right)$ *in their public good.*

Proof: To determine an individual's equilibrium behavior, we derive the first order condition of equation (5)

$$\frac{\partial \pi_{ik}^e}{\partial x_{ik}} = \frac{t}{m_k} - 1 + S\left(\frac{x_{ik}^c(X - X_k)}{X^2 \sum_{i=1}^{m_k} x_{ik}^c} + \frac{cX_k(x_{ik}^{c-1}(\sum_{i=1}^{m_k} x_{ik}^c) - x_{ik}^c(\sum_{i=1}^{m_k} x_{ik}^{c-1}))}{X \sum_{i=1}^{m_k} x_{ik}^{2c}}\right). \tag{6}$$

As we assume symmetric players, by rearranging and solving for x_{ik} we obtain[5]

$$x_{ik}^* = S\left(\frac{n-1+cn(m_k-1)}{[nm_k]^2(1-\frac{t}{m_k})}\right). \tag{7}$$

Remark: Due to symmetry in players, this strategy is the unique Nash-equilibrium. However, this strategy is not a dominant one and depends on individuals' expectations about other players' investment strategies. Moreover, we exclude the case in which the expected payoff from between-group conflict is excessively high, which would make it the dominant strategy for individuals to invest their full endowment, i.e. we assume

$$S \leq \frac{e(nm_k)^2(1-\frac{t}{m_k})}{n-1+cn(m_k-1)}. \tag{8}$$

As outlined by equation (7), individuals' equilibrium investments increase with the value of c, the multiplier t and the value of the prize S. In this equilibrium, each individual receives an expected payoff of

$$\pi^* = e + S\left[\left(\frac{n-1+cn(m_k-1)}{[nm_k]^2(1-\frac{t}{m_k})}\right)(t-1) + \frac{1}{nm_k}\right]. \tag{9}$$

All terms in the bracket are strictly positive, since $t > 1$ and $\frac{t}{m_k} < 1$. Individuals are better off by playing the equilibrium strategy x_{ik}^* rather than free-riding, as in classic public goods games. Consequently, introducing between-group competition moderates the within-group

[5]For detailed calculations see Appendix C.

conflict and increases cooperation.

Equilibria with group identity
In the next step, we introduce group identity. This far, individuals have adjusted their behavior solely based on pecuniary incentives. However, individual decision making is influenced by a person's sense of self, more specifically by the degree of identification with one's membership in groups. Therefore, investment decisions can be expected to depend on in-group attachments, as high attachments will be accompanied by an urge for cooperation. In general, individuals try to maintain a comfortable self-image and deviations from ideal levels are associated with losses in utility (Akerlof and Kranton, 2005; Ploner and Regner, 2013). Linking it to our setting, we assume that individuals suffer from utility losses by less cooperative behavior towards favored group-members, respectively when they do not invest their full endowment, with the loss in utility increasing proportionally to the withheld amount.[6] However, as described by Akerlof and Kranton (2005), as well as Huettel and Kranton (2012), such losses depend on the situational context. If individuals do not feel attached to their group, we cannot expect a loss in utility from non-cooperative behavior. To model this, we introduce z_{ik} ($0 \leq z_{ik}$) as the degree to which individual i from group k identifies with her group, namely the degree of her in-group attachment. An individual's expected utility function, formerly outlined by equation (5), changes to

$$\pi_{ik}^{identity} = (1 - z_{ik})(e - x_{ik}) + \frac{tX_k}{m_k} + \left(\frac{X_k}{X}\right) S \left(\frac{x_{ik}^c}{\sum_{i=1}^{m_k} x_{ik}^c}\right). \tag{10}$$

The more that an individual identifies with her in-group, associated with higher values of z_{ik}, the greater her loss in utility by less cooperation. In contrast, individuals with a minimal group attachment, i.e. $z_{ik} = 0$, will base their investment decision purely on pecuniary aspects.

Lemma 2: *With group identity and symmetric players, an individual's optimal investment strategy depends on her intensity of in-group attachment z_{ik}:*

(1) *if $z_{ik} < 1 - \frac{t}{m_k}$, individuals invest $x_{ik1}^* = S\left(\frac{n-1+cn(m_k-1)}{[nm_k]^2(1-\frac{t}{m_k}-z_{ik})}\right)$,*

(2) *if $z_{ik} \geq 1 - \frac{t}{m_k}$, individuals invest their full endowment, $x_{ik2}^* = e$.*

Proof: In order to determine optimal behavior, we derive the first order condition of equation (10), given by

$$\frac{\partial \pi_{ik}^{iden}}{\partial x_{ik}} = z_{ik} - 1 + \frac{t}{m_k} + S\left(\frac{x_{ik}^c (X - X_k)}{X^2 \sum_{i=1}^{m_k} x_{ik}^c} + \frac{cX_k(x_{ik}^{c-1}(\sum_{i=1}^{m_k} x_{ik}^c) - x_{ik}^c(\sum_{i=1}^{m_k} x_{ik}^{c-1}))}{X \sum_{i=1}^{m_k} x_{ik}^{2c}}\right). \tag{11}$$

[6] We are aware that our assumption of full contribution as the social norm is quite strict. It might well be the case that a norm, denominated as w, is expected to be rather $x_{ik}^* \leq w \leq e$ instead of $w = e$. However, it can be expected that individuals will profit from a utility gain due to an overcontribution with $x_{ik} > w$, in the same way they will suffer from a utility loss by an underprovision with $x_{ik} < w$. Following this, assuming $x_{ik}^* \leq w \leq e$ instead of $w = e$ would not change the general argument of our analysis.

However, note that by introducing z_{ik}, incentives to invest in the public good have changed. Even while assuming that (8) still holds, it might become individuals' dominant strategy to invest their full endowment, depending on the actual value of z_{ik}. We need to distinguish two cases:

Case 1: $z_{ik} < 1 - \frac{t}{m_k}$
By determining the symmetric Nash equilibrium from equation (11), we derive individuals' optimal investment strategy

$$x^*_{ik_1} = S\left(\frac{n - 1 + cn(m_k - 1)}{[nm_k]^2(1 - \frac{t}{m_k} - z_{ik})}\right). \tag{12}$$

Case 2: $z_{ik} \geq 1 - \frac{t}{m_k}$
In this case, it is the strict dominant strategy for individuals to invest their full endowment. Since the expected payoff by deviating from full cooperation is negative, we derive

$$x^*_{ik_2} = e. \tag{13}$$

Remark: In both cases we observe strictly higher investments in public goods with increased group identity compared to the case of low identity, as long as $z_{ik} > 0$. Notice that the higher the number of in-group members m_k, the greater needs to be either an individual's in-group attachment z_{ik} or the multiplier t for public goods to attract her for full cooperation, which constitutes the circumstance of increasing difficulties to sustain stable cooperations with increasing group size.
Since stable cooperation leads to higher expected payoffs, overall welfare also increases. We conclude that the higher the group attachments in a setting with multi-level interactions, the more cooperative individuals are expected to become and the higher the investments in public goods.

4. Experimental design

Within their groups, subjects play a standard public goods game while simultaneously competing for an external and commonly-known prize (contest). The prize is distributed among members of the winning group by either the egalitarian, $c = 0$, or the proportional profit-sharing rule, $c = 1$, with the probability of winning depending on all players' contributions to their public good. Payoffs are denominated in tokens, accumulated over periods and paid at the end of the experiment, where one token corresponds to EUR 0.01.
In each session, eight subjects participate and are allocated randomly into two groups of four persons, i.e. $n = 2$ and $m = 4$. The allocation remains constant over all ten periods, $T = 10$[7]. For reasons of comparison of low and high identity treatments we need to play a partners matching[8]. At the beginning of each round, subjects decide how much of their endowment,

[7]The group size of four as well as 10 rounds is commonly in public goods experiments(Zelmer, 2003).

[8]Gunnthorsdottir and Rapoport (2006) use 80-round strangers matching. Previous research indicates that partners matching compared to strangers matching increases the level of contribution (Keser and Van Winden, 2000).

$e = 50$, they want to invest in the public good. We set the maximum payoff from the public good to $g_k = 100$ to generate a marginal per capita return (MPCR) of 0.5.
The exogenous prize is determined by $S = 152$ (equal to Gunnthorsdottir and Rapoport, 2006) and awarded according to the contest success function (see (2)). Finally, after each round, subjects are informed about the prize-winning team, the underlying winning probabilities, their own payoff from the actual round, as well as how much they have earned over all periods played this far.
In *low identity* treatments, we allocate subjects randomly to either group 1 or group 2 without informing the subjects about the identity of their group members (minimal group identity). By contrast, in *high identity* treatments group identity is artificially increased above the minimal group identity by using a puzzle task (according to Eckel and Grossman, 2005)[9]. In detail, subjects participate in an unpaid team-building task prior to the experiment, in which they jointly have to construct a puzzle. Moreover, we also use a special labeling of group red and group green rather than group 1 and 2, as well as equipping subjects with color tags to wear on their clothes to present group affiliation. In the subsequent puzzle task, all subjects have to solve a colored puzzle, corresponding to their group color, in cooperation with their group members[10]. For this purpose, they are seated within their group, separated from the other group and are allowed to talk and support each other while solving the task. The groups had no information about the subsequent game to prohibit agreements or strategical planning.
The puzzle comprises five different pieces that add up to a square. However, since nobody possesses all five necessary pieces at the beginning, the subjects have to engage in trading with their group members. To enable comparison with *low identity* treatments, each subject there has to solve the same, but uncolored, puzzle task in separation and without knowing that they will play in groups in the subsequent experiment.
In all treatments, after the puzzle task was finished by each subject, the materials were collected, each of whom was placed alone in a cubicle and instructions for the subsequent task are distributed to the subjects. In addition, each cubicle was equipped with pen and paper for taking notes. After reading the instructions, all subjects had to pass a pre-experimental quiz to ensure their understanding of the instructions.
At the end of the experiment, the subjects had to complete a questionnaire. Besides general socioeconomic questions, we asked for individuals' in-group attachment. Subjects reported their degree of in-group attachment on a scale between 1 and 10, with higher scores representing stronger in-group attachment (Chen and Li, 2009)[11].

[9] Eckel and Grossman (2005) tested six different treatments to analyze the impact of team identity on team production, namely a baseline procedure, team color treatment, quiz treatment, puzzle treatment, wage treatment and tournament treatment. The puzzle task is the method of choice given that it leads to the highest level of contribution.

[10] For detailed instructions, see Appendix.

[11] On a scale from 1 (=absolutely not) to 10 (=extremely), how strong was your in-group attachment?

4.1. Treatment conditions

We employ four different experimental treatment conditions that differ in terms of group identity and prize-sharing mechanism.[12]

***Low ID EG*:** Subjects solve the puzzle task in separation and are subsequently randomly allocated to group 1 or group 2. The prize is distributed equally among the winning team's members, i.e. $c = 0$.

***Low ID PR*:** Subjects solve the puzzle task in separation and are subsequently randomly allocated to group 1 or group 2. The prize is distributed proportionally among the winning team's members, i.e. $c = 1$.

***High ID EG*:** Subjects are allocated to group green or group red and solve the puzzle task in cooperation with their team members. Communication is possible during the puzzle task. The prize is distributed equally among the winning team's members, i.e. $c = 0$.

***High ID PR*:** Subjects are allocated to group green or group red and solve the puzzle task in cooperation with their team members. Communication is possible during the puzzle task. The prize is distributed proportionally among the winning team's members, i.e. $c = 1$.

Table 1 briefly summarizes the game parameters and Nash equilibria for all four treatments.

Table 1: Experimental conditions and game parameter

	Group size	No of Sessions	Endowment	Size of Public Good g_k	Rounds	Prize	High Identity	Nash Equilibrium
Low ID EG	4	10	50	100	10	152	0	4.75
Low ID PR	4	10	50	100	10	152	0	33.25
High ID EG	4	10	50	100	10	152	1	> 4.75
High ID PR	4	10	50	100	10	152	1	> 33.25

Note: High identity is coded as a dummy: 0 = artificial group identity is **not** increased, 1 = artificial group identity **is** increased.

4.2. Hypotheses

In order to predict subjects' cooperative behavior we insert our experimental parameters to our theoretical framework. By taking individuals' group identity into consideration, we expect higher investments in public goods with increased identity, meaning higher values of z_{ik}. According to the literature as well as the theoretical framework, individuals' behavior in social dilemmas is not purely driven by self-interest, with people being rather altruistic and conditional cooperators when they are part of a group and perceive themselves as a part

[12] Abbreviations are to read as follows: Low identity is abbreviated as *Low ID* and high identity as *High ID*. If the prize is shared equally the index is *EG* and in case of proportional profit sharing it is *PR*.

of it. We assume that these effects will increase when group identity is made more salient, thus by intergroup competition and communication. We expect higher rates of cooperation in high identity treatments.

Hypothesis 1: Investments in public goods are higher with increased group identity.

As outlined by the theoretical framework, individuals adjust their investment behavior according to the prize-sharing mechanism, with a higher investment leading to a higher value of c. We expect subjects to invest more in public goods under the proportional sharing rule, $c = 1$, than under the egalitarian sharing-rule, $c = 0$.

Hypothesis 2: Investments in public goods are higher under the proportional than under the egalitarian profit sharing rule.

Based on the theory, if z_{ik} exceeds the value of $1 - \frac{t}{m_k}$, full cooperation becomes the dominant strategy. By increasing group identity, more individuals are expected to become full cooperators, defined as individuals who invest their entire endowment, $e = 50$ tokens, in each round.

Hypothesis 3: The number of full cooperators increases with increased group identity.

4.3. Experimental procedure

The experiment was conducted between May and July 2016 in the Laboratory for Behavioral Economics at the University of Goettingen. The experiment was programmed using zTree (Fischbacher, 2007). Participants were recruited with ORSEE (Greiner, 2004). We implemented a 2 x 2 design, crossing the dimensions IdentitynoIdentity and egalitarian profit sharingproportional profit sharing. Before the start of the main task, subjects went through a puzzle task either alone (no identity) or as a team (identity). 320 subjects participated in 40 sessions, which lasted about 45 minutes, with average earnings of EUR 11.17. Approximately 53% of the participants were female[13]. Overall participants were 24 years old[14] and roughly 41% of the participants are economics or business administration students[15].

5. Results and discussion

In the following section, we investigate how subjects willingness to cooperate is affected by (I) their group identity and (II) the applied profit-sharing rule. Furthermore (III), we analyze the interplay of identity and full cooperation. We start by reporting the data overview and

[13]Participants played in mixed groups. We find no differences for gender.

[14]We find no effect of age on the level of contribution. When interpreting such age effects we need to keep in mind that they might be due to different social conditions of the cohorts in other studies.

[15]Economic students are assumed to behave more rational. We find that economic students, ceteris paribus, contribute less than students from other fields. But, this effect is driven by the behavior in the low identity sub-sample. Here, economics students cooperate significantly less than those from other disciplines, while this effect is not observable in the high identity treatment. This indicates that the social incentive is stronger than the monetary incentive and that it outweighs a fully rational behavior.

summary statistics, followed by non-parametric and parametric tests. The main interest behind our experiment is the individual behavior, which cannot be depicted by averages. Given the panel structure of the data (320 individuals played in groups of eight over 10 rounds in 40 sessions), the main part of the analysis will be the regression analysis. A simple way of regression is just to control for clustered standard errors. A superior way is to treat the data set as a panel data set, which *"explicitly recognizes that n subjects are observed making a decision in each of T time periods"* (Moffatt, 2015, p. 90). Accordingly, for a more detailed view of how contributions are affected by identity and profit-sharing rules, we apply tobit panel models including the typical control variables.

5.1. Analyzing the effects of low vs. high identity

First, we study the effects of increased group identity on the level of contribution, comparing low and high identity treatments. We find significant differences between the mean contribution. On average, individuals mean contributions in low identity treatments are $\bar{x}_{\text{Low ID}} = 40.55$ tokens in contrast to $\bar{x}_{\text{High ID}} = 43.51$ tokens in high identity treatments (see Table 2). Overall, differences between low and high identity treatments on group level are significant at a 5% level (Mann-Whitney-U[16]: $z = -2.056, p = 0.0398$).

Table 2: Summary statistics

	Low ID	**Low ID EG**	**Low ID PR**	**High ID**	**High ID EG**	**High ID PR**
Mean contribution	40.55	39.27	41.83	43.51	44.38	42.64
SD	10.77	10.57	10.88	9.83	9.73	9.91
25%-quantile	35	32.8	39.7	41.2	43.25	40.6
50%-quantile	44.75	40.75	46.85	48	49.85	45.5
N	160	80	80	160	80	80

Note: Table 1 displays statistics of individuals decisions, therefore$N$ denotes the number of individuals participated in each treatment.

These findings are in line with previous research indicating that identity (Chen and Li, 2009; Eckel and Grossman, 2005) as well as between-group competition (Gunnthorsdottir and Rapoport, 2006) positively influences the level of contribution. Our results show that even the pure introduction of competition leads to significantly higher contributions (one-sample t-test: $t_{\text{Low ID EG}}(79) = 29.205, p_{\text{Low ID EG}} = 0.0000$ and $t_{\text{Low ID PR}}(79) = 7.058, p_{\text{Low ID PR}} = 0.0000$) than the predicted Nash equilibrium[17] (see Table 3).

The boxplot (Figure 1) displays distributional details for low and high identity treatments in general, with both differentiated as well by profit-sharing rules.
Additionally, we plot investments over all ten rounds to analyze whether the observed pattern is driven by individual behavior in one or particular rounds.
The positive effect of high group identity can be found for all ten rounds (see Figure 2 and Table 2). Overall and in each single round, investments are higher in the high identity

[16]We use independent observations (group level) for the Mann-Whitney-U test.
[17]Mean values are tested against the Nash equilibrium of 4.75 for LOW ID EG and 33.25 for LOW ID PR.

Figure 1: Contributions to the public goods game - low and high identity

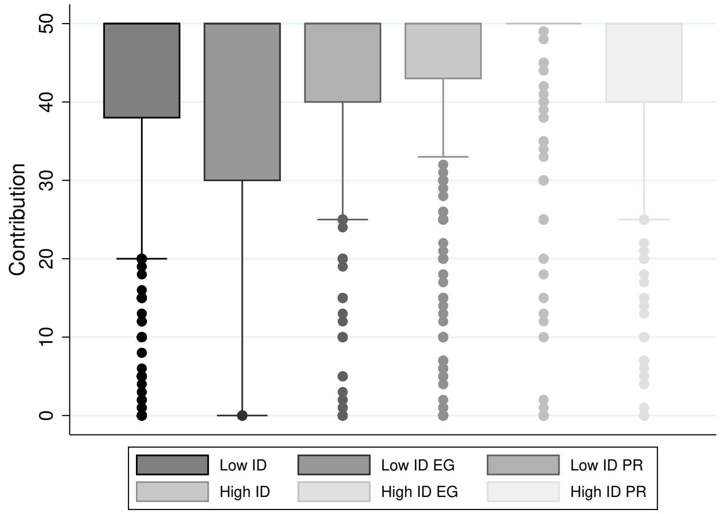
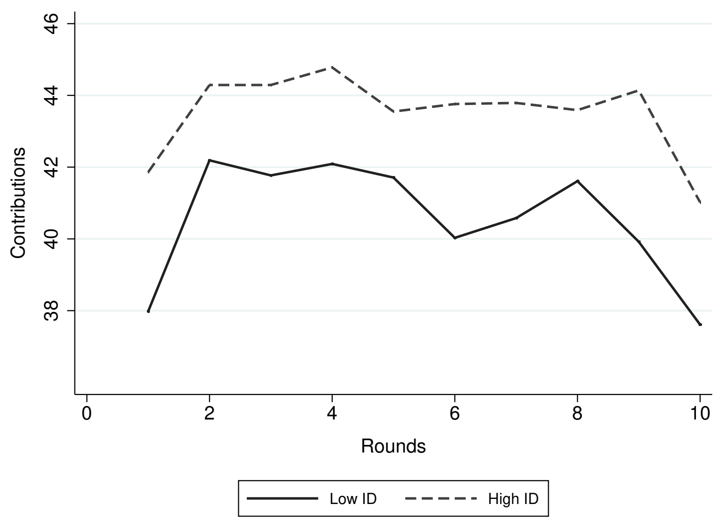


Figure 2: Investments - low and high identity per round



treatment. Contributions in low as well as high identity treatments increase from round one ($\bar{x}_{\text{Low ID}} = 37.98, \bar{x}_{\text{High ID}} = 41.86$) to two ($\bar{x}_{\text{Low ID}} = 42.19, \bar{x}_{\text{High ID}} = 44.29$). A paired t-test reveals that the difference is significant at the 1%level ($t_{\text{Low ID}}(159) = -4.332, p_{\text{Low ID}} = 0.0000$ and $t_{\text{High ID}}(159) = -3.364, p_{\text{High ID}} = 0.0005$) (See Appendix for details.)[18].

In sum, variations of investments are lower under the high identity treatments. This indicates that identity can sustain cooperation and increase the level of contribution. Contrary to previous findings of public goods games, we find that contributions are almost stable

[18]Furthermore, in both treatments we observe a significant end-game effect from round nine to ten (paired t-test: $t_{\text{Low ID}}(159) = 2.101, p_{\text{Low ID}} = 0.0186$ and $t_{\text{High ID}}(159) = 2.976, p_{\text{High ID}} = 0.0017$).

over time in the high identity treatment. Our results suggest that free-riding-reducing incentives, namely increased group identity and competition for monetary rewards, shift the focus from pure selfish interests to welfare maximizing considerations. Subjects only sometimes contribute 0 and the number of these actions on group level is significantly higher in the low identity treatment compared with the high identity treatment (Mann-Whitney-U: $z = -11.662, p = 0.0000$). However, we find no individual full free-riding ($\hat{=}$ contribution of 0) over all ten rounds.

Our results are similar to the findings of Eckel and Grossman (2005), indicating that increased group identity leads to increasing contributions from the first round to the second and relatively stable contributions until the end-game effect kicks in.

We only have ten independent observations per treatment given our data structure (group-level), whereby the power of the non-parametric tests is limited. For a more nuanced view of how contributions are affected by identity, it is helpful to simultaneously control for several variables such as profit-sharing rule, age, gender and pre-experimental experience while using tobit panel models[19], treating our dataset as a panel data set. Table 3 displays the results of these estimations. Accordingly, we estimate different models: first, we introduce step-wise the main interesting variables (whole data set). The analysis of sub-samples offers a more detailed insight into the data, thus secondly, we estimate three models for each subsample (low and high identity), while step-wise including the main interesting and control variables.

[19]We use these censored regression models given our data structure. Our dependent variable is the level of contribution. It is a non-negative integer and it is in the range from 0 to 50.

Table 3: Regression results

	Full model						Sub-sample: low identity			Sub-sample: high identity		
	(1a)	**(1b)**	**(1c)**	**(1d)**	**(1e)**	**(1f)**	**(2a)**	**(2b)**	**(2c)**	**(3a)**	**(3b)**	**(3c)**
High Identity	13.417***		13.5***	4.553	1.850	−0.162						
	(3.537)		(3.54)	(4.861)	(4.551)	(3.775)						
Egalitarian PSR		2.261	2.596	−6.205	−7.867	−4.684	−7.067	−8.593**	−5.109	11.681**	9.166*	8.141**
		(3.561)	(3.491)	(4.813)	(4.494)	(3.748)	(4.489)	(4.265)	(3.566)	(5.400)	(4.942)	(4.133)
*High Identity * Egalitarian PSR*				18.257**	17.920**	13.403*						
				(6.982)	(6.523)	(5.479)						
Attachment					3.681***	2.620***		2.984***	2.025***		4.590***	3.394***
					(0.580)	(0.495)		(0.738)	(0.627)		(0.904)	(0.770)
Investment own group in t-1						0.367***			0.374***			0.362***
						(0.028)			(0.036)			(0.044)
Prize won in t-1						9.691***			8.713***			12.096***
						(2.333)			(3.065)			(3.687)
Profit in t-1						−0.345***			−0.319***			−0.409***
						(0.056)			(0.071)			(0.093)
Female	−4.466	−4.991	−4.55	−3.687	−3.362	−3.089	−0.297	0.716	0.097	−7.847	−8.435*	−6.802
	(3.516)	(3.590)	(3.519)	(3.499)	(3.267)	(2.726)	(4.552)	(4.309)	(3.584)	(5.479)	(5.006)	(4.163)
Economics	−7.919*	−6.962	−7.841**	−8.589*	−9.202**	−7.695**	−11.489**	−12.308***	−10.345***	−5.778	−6.110	−4.785
	(3.566)	(3.632)	(3.569)	(3.547)	(3.318)	(2.771)	(4.604)	(4.363)	(3.637)	(5.412)	(4.951)	(4.105)
Experimental experience	1.304*	1.075*	1.323**	1.264*	1.21*	0.762	1.226*	1.129*	0.792	1.476*	1.495**	0.878
	(0.522)	(0.529)	(0.523)	(0.519)	(0.485)	(0.405)	(0.688)	(0.652)	(0.546)	(0.791)	(0.724)	(0.601)
Age	−0.391	−0.235	−0.419	−0.436	−0.401	−0.344	−0.646	−0.398	−0.319	−0.133	−0.347	−0.295
	(0.562)	(0.572)	(0.563)	(0.557)	(0.521)	(0.434)	(0.780)	(0.739)	(0.613)	(0.799)	(0.731)	(0.606)
Constant	65.566***	68.426***	64.833***	69.762***	49.733***	27.9*	74.687***	53.272***	26.494*	66.976***	44.685**	28.659*
	(13.060)	(13.324)	(13.1)	(13.099)	(12.619)	(11.302)	(17.907)	(17.659)	(15.716)	(18.804)	(17.746)	(15.960)
Obs	3200	3200	3200	3200	3200	2880	1600	1600	1440	1600	1600	1440
σ_u	28.346***	29.046***	28.35***	28.014***	25.848***	20.605***	25.588***	23.975***	18.930***	30.354***	27.232***	21.583***
	(1.657)	(1.697)	(1.657)	(1.638)	(1.528)	(1.423)	(2.015)	(1.914)	(1.829)	(2.666)	(2.415)	(2.182)
σ_e	21.274***	21.272***	21.275***	21.275***	21.235***	20.350***	22.178***	22.137***	21.318***	20.070***	20.033***	19.068***
	(0.542)	(0.542)	(0.542)	(0.542)	(0.540)	(0.559)	(0.750)	(0.748)	(0.779)	(0.779)	(0.777)	(0.796)
ρ	0.64	0.651	0.64	0.634	0.597	0.506	0.571	0.540	0.441	0.696	0.649	0.562
AIC	11583.26	11597.18	11584.71	11579.91	11542.81	9854.368	6609.1	6595.235	5609.86	4972.839	4949.933	4251.518
BIC	11631.82	11645.75	11639.35	11640.62	11609.59	9937.886	6652.122	6643.635	5673.129	5015.861	4998.333	4314.786

Tobit panel model with 0 for lower limit and 50 for upper limit. Estimations for whole sample (1a-f) and sub-samples(2a-c and 3a-c).Dependent Variable: Level of contribution to group's own public good. Standard errors in parentheses: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

When taking a closer look at the regression table (see Table 3), the positive impact of increased group identity on cooperative behavior is confirmed, whereby the coefficient is positive and highly significant. Going a step further, we interact high identity with the egalitarian profit sharing rule. Model 1d-1f indicate that the effect is mainly driven by the profit sharing rule. Egalitarian profit sharing is a mechanism which treats all individuals in the same way. Separating the data into two subsamples indicates that the egalitarian profit sharing rule has a negative impact in the low identity treatment while its impact in the high identity treatment is positive. Our results indicate that artificially increased group identity in the laboratory triggers cooperative behavior, with the strongest effect under the egalitarian profit sharing rule. It seems that increasing group identity leads individuals to feel that he or she should put more weight on the welfare of other in-group members.[20]

These results are mirrored when focusing more narrowly on the perceived level of group attachment. This step is made because group identity is associated with group attachment (Chen and Li, 2009), which is a basis for social identity. We asked the participants to value the strength of their in-group attachment. The coefficient of the group attachment variable is positive and highly significant in all models, while the effect is higher for high identity treatments. This indicates that higher perceived in-group attachment triggers higher contributions. Our results are in line with the findings of Chen and Li (2009), showing a positive effect of in-group attachment.

Result 1: Contributions to public goods are significantly higher with increased group identity.

5.2. Prize sharing mechanism

Differentiating the low identity condition by profit-sharing rules (Table 2), we find a lower mean value on group level with $\bar{x}_{\text{Low ID EG}} = 39.27$ for egalitarian profit-sharing compared to the proportional profit-sharing with $\bar{x}_{\text{Low ID PR}} = 41.83$ (Mann-Whitney-U: $z = 1.209, p = 0.2265$). The MWU Test is thus insignificant and indicates no difference between the profit-sharing rules in the low identity treatment[21]. Comparing our results to the expected equilibrium contributions (see Table 1) shows that in contrast to our assumptions, under both profit-sharing rules higher average contributions are realized in the low identity treatments. Possible explanations for these high contributions, compared to the usual values in public goods games, are that we use a partners matching and that we introduce a contest. Even without any artificial increased group identity, the group competes for an exogenous prize against another group. Partners matching as well as contests are mechanisms which lead to an increase of cooperative behavior (Keser and Van Winden, 2000).

[20]This is in line with findings of e.g. Chen and Li (2009); Solow and Kirkwood (2002); Kagel and Roth (2016). Already Gaertner et al. (1993) showed that it is possible to induce group identity by manipulating seemingly irrelevant variables. The puzzle task is a team-building task which leads to higher cooperative behavior, as previously shown by Eckel and Grossman (2005).

[21]If cooperative behavior is rewarded, cooperation is a rational strategy. The results of Gunnthorsdottir and Rapoport (2006) indicate that proportional rewarding looms larger than equal rewarding, which can be explained by the non-satiation axiom of choice theory. Thus, our results are in contrast to their findings, indicating only small differences between the profit sharing rules.

Figure 3: Investments - low identity per round

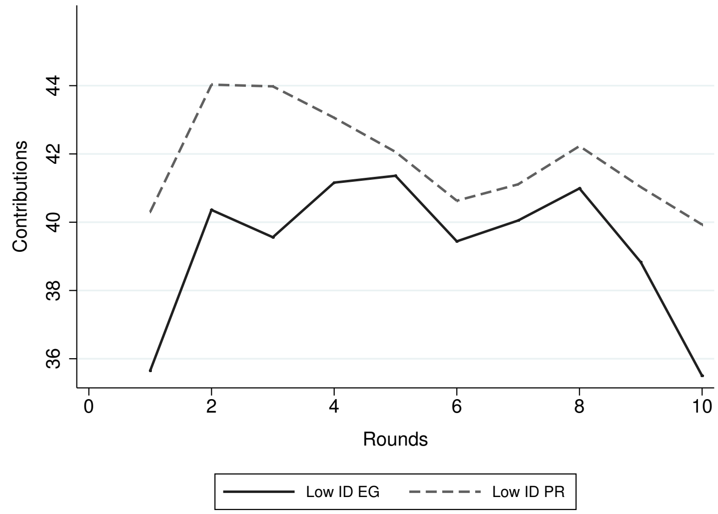
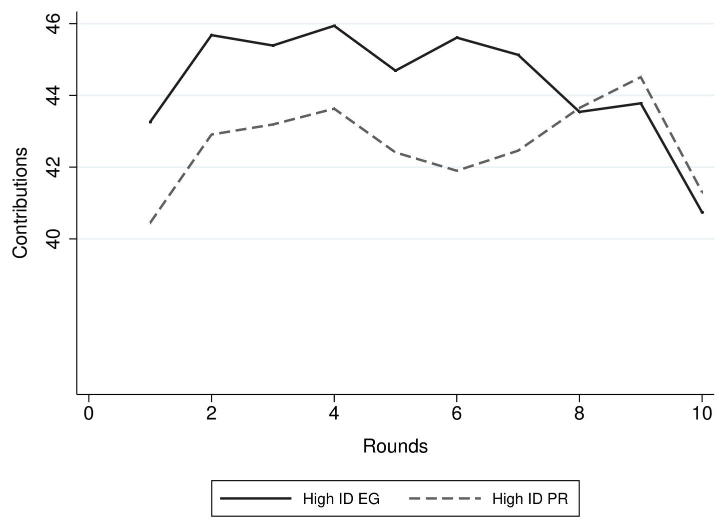


Figure 4: Investments - high identity per round



In high identity treatments, the mean contributions for both profit-sharing rules contradict hypothesis 3 as they show an opposite pattern in comparison to low identity treatments (Table 2). The contribution under the egalitarian profit-sharing rule on group level shows a higher mean value with $\bar{x}_{\text{High ID EG}} = 44.38$ tokens, compared to proportional profit sharing with a mean value of $\bar{x}_{\text{High ID PR}} = 42.64$ tokens (Mann-Whitney-U: $z = -1.436, p = 0.1509$). The MWU test is insignificant and indicates no difference between the profit-sharing rules in the high identity treatment. Nevertheless, the contribution is slightly higher under the egalitarian profit sharing rule. This particular result is in contrast to the findings of Gunnthorsdottir and Rapoport (2006), and a first, careful interpretation might be that identity is the reason for the reverse effect of the profit sharing rules in the high identity treatment.
Given the limited number of independent observations, the power of our non-parametric

tests is limited. Taking a closer look at our regression results (Table 3), we find support for our hypotheses that both profit-sharing rules impact on the level of contribution, albeit in different ways. Overall, there is no effect of the profit-sharing rule (1a-1f). Dividing the sample into the two sub-samples confirms what was already observable in the tendencies of the descriptive (non-significant) results. While we find no effect in the main (full) model (1f), this might be due to the circumstances that they offset each other. Analyzing the sub-samples indicates that the egalitarian profit sharing rule has a strong negative effect in the low identity treatment (2a-2c), while the effect is positive and significant in the high identity treatment (3a-3c). This indicates that the social incentive is stronger than the monetary incentive[22], which could be an explanation for higher mean contributions in the high identity treatment with equal prize sharing. Our findings for the low identity treatment, that proportional sharing is favored, are in line with those of Gunnthorsdottir and Rapoport (2006).

Result 2: Egalitarian and proportional profit sharing differ in their impact on individuals willingness to contribute. Contributions are higher under the proportional profit sharing rule in low identity treatments. Increasing identity leads to a reverse result. In high identity treatments contributions are higher under the egalitarian profit-sharing rule.

These findings are surprising upon first glance. As outlined by the theoretical framework and the complemented basic experiment (Gunnthorsdottir and Rapoport, 2006), we expected investments in public goods to be higher under the proportional rather than the egalitarian profit-sharing rule, given their different monetary incentives (Kugler et al., 2010).
There might be a plausible explanation for these findings. The egalitarian profit-sharing rule can be described as a more *social* sharing rule, given that all group members profit equally from a prize won. By contrast, the proportional profit-sharing rule is more related to rational economic behavior, since in this case individuals receive a higher expected payoff from investing in public goods, which should lead to higher equilibria contributions. While in low identity treatments these monetary incentives could outweigh social considerations, in high identity treatments individuals are primed to pro-social behavior due to the preceding team-building task, thus they might be more receptive for the influence of egalitarian sharing, which reverses the possible effects of the profit-sharing rules. Our results indicate that identity has a positive impact on the contribution level. Therefore, it might not be so surprising that subjects behave in a more social manner in the high identity treatments. Explanations in line with this argumentation are e.g. in-group attachment (Chen and Li, 2009), fairness preferences (Fehr and Gächter, 2000) and social preferences (Fischbacher and Gächter, 2010). Chen and Li (2009) show that individuals' distribution preferences are affected by their degree of group attachment, with subjects being more generous and less envious to-

[22]Additionally, having a closer look at the low identity treatment shows that the number of fully non-cooperative decisions per round (contribution$\hat{=}$ 0) in the low identity treatment is significantly higher under the equal profit sharing (6.5%) compared to the proportional (4.125%) profit-sharing rule (Mann-Whitney-U: $z = 9.165, p = 0.0000$ and see, Appendix Table 4). Analyzing this for the high identity treatment shows that the number of fully non-cooperative decisions per round (contribution$\hat{=}$ 0) in the high identity treatment is again significantly higher under the equal profit sharing (4.5%) compared to proportional (2%) profit sharing rule (Mann-Whitney-U: $z = 7.141, p = 0.0000$ and see, Appendix Table 4).

wards their in-group members. Moreover, group attachment changes reciprocal behavior as good intentions are more often positively rewarded and misbehavior less often rewarded towards in-group matches in comparison to out-group matches. Our group-attachment variable (Table 3) is positive and highly significant, giving support to this assumption. In addition, Fischbacher and Gächter (2010) show that social preferences can sustain cooperation. Nevertheless, contributions decline because people in general are imperfect conditional cooperators. Fehr and Schmidt (1999) argue that fairness can also be interpreted as self-centered inequity aversion. According to their model, we could assume that sharing the prize equally among group members reduces inequity, while a proportionally shared prize enhances inequity; even though cooperative behavior is more rewarded under the proportional prize sharing mechanism. Furthermore, we could assume that increased group identity, especially the way we increased it, i.e. meeting group members in person and successfully conducting a group task, ascribes more importance towards inequity aversion among group members.

5.3. Group identity and full cooperation

As derived by theory, if z_{ik} exceeds or equals the critical value of $1 - \frac{t}{m_k}$, full cooperation becomes the dominant strategy. Overall, 100 out of 320 individuals are full cooperators, with 36 full cooperators in low identity treatments and 64 in high identity treatments. In absolute terms, the number of full cooperators is significantly higher (Mann-Whitney-U: $z = -9.950, p = 0.0000$) with increased group identity.
Result 3: The number of full cooperators is significantly higher in high identity treatment.

6. Summary and concluding remarks

We explored experimentally how increased group identity impacts individuals' willingness to cooperate in a contest setting in the present paper. For this purpose, we played a public goods game with two groups competing for an exogenous price and introduced artificial group identity by using a puzzle task. We used a standard 2x2 design with partners matching by varying the level of group identity as well as added a contest with an exogenous and commonly-known prize (either egalitarian or proportional).
Our results show that first, investments in public goods increase with increased group identity and subjects' willingness to cooperate increases through artificially increased group identity in a contest setting. Secondly, we had thought that investments in public goods are higher under the proportional than under the egalitarian profit sharing rule. This can be confirmed for the low identity treatments. Subjects invest less in public goods under the egalitarian sharing rule than under the proportional one. The effect is reverse in high identity treatments as subjects contribute significantly more to the public good under the egalitarian profit-sharing rule. This finding is astonishing as it contradicts previous findings indicating a stronger effect of the proportional profit sharing rule. Possible explanations for this finding could be e.g. inequity aversion (Fehr and Schmidt, 1999). The third point we assumed was that the number of full cooperators increases with increased group identity. Looking at the varying prize-sharing mechanisms shows that the number of subjects who fully cooperate is significantly higher when group identity is artificially increased.

Our findings contribute to a better understanding of group behavior and the role of identity in a contest setting. Summing up all results shows that cooperative behavior can be described by, at least, three factors: first, increasing group identity and perceived in-group attachment impact positively and significantly on the willingness to cooperate; second, contest situations (e.g. external monetary incentives, even if they are not certain) increase cooperation. And third, history, or to be more precise, the previous rounds, matter, especially if group members experience a positive event within their group, like winning the prize or the high investment of group members.

Appendix A: Tables

Table 4: Free-riding per treatment and round

	Rounds										
	1	2	3	4	5	6	7	8	9	10	Total
Low ID EG	3	4	4	4	4	6	3	3	8	13	52 out of 80
Low ID PR	0	0	1	1	4	5	4	3	7	8	33 out of 80
High ID EG	2	1	2	2	4	3	3	5	5	9	36 out of 80
High ID PR	0	0	1	0	3	4	2	1	0	5	16 out of 80
Total	5	5	8	7	15	18	12	12	20	35	137 out of 320

Table 5: Mean individual contribution per round and treatment

	Low ID		**Low ID EG**		**Low ID PR**		**High ID**		**High ID EG**		**High ID PR**	
Round	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1	37.98	14.57	35.65	15.91	40.3	12.78	41.86	13.14	43.28	12.36	40.45	13.81
2	42.19	12.62	40.36	14.50	44.03	10.17	44.29	11.1	45.68	9.92	42.91	12.06
3	41.77	13.2	39.56	14.98	43.98	10.8	44.29	11.51	45.39	11.34	43.19	11.65
4	42.09	13.17	41.13	14.12	43.06	12.15	44.78	10.24	45.94	10.05	43.63	10.35
5	41.71	14.26	41.36	14.45	42.06	14.15	43.55	13.25	44.69	12.59	42.41	13.87
6	40.03	16.08	39.44	16.1	40.63	16.14	43.76	12.92	45.61	11.6	41.9	13.95
7	40.58	14.37	40.05	14.23	41.11	14.58	43.79	13.03	45.13	12.05	42.46	13.89
8	41.61	14.4	40.99	14.27	42.23	14.59	43.59	13.32	43.54	14.82	43.65	11.72
9	39.93	17.31	38.83	17.12	41.02	17.53	44.14	12.44	43.78	14.2	44.51	10.47
10	37.61	18.58	35.3	19.54	39.92	17.38	41.02	16.12	40.74	16.82	41.3	15.48
Mean	40.55	10.77	39.27	10.57	41.83	10.88	43.51	9.83	44.38	9.73	42.64	9.91
N	160		80		80		160		80		80	

Appendix B - Instructions

Puzzle instructions (Task 1)

All instructions were originally written in German and are available upon request. The puzzling instructions for low identity treatments were included in zTree and participants received envelopes containing the puzzle while being seated at computers. The puzzling instructions for high identity treatments were printed and laid out on tables where all members of a group were seated to solve the task together. The participants did not receive any information about what kind of treatment they played.

Instructions for the first task (in low identity treatments)

Your task in the 1*st* part is to form a **square**.
The following rules must be obeyed during the course of this exercise:

1. Open the envelope and take out the pieces of the puzzle.
2. You have 5 different pieces; each piece exists only once.
3. You have to puzzle until you solve it.
4. The puzzles have a gray top side and a white bottom side. The gray side must always face upwards.
5. When you have solved the puzzle, please click the "next" button and wait for further instructions.

Instructions for the first task (in high identity treatments)

The task of your team in the 1*st* part is to form five squares of equal size. The task will not be complete until each team member has before him/her a perfect square of the same size as that held by all other team members.
The following rules must be obeyed during the course of this exercise:

1. Open the envelope and take out the pieces of the puzzle.
2. In the beginning, each of you has 5 different pieces.
3. You have to exchange and puzzle together with your group members until each of you has solved his/her puzzle.
4. The puzzles have a colored top side and a white bottom side. The colored side must always face upwards.
5. There are 5 different pieces and each piece exists 4 times. Each player needs one piece of each kind to solve his/her puzzle.
6. You may not simply throw pieces into the center for others to take; you must give the piece directly to one other team member. Team members may give pieces to other team members but may not take pieces from other team members.
7. When all group members have completed their puzzle, you are allowed to talk about whatever you want. Please remain seated and wait for further instructions. You do not need to give any signal to the adviser.

Experimental Instructions (Task 2)

Depending on the treatment, subjects received different instructions: T1: low identity treatment, T2: high identity treatment; a: egalitarian profit-sharing rule, b: proportional profit-sharing rule.

Instructions for the second task
You are about to participate in an experiment in which two groups (á 4 players) play for winning a lottery (in each round). 10 rounds will be played with an identical course. [T1: At the beginning, you will be allocated randomly to either group 1 or group 2] [T2: You play in group red/green]. Within the experiment, there are two types of interaction:

1. *The within-group interaction* and
2. *The between-group interaction.*

Both types of interaction are compensated. Therefore, your final payoff depends on your decisions, your group members' decisions and the decisions of the other group's members.

The course for each round in brief:

1. Each player receives an endowment of **50 tokens**.
2. Each player decides how many tokens of his/her endowment he/she wants to provide for his/her group's project. It is possible to provide any integer amount between 0 and 50 tokens. These tokens of the endowment that are not provided will be kept for oneself.
3. The tokens provided by all players of a group generate the **group project**. Each of the two groups generate an independent group project. The number of tokens provided to one's group project are **doubled** and **distributed equally** among all group members.
4. Both groups play to win a lottery. The probability of winning the lottery depends on the total sizes of the group projects of both groups. The **larger** one's own group project **the more likely** it is to win the prize.
5. At the end of each round, you will receive a summary of the results.

General information

- All decisions during the experiment are anonymous. You will not receive any information on the individual decisions of the other players at any point of time.
- Earned tokens will be rounded to the nearest integer number.
- At the end of the game, tokens earned will be converted into euros and paid out (1 token = EUR 0.01).

(1) Within-group interaction
In every round, a group project is generated based on the group members provided tokens. The sum of tokens provided by all group members equals the value of this group's project. **At the end of every round, the value of the group project is multiplied by 2 and distributed equally among all 4 group members**. Tokens not provided to the group project move directly into one's payoff.

For each player, the payoff from the *the within-group interaction* is, consequently, based on the retained tokens (first square bracket) and the payoff from the group project (second square bracket).

$$\text{Payoff from the } \textit{the within-group interaction} =$$
$$[\text{Endowment of 50 tokens} - \text{Tokens provided for group project}] + [\frac{\text{Value group project} * 2}{4 \ \text{ players}}]$$

Examples

- If all group members retain their entire endowment for themselves, each member receives a payout of 50 tokens in this round from *the within-group interaction* (50 tokens from the private account; 0 tokens from the group project) $\rightarrow \frac{4*0 \text{ tokens } *2}{4 \, players} = 0$ tokens $/player$.
- If all group members provide their entire endowment to the group project, each member will receive a payout of 100 tokens in this round from *the within-group interaction* (0 tokens from the private account; 100 tokens from the group project) $\rightarrow \frac{4*50 \text{ tokens } *2}{4 \, players} = 100$ tokens$/player$.

(2) Between-group interaction (lottery)
In every round, your group plays against the other group to win a lottery. It is only possible for either your group or the other group to win. The payoff amounts to 152 tokens. The winning group is determined by the probability displayed below. This implies that no group can be certain to win the prize, even if it has a higher probability of winning than the other group. However, the probability of one group winning can be influenced by the number of tokens provided to the group project. **The larger one's own group project compared to the other group's project, the higher the probability of one's own group winning the lottery in this round**.

$$\text{Probability of your group winning the lottery} =$$
$$\frac{\text{Value your group's project}}{\text{Value of your group's project} + \text{Value of the other group's project}}$$

Example
Assume that group 1 provides 100 tokens to their group project and group 2 provides 200 tokens to their group project, then. . .
- the probability of group 1 winning the prize is $\frac{100}{100+200} = 33\%$;
- the probability of group 2 winning the prize is $\frac{200}{100+200} = 66\%$.

Distribution of the lottery payoff (in case your group has won)
If your group has won the prize, the payoff of 152 tokens is distributed [T1a,T2a: equally among all members of your group. In this case, each member of your group receives

$$38 \text{ tokens } \left(= \frac{152}{4}\right)]$$

[T1b, T2b: proportionally among all your group's members according to individuals' provisions to the group project. Therefore, your share of the lottery payoff depends on the number of tokens that you provided to the group project, as well as the number of tokens provided to the group project by your group members]

Example:
Player 1 provides 40 tokens to the group project. His/her group members provide 20 tokens each. Consequently, the group project has a value of 100 tokens. Assume, that this group wins the lottery, then the lottery payoff is distributed as follows: player 1 receives a share of 61 tokens from the lottery prize (152 tokens $*\left(\frac{40}{100}\right) = 60,8 =$ **61 tokens**) and her group members receive 30 tokens each (152 tokens $*\left(\frac{20}{100}\right) = 30,4 =$ **30 tokens**).]

In case your group does not win the lottery, you will receive any payoff from *the between-group interaction*.

Information about total payoff per round
In each round, your total payoff comprises the payoff from *the within-group interaction* as well as of the payoff from *the between-group interaction* (lottery).

Appendix C: Derivations

For simplification, we use $\sum_{i=1}^{m_k} x_{ik}^c = \sum x_{ik}^c$.

$$\begin{aligned}
\frac{\delta\pi_{ik}^e}{\delta x_{ik}} &= \frac{t}{m_k} - 1 + S\left(\frac{x_{ik}^c(X - X_k)}{X^2\sum x_{ik}^c} + \frac{cX_k(x_{ik}^{c-1}(\sum x_{ik}^c) - x_{ik}^c(\sum x_{ik}^{c-1}))}{X\sum x_{ik}^{2c}}\right)\\
&= \frac{t}{m_k} - 1 + S\left(\frac{x_{ik}(X - X_k}{X^2\sum x_{ik}^c} + \frac{cX_k(x_{ik}^{c-1}(\sum x_{ik}^c) - x_{ik}^c(\sum x_{ik}^{c-1}))}{X\sum x_{ik}^{2c}}\right)\\
&= \frac{t}{m_k} - 1 + S\left(\frac{x_{ik}^c(\sum x_{ik}^c)(X - X_k) + cXX_k(x_{ik}^{c-1}(\sum x_{ik}^c) - x_{ik}^c(\sum x_{ik}^{c-1}))}{X^2\sum x_{ik}^{2c}}\right).
\end{aligned}$$

Assuming symmetric players gives $x_{ik} = x_i$, $X_k = m_k x_i$, and $X = nm_k x_i$ and changes the former equation to

$$\begin{aligned}
&= \frac{t}{m_k} - 1 + Sx_i^c\left(\frac{m_k x_i^c[(n-1)m_k x_i] + cn(m_k x_i)^2(x_i^{-1}m_k x_i^c - x_i^{c-1})}{(nm_k x_i)^2[m_k]^2 x_i^{2c}}\right)\\
&= \frac{t}{m_k} - 1 + Sx_i^c\left(\frac{[m_k]^2 x_i^{c+1}(n-1) + cn(m_k x_i)^2 x_i^{c-1}(m_k - 1)}{[nm_k]^2[m_k]^2 x_i^{2+2c}}\right)\\
&= \frac{t}{m_k} - 1 + S\left(\frac{n - 1 + cn(m_k - 1)}{[nm_k]^2 x_i}\right).
\end{aligned}$$

Finally, solving for x_i gives

$$x_{ik}^* = S\left(\frac{n - 1 + cn(m_k - 1)}{[nm_k]^2(1 - \frac{t}{m_k})}\right).$$

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